ISEIS

Journal of Environmental Informatics 14(1) 25-30 (2009)

Journal of Environmental Informatics

www.iseis.org/jei

Consumer Preferences for Small-lot Greenhouse Gas Emission Credits Attached to Automobile Insurance

Y. Yoshida[1,*], T. Kikushige[1], R. Matsuhashi[1], and Y. Nomura[2]

[1]*The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8653, Japan*
[2]*Aarata Sustainability Co., Ltd., Sumitomo Fudosan Mita Twin Bldg. East Wing 13F, 4-2-8, Shibaura, Minato, Tokyo 108-0023, Japan*

Received 25 June 2008; revised 7 May 2009; accepted 20 May 2009; published online 10 September 2009

ABSTRACT. Achievement of CO_2 emission reductions in the automobile sector is a complex problem because of the difficulties in regulating consumer behavior. The approach of the present study is not government regulation of consumer CO_2 emissions but the encouragement of responsible environmental behavior using the bounded rationality of consumers based on behavioral economics. Currently, greenhouse gas (GHG) emission credits are mainly traded among corporations. However, the use of small-lot emission credits is expected to begin spreading to consumers. We propose a system through which small-lot emission credits can be purchased by the consumers during the purchase or renewal of automobile insurance. Drivers can offset vehicle CO_2 emissions by purchasing emission credits. In the present study, we analyzed the market potential for small-lot GHG emission credits attached to automobile insurance. A consumer survey of 351 drivers was conducted in Japan. Consumer preferences are evaluated using conjoint analysis and the contingent valuation method (CVM). The average value of the marginal willingness to pay (WTP) for GHG emission credits is estimated to be approximately 2171 yen per ton-CO_2. The median WTP for GHG emission credits is estimated to be approximately 2260 yen per year. Assuming that the average driver in Japan travels a distance of 10,000 kilometers per year and the vehicle fuel efficiency is 10 kilometers per liter, the WTP for GHG emission credits corresponds to approximately 30 percent of each driver's CO_2 emissions.

Keywords: preference, emission credit, automobile insurance, conjoint analysis, CVM, WTP, carbon offsetting

1. Introduction

Carbon dioxide emissions from consumer energy use are increasing. Achievement of CO_2 emission reductions in the automobile sector is a complex problem because of the difficulties in regulating consumer behavior. Many options are available to consumers that are interested in contributing to the mitigation of global warming, including measures that require consumers to either directly or indirectly reduce CO_2 emissions. Energy conservation enables consumers themselves to reduce CO_2 emissions. This direct measure, however, reflects voluntary behavior and cannot assure reduced emissions. Indirect methods, such as subscriptions to environmental funds, contribute to CO_2 emission reductions through the efforts of the recipient organizations. However, most consumers are not aware of ways in which to contribute to CO_2 emission reductions despite increased awareness of environmental issues in developed countries.

In Japan, an environmental contribution system called the "Green Electricity Fund" allows consumers to donate money toward the construction of renewable energy power plants, which use technology such as photovoltaic cells or wind turbines to produce electricity. However, this system has not raised sufficient funds to contribute to CO_2 emission reductions because of a lack of incentives to donating. Systems that motivate consumers to behave in an environmentally desirable manner are needed to encourage action. We propose a system under which CO_2 emission credits can be voluntarily purchased by consumers during the purchase or renewal of automobile insurance. This can be seen as one of the carbon-offset programs which are beginning to spreading recently. Carbon offsetting is one of the indirect methods for contributing GHG emission reduction by consumers. There is, however, a criticism for carbon-offset programs from the viewpoint of the additionality (Rousse, 2008). Carbon offsetting fails if the donors for carbon-offset program use it for the excuse for their GHG emission increase. Another criticism has to do with verification to assure that offsets are achieved (Gillenwater et al., 2007). The credits from CERs (Certified Emission Reductions) are more reliable than those of VCOs (voluntary carbon offsets) since additionality and baselines in the CDM (Clean Development Mechanism) are verified to a higher degree than VCOs (Bumpus and Liverman, 2008). It is true that carbon-offset programs have the controversial aspects. Carbon-offset programs, however, contribute GHG emission reduction under the assumption that credits are well verified and they are not used

* Corresponding author. Tel.: +81 4 71364710; fax: +81 4 71364710.
E-mail address: y-yoshida@k.u-tokyo.ac.jp (Y. Yoshida).

