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Consumers' willingness to pay for electricity after the Great East Japan Earthquake

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ABSTRACT

The Great East Japan Earthquake of March 11, 2011 severely damaged the Fukushima Daiichi nuclear power plants, and reminded people of the potential risk of an electricity supply shortage. Consumers have started to pay attention to the source of electricity production since then. This study presents the results of both discrete choice experiments and choice probability experiments to determine citizens' willingness to pay (WTP) for residential electricity produced by solar, wind, and nuclear power, and by natural gas to evaluate the three energy-mix scenarios presented by the government of Japan. In addition, we measure the effects of positive or negative information about nuclear energy. The results indicate that on average, Japanese consumers have a negative WTP for electricity produced by nuclear power regardless of the information they read, and that their WTP for energy-mix change is far less than the price increase already planned by electrical companies, which do not have any prospects for an actual change in their energy mix.

1. Introduction

The Great East Japan Earthquake of March 11, 2011 (hereafter, 3.11) severely damaged the Fukushima Daiichi nuclear power plants, and reminded people of the potential risk of electricity supply shortages and of the effects of radiation.[1] Consumers began to think again about alternative sources of electricity. Although nuclear power had been an important source of clean and stable energy before the 3.11, the spread of radioactive materials from the Fukushima plants made citizens disapprove of nuclear power energy. For example, according to the 89,124 public comments on Japan's future energy mix scenarios collected by the government in August 2011, more than 80% of the respondents favored a scenario involving 0% nuclear electricity in 2030.[2]

This study applies both choice probability experiments and discrete choice experiments to determine citizens' willingness to pay (WTP) for residential electricity produced from different energy sources. Further, we hypothetically

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[1] Tanaka and Ida (2013) observed awareness of voluntary electricity conservation among the households after the Great East Japan Earthquake applying the conjoint analysis.

[2] The expected price change for each scenario was not provided by the government. Therefore, the expected price change might not have been considered clearly by the public.

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evaluate the three energy-mix scenarios proposed by the Japanese government. In addition, we measure the effects of conveying positive and negative information regarding nuclear energy on WTP.

We find that on average, consumers have a negative WTP for electricity produced by nuclear power regardless of the information they read and that their WTP for energy-mix change is less than the price increase already planned by electrical companies, which do not have any prospects for an actual change in their energy mix.

There is a large body of literature measuring WTP for residential electricity in various countries. In the US, Roe et al. (2001) analyzed US consumers' demand for environmental attributes of deregulated residential electricity services. They combined a survey designed to elicit consumers' WTP for such attributes and a hedonic analysis of actual price premiums charged for green electricity in several deregulated markets. From 835 valid responses obtained from eight US cities, they found that only certain population segments were willing to pay larger premiums for emissions reductions. A hedonic approach also indicates that a 1% increase in renewable sources increases the premium for a household using 1000 kWh per month by about $6 per annum. Borchers et al. (2007) estimated WTP for voluntary participation in green energy electricity programs with 128 completed interview surveys. Their model estimated WTP for a generic green energy source and compared this to WTP for green energy from specific energy sources, including wind, solar, farm methane, and biomass. They found that there exists a positive WTP for green energy electricity in general, but that biomass and farm methane provided less utility than the other three green sources.

Narrowing the topics, Soskin and Squires (2013) investigated WTP for solar water heating systems, photovoltaic (PV) rooftop systems, and a green pricing (GP) control group. Collaborating with a city-run public utility in Florida to mail field surveys to nearly 25,000 electricity customers, the authors found that homeowner home rooftop solar (HRS) and GP participation rates were comparable. Among respondents' attributes included in the analysis, education, income, and environmental support displayed the expected direct impact on WTP for HRS and GP.

In Europe, Willis et al. (2011) focused on respondents' age attributes. They investigated whether households made up of older people were less inclined to adopt new technologies, and if those households had different behavioral responses to energy efficiency compared with the rest of society. Through a computer-assisted personal interview (CAPI) in late 2007, they obtained 1279 questionnaires from households in Britain. Households with members aged 65 and above were considerably less likely to adopt micro-generation renewable energy technologies (solar thermal, solar voltaic, and wind power) compared with the rest of the population. Zorić and Hrovatin (2012) analyzed the WTP for electricity generated from renewable energy sources in Slovenia. They conducted a household survey, which was a combination of an Internet and field survey, in 2008 to get 450 responses. The results imply that the decisions regarding "whether to participate in green electricity programs" and "how much to pay for green electricity" were influenced by different factors. While age had a negative influence on both the decisions, education and environmental awareness exhibited a positive influence on the decision of whether to contribute; the decision of how much to contribute primarily depended on household income. These researchers also provided a concise literature survey of the estimated WTP for green electricity (Zorić and Hrovatin, 2012, Table 1, p. 18).

In Asia, Nomura and Akai (2004) reported the results of a survey using the contingent valuation method (CVM) of the willingness of Japanese households to pay more, in the form of a flat monthly surcharge, for renewable energy. The median value of WTP for renewable energy by Japanese households is estimated at about ¥ 2000 per month per household (US$16.7 at an exchange rate of ¥ 120 per US$). Yoo and Kwak (2009) used CVM to obtain estimates of the WTP values for raising the ratio of green electricity in Korea. They used 800 face-to-face interviews to derive a positive WTP for green electricity. Zhang and Wu (2012) identified market segments and estimated the residents' WTP for green electricity in China. Applying a CVM with payment card method to an e-mail survey, they received 1139 replies from respondents in Jiangsu province; they found that those with high income and higher education had a higher WTP, and a Veblen effect existed in certain Chinese market segments.

The literature above generally focuses on WTP for natural, renewable energy and does not include electricity generated by nuclear energy. Some literature deals solely with nuclear power electricity and related facilities. Jun et al. (2010), using CVM, estimated the social value of nuclear energy consumers' WTP for nuclear energy. Using data from 329 face-to-face interviews in Korea, from four metropolitan areas and four local areas with nuclear power plants, they suggested that the social value of nuclear energy approximately increased by 68.5% with the provision of adequate information about nuclear energy to the public. Schneider and Zweifel (2013) experimentally measured marginal WTP for increased insurance coverage against the risk of an accident at the nuclear power plant (MWPC) as well as WTP for solving the nuclear waste disposal problem (WTPW). Using a stated choice experiment in Switzerland, they tested two crucial predictions. First, once attitudes influencing the choice of residential location are controlled for, MWPC values should decrease and then increase with distance from the plants. Second, however, such an effect should be absent from WTPW values. Both predictions were largely confirmed, lending credence to the estimated MWPC of US$1.2 per year for 1% more coverage and WTPW of US$125 per year for solving the waste disposal problem. Frey et al. (1996) provided an interesting interpretation of the relationship between the political and market behavior of citizens regarding local disamenities. They empirically tested the role of monetary compensation for low- and mid-level radioactive nuclear waste repositories in a small village in Switzerland. Once compensation was introduced, the opportunity costs of rejecting financial rewards and investment opportunities were largely ignored at the polls. Nevertheless, the expected compensation left its mark on private behavior, and citizens demanded new moral arguments that were in line with their economic interests, such as highlighting the moral virtues of accepting the facility.