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Decision-making governance for purchases of solar photovoltaic systems in Japan☆

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ABSTRACT

In this study, we analyze the factors that affecting purchasing decision time for solar photovoltaic (PV) s in Japan. Based on our survey, consumers spend about 4 months to make purchase decision. Also, our estimation results show that information and knowledge that consumers obtained from the neighborhood and elsewhere make consumers more careful in their decision-making and extend the purchase decision. On the other hand, experts on the advantages and disadvantages of installation shortened the decision time. The situation and environment of each household in terms of income, family size, and the way of purchase of new homes have influenced on the decision to purchase a PV system. In addition, the availability of feed in tariffs was highly correlated with purchasing motivation, but unexpectedly the capital subsidy programs have either little impacts or even delayed impacts on the purchasing timing.

1. Introduction

Recently, the Fukushima Nuclear Power Plant accident that followed the Tohoku Earthquake in March 2011 caused people to worry about electrical power shortages and nuclear power plant reliability in Japan. In recent years, the electricity consumption per home has decreased in Japan. However, eliminating the supply of electricity from the nuclear power plant caused large increases in CO_2 emissions from alternative electricity sources, e.g., natural gas. Therefore, the government of Japan has promoted energy conservation and renewable energy in the residential sector. In 2014, the cabinet approved a new strategic energy plan (its 4th). Based on this plan, the Ministry of Economy, Trade and Industry formulated its long-term plan for energy supply and demand in Japan. In this plan, the government identifies a target share for renewable energy of approximately 20% of the total energy use in 2030. This target will be difficult to achieve, as the percent of renewable energy resources of the total energy use was only approximately 6% in 2014. Therefore, achieving a rapid increase in renewable energy is an important political issue in Japan. However, the situation in other developed countries is the same.

Many countries are trying to diffuse renewable energy by feed-in tariff (FIT) programs. In fact, one of the convenient tools for encouraging the diffusion of renewable energy is FIT. Developed countries have already employed FIT to achieve rapid increases in the diffusion of renewable energy. However, we do not fully understand how much the FIT rate and other factors influence the purchasing decision period of renewable energy sources. The decision-making process of a firm for investing in renewable energy is simple. However, the decision-making process of the average person who purchases durable goods related to energy use is difficult to understand.

There are several examples of policies, such as diffusion policies for durable goods, related to global energy use. Traditional policy implementations used to diffuse new technology include tax rebates and subsidies. In particular, tax rebates and subsidy programs for energy-efficient automobiles are a typical example. A few previous studies have already revealed the costs and benefits of such programs. For example, Gallangher and Muehlegger (2011) assessed the relative effects of tax incentives, gasoline prices, social preferences and other non-monetary incentives in Canada. Their study found that sales tax incentives have a much greater effect than income tax incentives on the demand for hybrid cars. Additionally, Tanaka and Managi (2015) analyzed the case of tax rebates and subsidy programs for ecologically friendly automobiles in Japan. They found that the performance of subsidy programs for ecologically friendly automobiles in Japan was not better than similar

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programs in other developed countries. In addition, other previous studies have shown that actual technological diffusion policies do not do enough to encourage the use of energy-saving devices and equipment (Kenneth and Kurt, 2007; Brännlund et al., 2007). In fact, previous studies have focused on the importance of non-monetary incentives on purchasing behavior (information and psychological factors). One of the major concerns of economists is time preference. In fact, many studies have revealed that each consumer purchases energy-related durable goods based on the high time discount rate (Hausman, 1979; Newell and Siikamäki, 2015).

In addition, recent studies investigated how the information effect affects purchasing behavior for energy-related durable goods. For example, Allcott (2011a) noted the miles per gallon (MPG) illusion affects the purchasing behavior for automobiles. In short, information about the fuel use of automobiles affects the purchasing behavior for automobiles. The notation system sometimes causes misunderstandings regarding the essential value of an automobile for future use.

Previous studies have also analyzed the effects of subsidies on solar photovoltaic (PV) systems. PV systems are an energy generation/supply technology. In Japan, these systems help control the power demand of residential areas. PV systems have been subsidized in various ways since the 1970s. In recent years, many countries have implemented subsidy programs for the installation of PV systems to tackle climate change. However, diffusion speed through subsidy programs is not sufficient for achieving the ambitious target share of renewable energy sources. Thus, many countries employ FIT. FIT has also been implemented in many countries as one of the diffusion policy tools that depends on economic incentives. The central principle of FIT policies is to offer guaranteed prices for fixed periods of time for electricity produced from renewable energy sources. Guaranteed prices will not change throughout the identified time period. In the case of Japan, FIT was introduced in 2012. The guaranteed price of renewable energy depends on the type of renewable energy source and the year the PV system was installed. For example, the guaranteed price of wind power (generation capacity less than 20 kW) is 22 Japanese Yen per 1 kWh. For other types of renewable energy, the guaranteed prices are defined as follows: geothermal power is 40 Japanese Yen (generation capacity less than 15,000 kW), hydropower is 34 Japanese Yen (generation capacity less than 200 kW), and methane fermentation gas is 39 Japanese Yen. Additionally, FIT in Japan covers solar power generation. The guaranteed price for solar power generation is 31 Japanese Yen per 1 kWh (generation capacity less than 20 kW, and a power control support system is not required). The guaranteed price for solar power will not change for 10 years. However, the period of the guaranteed price for solar power depends on the generation capacity. In the case of a generation capacity greater than 10 kW, the period of the guaranteed price extends to 20 years.