ISSN: 1726-2135 print/1684-8799 online
 doi:10.3808/jei.200900150

for the excuse for emissions. There is a movement in UK that has launched a scheme for appropriately regulating Carbon offset products (Defra, 2009). The potential of carbon-offset has been discussed from the viewpoint of sustainable tourism. Becken (2004) surveyed the awareness of GHG emission and carbon offset in tourism. Gossling (2007) discussed the scheme to compensate GHG emissions from transport. Gössling et al. (2009) surveyed the preference of carbon- offset programs in Sweden and analyzed whether voluntary carbon offsets can make a significant contribution to compen- sating emissions caused by aviation. Many past studies have not evaluated the WTP for voluntary carbon offsets. We estimate the WTP for carbon offset of automobiles during the purchase or renewal of automobile insurance.

CO_2 emissions emitted from the consumer's automobiles are offset. This program should appeal to the consumers because passenger cars are directly energy-use product. Furthermore, additional payment procedures are not necessary because the credits are attached to their annual automobile insurance purchases. In the present paper, we analyze consumer acceptance of the emission credits based on a questionnaire survey of consumers.

2. Emission Credits Attached to Automobile Insurance

Greenhouse gas (GHG) emission credits are mainly traded between corporations. The concept of small-scale emission credits is expected to spread to consumers. In the present study, we first describe a method for dividing GHG emission credits into small-lots utilizing the trust system. The scheme is shown in Figure 1. A primary credit buyer has an account within the United Nations clean development mechanism (CDM) registry. The primary buyer also has an account in the national registry. A trustee bank has an account in the national registry. The primary buyers can trade emission credits with each other and also trade with the government. A secondary buyer, who wishes to purchase a relatively small number of credits, can trade with the primary credit buyer through the trustee bank. Both the primary buyer and the secondary buyer have accounts in a trustee bank. The secondary buyer formally obtains a small number of credits, receiving the trust beneficiary right. Purchasing the trust beneficiary right from a trustee bank provides two advantages over direct purchases from the primary buyer. The first is the suitability of the trustee bank to provide small-lot services in contrast to direct purchasing, which is suitable for large trades such as credits of one million tons. The other advantage is the simplicity of the procedure. The secondary buyer need not make an account in the national registry but can purchase credits from the primary buyer or trustee bank.

In the present study, the insurance company that sells emission credits attached to automobile insurance policies corresponds to the secondary buyer. Trust beneficiary rights cannot be given to private individuals because the procedures become too cumbersome. Instead, the insurance company issues certification to consumers who purchase the emission credits. The insurance company has to pay sufficient attention to the sources of emission credits since consumer choices are influenced

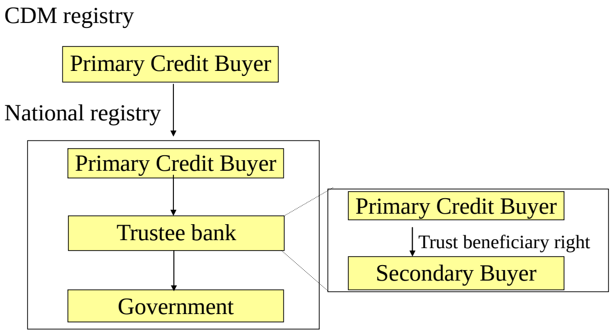

Figure 1. Method for dividing GHG emission credits into small-lots utilizing the trust system. The secondary buyer need not have an account in the national registry.

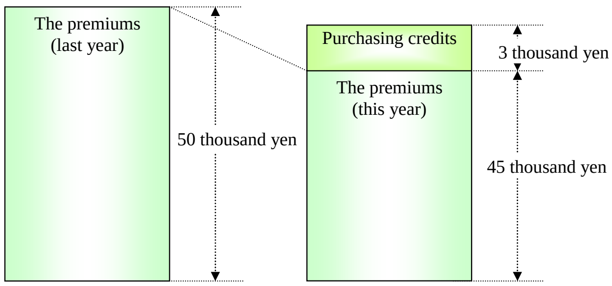

Figure 2. Example of a consumer purchase of 3000 yen of emission credits during automobile insurance renewal.

