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Consumer Needs for Measures to Promote Biodiversity-enhanced Agriculture:
Application of the Contingent Valuation Method and Benefit Transfer

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1. Introduction

Recently in Japan, biodiversity-enhanced agriculture[1] has gradually spread. In response, the government has been promoting its development. For example, the Ministry of Agriculture, Forestry, and Fisheries (MAFF), has promoted the "*Ikimono mark*"[2]. In 2011, direct support measures for environmental conservation agriculture also began. Biodiversity-enhanced agriculture is effective when various stakeholders, including farmers, consumers, and distribution companies, work together to promote it. However, their perception and involvement regarding biodiversity-enhanced agriculture is insufficient.

There have been several previous studies on the relationship between biodiversity-enhanced agriculture and consumers (Katata *et al.*, 2008; Yabe *et al.*, 2010; Oishi *et al.*, 2011; Oishi *et al.*, 2012). Many of these studies examined consumer perceptions regarding biodiversity-enhanced agriculture and preferences for related products[3]. Yet there remains insufficient research on consumer needs to promote measures related to biodiversity-enhanced agriculture.

This paper analyzes consumer needs for measures to promote biodiversity-enhanced agriculture, in the form of direct payments to farmers. We use the contingent valuation

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method for consumer needs analysis. We also examine the similarity of needs between study areas by using benefit function transfer.

The remainder of the paper is organized as follows. In Section 2, we describe the model and the data used in the analysis. Section 3, we describe the results of analysis and a discussion. In Section 4, we give our conclusions.

2. Materials and Methods

(1) Materials

We analyzed contingent valuation (CV) data obtained via an Internet-based questionnaire conducted on 24–27 March 2011[4]. Participants were men and women 20 years old or older who are registered with a research firm. Participants were grouped by gender and age (20–29, 30–39, 40–49, 50 and above). 800 people living in each of Hokkaido, Tokyo, Aichi, Osaka, and Hyogo were surveyed, for a total of 4,000 responses.

Would you support a tax established to promote biodiversity-enhanced agriculture?

Assume that the tax was to be collected from all households in Japan for each of the next 10 years. Tax money would be paid directly to farmers to insure that it was used only to promote biodiversity-enhanced agriculture.

In that case, would you pay a _____ yen tax each year for the next 10 years?

1. Yes 2. No

Figure 1 WTP questions

Participants were asked questions regarding willingness to pay (WTP) a tax to promote biodiversity-enhanced agriculture, paid directly to farmers. Responses were from the single-bounded dichotomous choices shown in Figure 1. Based on the results of a pre-survey, we set choices as 500, 1,000, 3,000, 5,000, and 10,000 yen per household per year. We excluded responses that indicated lexicographic preference or resistance.

The questionnaire requires knowledge of biodiversity-enhanced agriculture, a topic for which widespread knowledge cannot be assumed. Participants were therefore provided with information on biodiversity-enhanced agriculture before responding.

(2) Methods

1) WTP calculation

We calculated WTP for a tax to promote biodiversity-enhanced agriculture paid directly to farmers by a parametric method, specifically, a log-logistic model based on a random utility model (Kuriyama, 1977; Terawaki, 2002). Note that we truncated the highest bid to 10,000 yen when calculating the mean WTP.

2) Benefit transfer test

Methods of benefit transfer that target environmental evaluation such as the contingent valuation method and the travel cost method include unit value transfer, benefit function transfer (transferred to other regions benefit function), and meta-analysis transfer. Among these, research on benefit function transfer has been particularly active in Japan. To test the possibility of benefit function transfer, we conducted a hypothesis test on the consistency of the parameters using the likelihood ratio test (Terawaki, 2002). The null hypothesis in this test is "benefit function transfer is possible," and the alternative hypothesis is "benefit function transfer is impossible." The likelihood ratio test statistic is given by.

$$LR = -2\left[\ln L(\hat{\theta}_r) - \sum_{g=1}^{G} \ln L(\hat{\theta}_g)\right] \cdots\cdots (1)$$

$\ln L(\hat{\theta}_r)$ Here, denotes the log-likelihood estimate obtained under the assumption that the parameters are uniform $\ln L(\hat{\theta}_g)$ across the divided regions. denotes the log-likelihood assessed by an estimate of the divided "g area." G denotes the number of divided areas.

In equation (1), there is a χ^2 distribution of degrees of $\sum_{g-1}^{G} K_g - K$ freedom, where K_g denotes the number of parameters of the divided "g area," and K denotes the number of parameters for the model when the region is not divided. The null hypothesis in this test is "benefit function transfer is possible between the target regions," and the alternative hypothesis is "benefit function transfer between the target regions is impossible." Hypothesis testing was carried out at a 10% significance level.

3. Results and Discussion

(1) WTP calculation

Table 1 shows the estimation results based on the parametric method, and Table 2

Table 1 Estimation results based on the parametric method

Hokkaido	Variable	Coefficient	t value	p value	
	constant	7.76	9.22	6.38E-19	***
	ln (Bid)	-0.88	-8.60	8.65E-17	***
	n	551			
	Log likelihood	-301.01			

Tokyo	Variable	Coefficient	t value	p value	
	constant	8.15	8.99	4.62E-18	***
	ln (Bid)	-0.92	-8.34	6.5E-16	***
	n	523			
	Log likelihood	-279.52			

Aichi	Variable	Coefficient	t value	p value	
	constant	7.16	8.46	2.71E-16	***
	ln (Bid)	-0.80	-7.74	5.38E-14	***
	n	518			
	Log likelihood	-284.55			

Osaka	Variable	Coefficient	t value	p value	
	constant	7.08	8.79	2.35E-17	***
	ln (Bid)	-0.84	-8.38	5.07E-16	***
	n	512			
	Log likelihood	-299.02			

Hyogo	Variable	Coefficient	t value	p value	
	constant	9.70	9.98	1.66E-21	***
	ln (Bid)	-1.14	-9.61	3.61E-20	***
	n	504			
	Log likelihood	-261.72			

Note: Variables that are significant at the 1% probability are denoted by ***.