Although FIT gives consumers large incentives to install PV systems, some previous studies have shown that the diffusion speed is slower than that from government predictions (Negro et al., 2012). For example, the Japanese FIT rate is larger than that of other countries; however, the diffusion speed in Japan is lower than that in other countries. Of course, several factors affect this. However, previous studies did not investigate the differences in consumer purchasing behaviors regarding PV systems between different countries. Additionally, previous studies have not revealed which factors affect the purchasing behaviors regarding PV systems. One of the few studies that focused on purchasing speed showed the importance of the information exchange between people on the purchasing speed (Rai and Robinson, 2013).

Based on this background, we need to better understand the factors that affect purchasing behavior. In particular, we focus on the information channel effect and other important psychological effects on decision-making speed, while controlling several household attributes. Many previous studies have focused on evaluating diffusion policies based on the costs and benefits of direct economic incentive schemes. However, previous studies in recent years have proposed that an indirect effect is motivating people to implement pro-social behavior. In addition, studies have shown the cost-effectiveness of such indirect schemes. For example, Allcott (2011b) showed that the peer effect affects consumer energy use. Many developed countries, including Japan, are facing a severe financial situation. Thus, determining an indirect cost-effective scheme is necessary for real policymaking. Specifically, it is important to understand how the effects of the information channel and other psychological factors influence the purchasing behavior for durable goods related to energy use and contribute to improving traditional diffusion policies and making new diffusion policies. However, the impact of a factor can be different in each country and area. Therefore, our study can confirm the robustness of the information channel effect by comparing our results with those of previous studies.

Specifically, we analyze the duration of purchasing decisions (the “decision period”) as a key feature of solar PV system purchasing behavior. We explore both decision timeframes and the key factors that guide PV- system purchasing decisions. Sommerfeld et al. (2017) conducted one of the few studies that focused on the changes in energy use behavior after the installation of PV systems using FIT. In particular, they tried to identify different effects between the two types of FIT rate setting through a qualitative explorative field study. Finally, they found that different FIT rates critically affected the changes in energy consumption behavior after the installation of the PV system. However, they did not focus on the decision period. Information regarding the behavior of consumers and their preferences regarding PV system installation helps to clarify its cost-effectiveness and provides guidelines for future diffusion and policy design.

Understanding purchasing speed helps make policies that encourage the smooth installation of renewable energy. With the progression of climate change, developed countries need to speed up the diffusion of renewable energy usage. Therefore, speeding up the purchase of a PV system is an important policy issue in Japan, as well as in other countries. The diffusion speed of energy-efficient technology is a key issue in actual policymaking. Therefore, we need to understand more details regarding consumer behavior. In particular, increasing the purchasing rate of PV systems directly contributes reducing CO_2 emissions.

In addition, the purchasing speed of goods is a research topic in behavioral science and consumer research. People spend their own time on each activity. One of the important research topics in behavioral science is determining how much time people spend on each activity. Research has suggested that understanding the consumer's perception of time can contribute to developing consumer research (for example, Graham, 1981). In fact, other studies analyzed consumer behavior up to the actual purchase of goods (for example, Marmorstein et al., 1992). Therefore, our analysis and results can contribute to an academic field that is gaining new attention. In particular, few studies have considered the time span leading up to the purchase of energy-related goods in this field.

2. Background

Haws et al. (2014) conceptualized the relationship between green consumption values and purchasing/consumption behaviors. The authors showed that green consumption values were correlated with a preference for environmentally friendly products. Jager (2006) studied consumer preferences and behaviors with the aim of promoting the diffusion of PV systems. He conducted a survey of 197 existing PV system users in Holland. Using a model based on social psychology, Jager (2006) analyzed factors that affected consumer purchasing decisions regarding PV systems. The results showed that the majority of people who had purchased PV systems exhibited a high degree of environmental awareness. In short, they showed that providing information on the environmental benefits of PV systems was an effective way to increase the number of systems purchased. In addition, roughly half of the purchasers attended informational sessions or exhibitions prior to