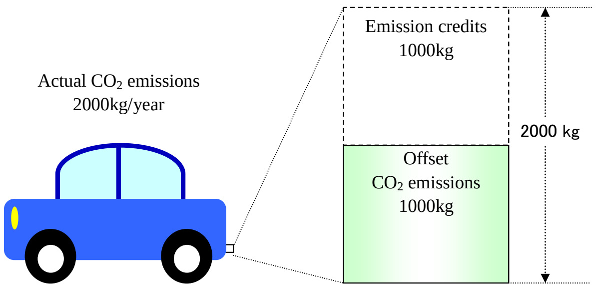

Figure 3. Carbon offset for a purchase of 1000 kg of emission credits. 1,000 kg of CO_2 emission reduction contributes toward GHG emissions reduction by the government.

by CDM project type, such as forestation or renewable energy.

Figure 2 shows an example of a person who purchases 3,000 yen of emission credits when renewing the automobile insurance. In this case, the insurance fee decreases from 50, 000 yen to 45,000 yen because of obtaining a discount from the insurance company. The reduction in insurance payment would motivate the consumer to buy the credits. Figure 3 depicts the carbon offset when the person buys 1,000 kg of emission credits. 1,000 kg of CO_2 emission reductions contributes to the total GHG emissions reduction by the government. The insurance company divides the credits into small-lots so that

Table 1. Sample Questions to Determine the Preference for Emission Credits Attached to Automobile Insurance

	Choice 1	Choice 2	Choice 3	Choice 4
Offset CO_2 emissions	10%	100%	50%	None
(Ratio to the yearly emissions from the respondent's car)	costs 500 yen/year	costs 5,000 yen/year	costs 2,500 yen/year	
Compensation	Same	Same	Ampler	Same
(Compared with previous year)			costs 1000 yen/year additionaly	
Yearly premiums	5,500 yen/year	10,000 yen/year	8,500 yen/year	5,000 yen/year

an individual can buy the credits after purchasing the trust beneficiary right from a company that has a larger number of emission credits.

3. Overview of the Survey

We prepared a two-phased survey to determine factors that contribute to consumer choices. The survey was conducted via the Internet in April 2007. The first phase was a screening survey to extract the respondents who are able to answer questions concerning the fuel efficiency of their own car and the insurance cost. The second phase was the main survey for the screened 351 respondents. The second phase consisted of a questionnaire in three parts. First, the respondents were asked to provide individual information such as age, sex, and occupation. We requested information regarding the respondent's automobile, including age, fuel efficiency, yearly travel distance, and frequency of use. In addition, we asked for yearly insurance premiums and insurance grade. Next, we prepared questions to determine the preference for emission credits attached to the automobile insurance. The questions were based on conjoint analysis (Louviere and Woodworth, 1983; Louviere, 1994). Conjoint analysis has been applied to psychometrics and marketing research (Green and Srinivasan, 1978; Green and Srinivasan, 1990), and has recently applied to environmental economics (Adamowicz et al., 1994; Adamowicz et al., 1997; Roe et al., 1996). Conjoint analysis, as well as contingent valuation method (CVM), belongs to the stated preference method, which is utilized to evaluate the preference for new products or contingent commodities. Conjoint analysis enables us to evaluate the willingness-to-pay (WTP) for every attribute. In the present study, we adopted choice-based conjoint (CBC) analysis. The statistical models and statistical estimation of the parameters used in conjoint analysis are described in many previous articles (Domencich and McFadden, 1975; Anderson et al., 1992). Table 1 presents sample questions based on conjoint analysis. Each respondent selects one response among four choices. Choice 4 is the default without emission credits and with the same compensation as the previous year. The other choices provide for emission credits that are attached to the insurance. The required CO_2 emissions offset is dependent on the fuel efficiency and yearly travel distance of each respondent's car. The number of offset emissions is based on the answers to the fuel efficiency and travel distance questions. Each respondent can select the desirable amount of offset emissions among four trade-off choices. We prepared six questions, including those in Table 1, for each respondent. The marginal WTP can be estimated from the answers to these questions. That is, we can estimate the maximum price that the respondents would pay for 1 kg of offset emissions.