Table 2 Calculation results of annual WTP (yen)

	Number of sample	Parametric method		*cf.* Nom-parametric method	
		WTPmedian	WTPmean	WTPmedian	WTPmean
Hokkaido	551	6,671	6,024	7,787	6,136
Tokyo	523	6,791	6,091	6,007	6,132
Aichi	518	7,558	6,179	8,182	6,303
Osaka	512	4,575	5,290	4,655	5,357
Hyogo	504	5,068	5,548	4,887	5,616

shows the calculation results of annual WTP per household in each region. In Table 1, ln(BID) (logarithm of the bid)is a significant variable with negative sign in all regions. This indicates that higher bids reduce likelihood to pay, which is a consistent result.

In Table 2, in the parametric method the median WTP was in the range 4,500–7,600 yen, and the mean WTP was in the range 5,200–6,200 yen. Aichi had the highest median and mean WTP, perhaps due to the 2010 COP10 (10th Conference of the Parties to the Convention on Biological Diversity), which was held there. This event may have increased awareness of biodiversity-enhanced agriculture[5].

For comparison, Table 2 shows the calculation results of annual WTP by the parametric and nonparametric (Turnbull) method. Trends were highly similar for both methods.

(2) Benefit transfer test

We first conducted a test of benefit transfer between the five regions, but the null hypothesis that "benefit function transfer is possible between the five regions" was rejected (test statistic 16.9, p-value 0.03). We therefore conducted tests between each pair of regions. Figure 2 shows the results, which confirmed that there is a possibility of

	Hokkaido	Tokyo	Aichi	Osaka
Tokyo	0.17			
	0.92			
Aichi	0.40	0.65		
	0.82	0.72		
Osaka	6.23	7.98	7.52	
	0.04 **	0.02 **	0.02 **	
Hyogo	3.70	3.37	6.23	6.01
	0.16	0.19	0.04 **	0.05 **

Figure 2 Test results for benefit function transfer

Note: Upper numbers are test statistics (likelihood ratio test statistics), lower numbersare p-values. p-values less than 10% (5%) are denoted by **.

benefit function transfer in half of the pairs (namely, between Hokkaido and Tokyo, Hokkaido and Aichi, Hokkaido and Hyogo, Tokyo and Aichi, and Tokyo and Hyogo). Benefit function transfer was confirmed between all pair combinations of Hokkaido, Tokyo and Aichi, suggesting highly similar needs for biodiversity-enhanced agriculture measures in those areas. In contrast, benefit function transfer was not confirmed between Osaka and any other area. This suggests differing needs in Osaka than in other areas.

4. Conclusions

We used the contingent valuation method to analyze consumer needs for measures to promote biodiversity-enhanced agriculture through direct payments to farmers. We also examined the similarity of needs between the study areas by using benefit function transfer.

The median WTP was in the range 4,500–7,600 yen, and the mean WTP was in the range 5,200–6,200 yen. These results suggest that consumers support biodiversity-enhanced agriculture to some extent. We confirmed benefit transferability among those regions with highest WTP (Aichi, Hokkaido, and Tokyo). WTP was relatively low in Osaka and Hyogo, and benefit function transfer was not confirmed between these regions. Verification of factors causing these differences remains as a topic for future study.

The MAFF began direct support measures for environmental conservation agriculture in 2011, and direct payments for initiatives related to effective biodiversity conservation have begun. Examples include organic agriculture and *fuyumizu-tambo* (winter-flooded rice fields). Reviews of agricultural technology and scale for targeted assistance should result in initiatives that promote biodiversity-enhanced agriculture.

Notes :

1) There is no definitive translation, referred to as "biodiversity-enhanced agriculture" in this paper.

2) The MAFF conducts promotion of the "*Ikimono mark*". For more information, see MAFF (2010).

3) For example, Katata *et al.* (2008) evaluated consumers' preference to agricultural products (rice) that contribute to the conservation of habitat Toki.

4) This survey was conducted as part of the "Promotion project of biodiversity-enhanced agriculture (MAFF; Promotion Project FY2010 Comprehensive measures global environment)".

5) Total annual WTP was calculated by multiplying the estimated WTP of each area by the number of households (Census 2010) and using ratio sample selection (number of samples used in the calculation WTP/800). Total annual WTP calculated from median and mean values, respectively, were 11.1 billion and 10.1 billion yen in Hokkaido, 28.4 billion and 25.5 billion yen in Tokyo, 14.4 billion and 11.7 billion yen in Aichi, 11.2 billion and 13.0 billion yen in Osaka, and 7.2 billion and 7.9 billion yen in Hyogo. These amounts are higher than the budget for direct support of environmental conservation agriculture measures (26.4 billion yen in the fiscal 2012 budget).

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