The third part of the questionnaire included the CVM. The CVM enables us to establish the distribution of the WTP. That is, we can estimate the maximum cost that respondents would be willing to pay for the offset emissions. Double-bounded dichotomous choice is adopted for the elicitation method as shown in Figure 4. The first submission is randomly chosen from 500, 1,000, 2,000, 3,000, or 4,000 yen. The second submitssion depends on the answer of the first submission. If a respondent accepts or rejects the cost of first submission, the second submission becomes higher or lower. We can estimate the distribution of WTP for offset CO_2 emissions from the answers to this question.

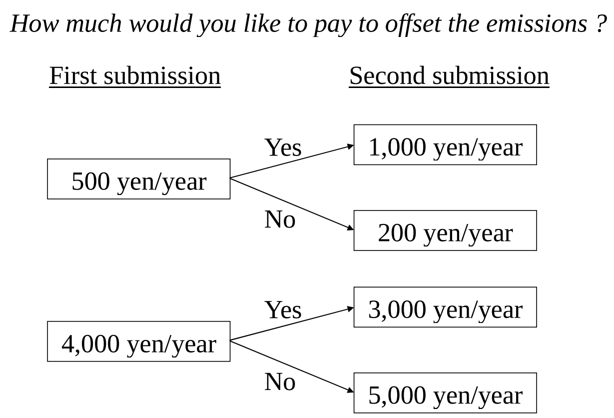

Figure 4. Double-bounded dichotomous choice adopted for the CVM elicitation method (the first submission is chosen randomly from 500 yen/year to 4,000 yen/year; the distribution of WTP can be estimated from this question).

4. Results of the Survey

The results of the conjoint analysis were used to estimate the average utility function U as follows:

$$U = -0.22x_1 + 0.47x_2 \tag{1}$$

where x_1 is the total payment including emission credits (unit: 1,000 yen / year), and x_2 is offset emissions (unit: 1,000 kg /

Table 2. Correlation Matrix between Attributes

	Age (year)	Annual income (million yen/year)	Travel distance (km/year)	Fuel efficiency (km/L)	Score of environmental awareness
Age	1	0.04	0.02	-0.13	0.01
Annual income	*	1	0.05	-0.07	0.05
Travel distance	*	*	1	0.22	0.00
Fuel efficiency	*	*	*	1	0.14
Score of environmental awareness	*	*	*	*	1

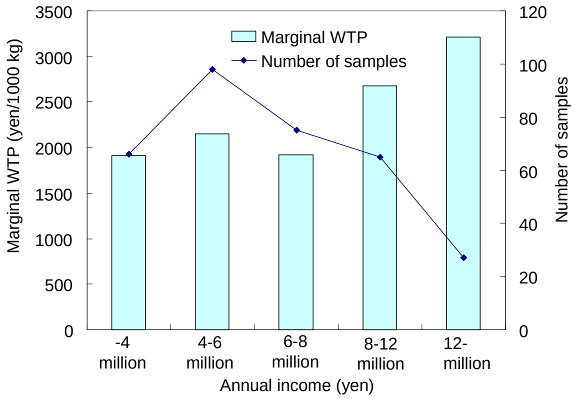

Figure 5. Marginal WTP for the carbon offset for the population segments classified by annual income.

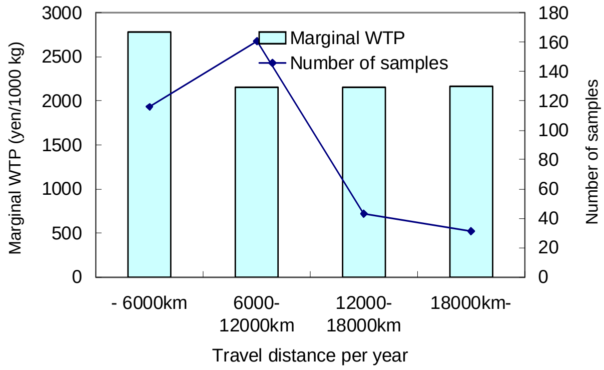

Figure 7. Marginal WTP for the carbon offset for the population segments classified by travel distance.

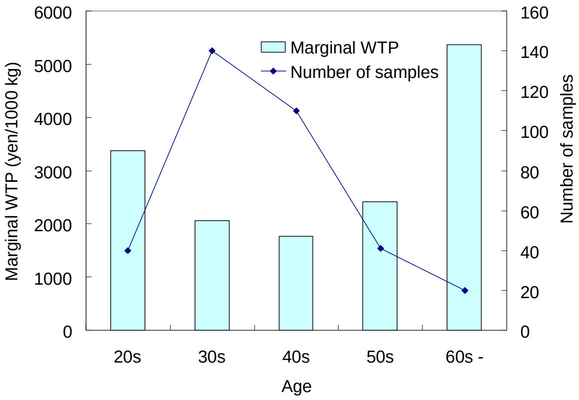

Figure 6. Marginal WTP for the carbon offset for the population segments classified by age of respondent.

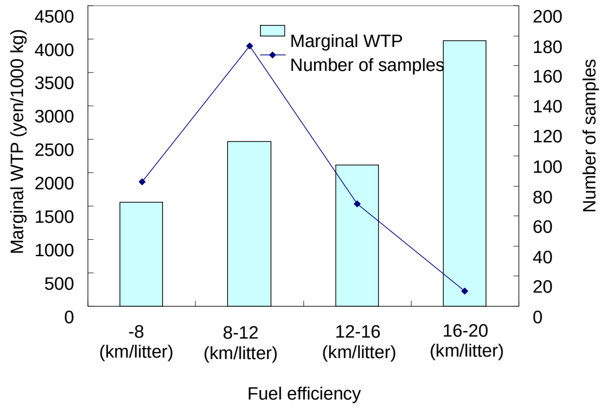

Figure 8. Marginal WTP for the carbon offset for the population segments classified by vehicle fuel efficiency.

year). Both parameters are statistically significant. The ratio of the two parameters is used to estimate the mean of marginal WTP for emission credits, 2,171 yen per 1,000 kg. This value is relatively high for the WTP as voluntary contributions for car- bon offsets, as compared with the carbon price established by the European Union Greenhouse Gas Emissions Trading Sche- me (EU ETS). Although a bias may exist with this kind of en- vironmental survey, the idea of emission credits attached to au- tomobile insurance can motivate contributions to environmen- tal protection, providing an opportunity to pay for emission cre- dits.

We estimated the utility functions for various segments of the sample population. Figure 5 and Figure 6 show the marginal WTP for carbon offset for the population segments classified by annual income and age, respectively. The high-income group and older age group show a high WTP. It is reasonable that high-income group affords to pay more. There is not significant difference in WTP between low-income group and middle-income group. It is because unmarried young segment in low-income group have a certain level of disposable income. The age segments of high WTP include retired or unmarried people who have relatively high disposable income. The ages of 30s and 40s can afford less due to paying more for parental care.

The results of Figure 7 and Figure 8 link to Figure 9 because CO_2 emissions are the function of travel distance and fuel

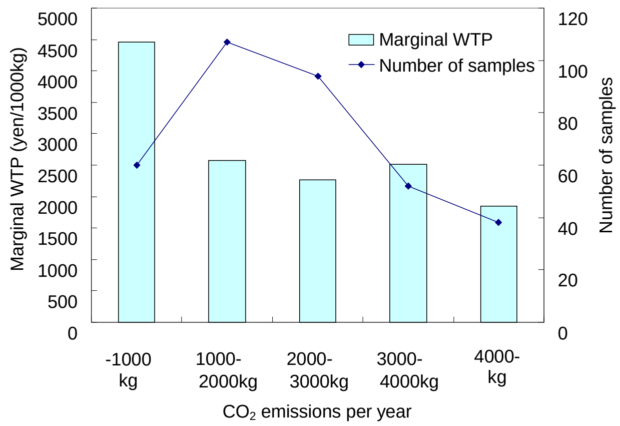

Figure 9. Marginal WTP for the carbon offset for the population segments classified by CO_2 emissions.

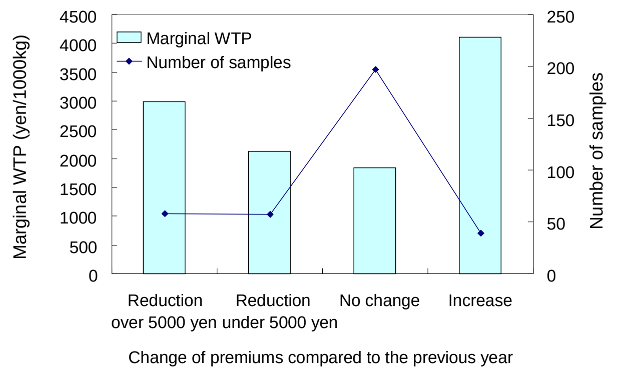

Figure 10. Marginal WTP for the carbon offset for the population segments classified by cost of insurance premiums compared with the previous year.

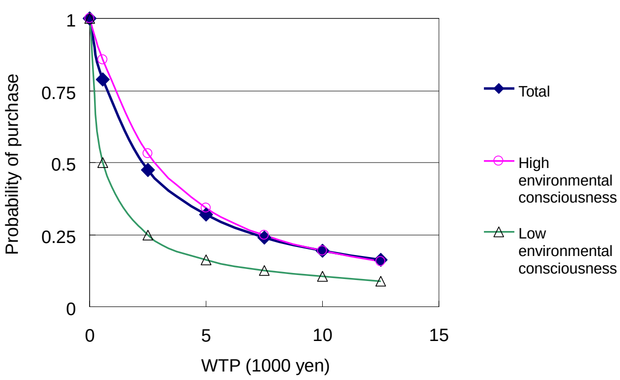

Figure 11. WTP per year for the carbon offset as the result of CVM. Median WTP is 2,260 yen per year.

efficiency. Travel distance, which varies widely between individuals, has the larger impact on CO_2 emissions than fuel efficiency. Therefore, Figures 7 and 9 reflect that higher total payment for carbon offset is not necessary for the segment of long travel distance and large CO_2 emissions. The result of Figure 8 links to the environmental awareness. The large WTP of high fuel efficiency segment is explained by the positive correlation between fuel efficiency and score of environmental awareness as shown Table 2. Table 2 shows the correlation between attributes. There appears to be a small positive correlation between travel distance and fuel efficiency, and score of environmental awareness and fuel efficiency. The score of environmental awareness is the sum of the number of response "Yes" for the questions that ask whether each respondent behaves environment-friendly or not in daily life. Figure 10 shows the marginal WTP for carbon offsets by the population segments that are classified by changes to insurance premium costs, as compared with the previous year. The group whose premiums do not change shows the least WTP, although the higher WTP among consumers in the group whose premiums increase from the previous year does not appear to be logical. These results indicate the bounded rationality of consumers. Consumers do not always choose among options in order of utility. They respond to a benchmark of utility and sometimes make decisions based on the discrepancy between the value of utility and the benchmark of utility. In this case, the benchmark is considered to be the insurance premiums of the previous year. Higher WTP of the group whose premiums increase can be explained by the smaller rate of carbon-offset cost in the total insurance cost. However, the group whose premiums decrease shows high WTP in spite of relatively larger rate of carbon-offset cost in the total insurance cost. It can be due to an asymmetry of worth, with which cost reduction can trigger more WTP than cost increase. Figure 11 shows the results of the CVM. Median WTP for GHG emission credits, which is a value of WTP when the purchase probability is 0.5, is estimated to be approximately 2,260 yen per year. Assuming the average travel distance for a driver in Japan is 10,000 kilometers per year and the fuel efficiency is 10 kilometers per liter, the WTP for GHG emission credits corresponds to approximately 30 percent of each driver's of CO_2 emissions. This result indicates that the emission credits attached to automobile insurance are a promising way for GHG emission reduction. We classified the sample population by the score of environmental awareness. The median WTP of the highly environmentally consciousness individual is 2,800 yen per year, while that of low environmental consciousness is 570 yen per year.

5. Conclusions

We proposed a system under which small-lot emission credits can be purchased by consumers at the time of automobile insurance purchase or renewal. Drivers can offset CO_2 emissions from their vehicles by purchasing emission credits. We analyzed the market potential for small-lot GHG emission credits attached to automobile insurance. The average value of the marginal WTP for emission credits is estimated to be 2,171 yen per 1,000 kg. The median WTP for emission credits is estimated as 2,260 yen per year. The sample population segments with a high WTP for GHG emission credits are higher income groups and owners of fuel-efficient cars. Drivers who travel long or short distances show a higher WTP than those who travel medium distances. The group whose premiums do not change shows the least WTP. The survey results indicate that the sale of emission credits attached to automobile insurance is a promising way for individuals to make environmental contributions.

Acknowledgments. This study was financially supported by "Trust Sixty Foundation". The authors would like to thank the members of the foundation, especially Mr. Ken Nakajima, Mr. Tastuyuki Moriyama, and Mr. Kenichiro Fuse (Metropolitan Business Strategy Section, Aioi Insurance Co., Ltd.).

References

Adamowicz, W., Louviere, J., and Williams, M. (1994). Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities, *Jornal of Environmental Economics and Management*, 26, 271-292.

Adamowicz, W., Swait, J., Boxall P., Louviere, J., and Williams, M. (1997). Perceptions versus Objective Measures of Environmental Quality in Combined Revealed and Stated Preference Models of Environmental Valuation, *Jornal of Environmental Economics and Management*, 80, 64-75.

Anderson, S.P., de Palma, A., and Thisse, J.F. (1992). *Discrete Choice Theory of Product Differentiation*, the MIT Press.

Becken, S. (2004). How tourists and tourism experts perceive climate change and carbon-offsetting schemes, *Journal of Sustainable Tourism*, 12(4), 332-345, doi:10.1080/09669580408667241.

Bumpus, A.G., and Liverman, D.M. (2008), Accumulation by Decarbonization and the Governance of Carbon Offsets, *Economic Geography*, 84(2), 127-155.

Department for Environment, Food and Rural Affairs (Defra) UK (2009). The UK Government's Quality Assurance Scheme for Carbon Offsetting (UK). http://offsetting.defra.gov.uk/.

Domencich, T., and McFadden, D. (1975). Urban Travel Demand: A behavioral Analysis, North-Holland.

Gillenwater, M., Broekhoff, D., Trexler, M., Hyman, J., and Fowler, R. (2007). Policing the voluntary carbon market, *Nature Reports Climate Change*, 6, 85-87.

Gossling, S. (2007). Voluntary Carbon Offsetting Schemes for Aviation: Efficiency, Credibility and Sustainable Tourism, *Journal of sustainable tourism*, 15(3), 223-248, doi:10.2167/jost758.0.

Gössling, S., Haglund, L., Kallgren H., Revahl, M. and Hultman, J. (2009). Swedish air travellers and voluntary carbon offsets: towards the co-creation of environmental value? *Current Issues in Tourism*, 12(1), 1-19, doi:10.1080/13683500802220687.

Green, P.E. and Srinivasan, V. (1978). Conjoint Analysis in Consumer Research: Issues and Outlook, *Journal of Consumer Research*, 5, 103-123.

Green, P.E., and Srinivasan V. (1990). Conjoint Analysis in Marketing: New Developments with Implications for Research and Practice, *Journal of Marketing*, 54, 3-19.

Louviere, J.J., and Woodworth, G. (1983). Design and Analysis of Simulated Consumer Choice or Allocation Experiments: An Approach Based on Aggregate Data, *Journal of Marketing Research*, 20, 350-367.

Louviere, J.J. (1994). *Conjoint Analysis*, in Bagozzi, R. P., ed., Advanved Method of Marketing Research, Blackwell, pp. 223-259.

Roe, B., Boyle, K.J., and Teisl, M.F. (1996). Using Conjoint Analysis to Derive Estimates of Compensating Variation, *Journal of Environmental Economics and Management*, 1, 132-149, doi:10.1006/jeem.1996.0037.

Rousse, O. (2008). Environmental and economic benefits resulting from citizens' participation in CO2 emissions trading: An efficient alternative solution to the voluntary compensation of CO2 emissions, *Energy Policy*, 36(1), 388-397, doi:10.1016/j.enpol. 2007.09.019.