External Economies of Agriculture

Kentaro Yoshida* and Eiichiro Nishizawa*

Abstract

Agricultural activities contribute to our society not only by supplying food and raw materials but also by providing useful services such as flood prevention and amenities. Unfortunately, most of these services are neither traded nor priced in the market and are thus regarded as "external economies". Problems become serious when the externality is so large that the market equilibrium deviates substantially from the social optimum. The level of agricultural activities determined only through the market mechanism may be too low for the society as a whole if external economies are to be taken into account.

Agricultural externalities seem substantial in many Asian countries where paddy farming is predominant. Paddy farming, unlike upland farming, helps check flood, retains water as reservoir. Traditional arts and rituals are closely associated with it. This fact should be reflected in the actual policy making. In this respect, it is important to evaluate the size of these externalities. Several methods to measure them in monetary terms have been developed, including the contingent valuation method (CVM), hedonic price method and travel cost method.

CVM elicits respondents' monetary valuation of non-market goods and services through the use of well prepared questionnaires. Based on our study, it is estimated that the Japanese evaluate the total agricultural externalities in their country at as much as 4.1 trillion yen a year. This paper highlights the methodological issues and results of the study by focusing on the CVM valuation and its policy implications in Japan.

Introduction

Agriculture plays many roles other than production, such as prevention of flood and creation of amenities. These environmental services of agriculture have been drawing the attention in Japan. How to appreciate and maintain these services is one of the topics under examination in the revision of the Basic Agricultural Act. The attention stems from the decline in and the abandonment of farmland due to the urban sprawl and the decrease in the labor force in the agricultural sector, leading to the increase in the vulnerability to natural disasters and the loss of traditional rural landscape. These phenomena have become apparent to many people, which made them understood the importance of the environmental services of agriculture.

Local municipalities make efforts to maintain the environmental services of agriculture. For example, terraced paddy fields form a unique rural landscape, but farming them is not economically viable in most areas. The City of Wajima, Ishikawa Prefecture, established the

* National Research Institute of Agricultural Economics (NRIAE), Japan

Conservation Fund of Terraced Paddy Fields. The City, Prefecture, and private companies offer money. Interest of fund is appropriated for the subsidy to the farmers who cultivate terraced paddy fields. The City also organizes volunteers to help farming there. The Town of Yusuhara, Kochi Prefecture, and the Town of Kiwa, Mie Prefecture introduced the owner-system of terraced paddy fields. In Yufuin Town, Ohita Prefecture, the municipality, the tourist association, the hot spring inn union give a grant to livestock formers who preserve the traditional farming landscape. Some local governments give subsidies to rice-growing farmers, recognizing that paddy fields adjacent to urban areas play a role of reservoir and prevention of flood.

The appreciation of the many services provided by farming is not idiosyncratic to Japanese. Policies for preserving rural landscape such as pasture land in mountainous areas and hedgerows, have been enacted in European countries. The Rural Development Programme in OECD tries to draw guidelines for the rural amenity conservation policies.

Based on the interest on the environmental services of agriculture, economists have attempted to evaluate the services in monetary terms. This paper gives an estimate of the value of the environmental services provided by Japanese agriculture as a whole using the contingent valuation method.

Environmental services of agriculture and economic valuation of the environment

1 Environmental services of agriculture as external economies

Agriculture and forestry provide the following environmental services.

1) Conservation of national land

(1) Stabilization of water flow, prevention of flood and drought
(2) Purification of water
(3) Prevention of soil erosion
(4) Prevention of landslides
(5) Cleaning the air by absorbing carbon dioxide and supplying oxygen and trapping dust
(6) Moderation of weather

2) Amenity creation

(1) Preservation of wildlife and ecosystems
(2) Formation of rural landscape
(3) Provision of opportunities for recreational activities
(4) Provision of residential amenities
(5) Preservation of traditional culture

The environmental services are recognized as externalities or public goods. Externalities are "positive or negative spillovers which occur in the production and consumption of goods and services. They affect people's welfare but are not themselves the object of market transactions as there is no monetary compensation for gains or losses in welfare. As externalities are produced incidentally or externally to the market they do not appear in the revenue and cost account of the producer or industry, although for the individuals affected or for society as a whole they represent real costs and benefits" (OECD, 1994). Public goods are

characterized as non-excludable and non-rival.

1) Non-excludability

Consumers pay a price for ordinary goods like foods and clothes. As for certain services such as national defense and administrative services, however, it is difficult or prohibitively expensive to exclude those who receive the service without payment for it. Therefore, free-riders cannot be excluded from the beneficiaries of the service.

2) Non-rivalry

If the quantity of ordinary goods is given, the increase in consumption by someone leads to the decrease in the consumption of goods of somebody else. Enjoyment of some services such as landscape by someone, however, does not preclude others from enjoying it. In other words, the consumption of these services does not compete with each other.

Market mechanisms would supply insufficient amount of public goods due to free riding. In conjunction with the production of foods and materials which are traded in markets, i.e., private goods, agricultural activities provide the above environmental services as public goods, and consequently generate externalities. Beneficiaries of these services do not pay for them, since there are no markets for these services. Even if markets existed, provision would be below the socially desirable level of supply, because these services have characteristics of public goods. Therefore, environmental services need to be publicly supported.

2 Methodology of environmental valuation

The rise of environmental consciousness stimulated researchers and policy makers to evaluate the environmental benefit and the damage to the environment in monetary terms in order to obtain policy implications. Not only in North American and European countries, but also in Japan, is the environmental valuation the emerging agenda.

What are the merits of monetary valuation of the environment? First, it clarifies individual's preference. The valuation of goods and services, including the environment, differs from person to person. The monetary valuation enables to make a quantitative comparison of individual preferences. Second, the quantitative valuation gives clearer argument and much policy implication. And finally, it can be employed in cost-benefit analysis. The cost-benefit analysis compares costs and benefits of a certain project or policy. Introducing environmental benefits and damage to the environment to the cost-benefit analysis would lead to more appropriate decision making.

The methodology of environmental valuation has developed remarkably. The valuation methods are classified into two categories by the nature of data source. One category consists of methods which use the information on surrogate goods of environmental services, including travel cost method and hedonic price method. Methods in the other category use the information on stated preference of individuals. The contingent valuation method, which is applied in this paper, falls into this category.

3 Travel cost method

Consumers' time and money costs for access to an environmental service (recreational activities, for example) can be considered to be the willingness to pay for the service. Travel cost method uses the information on consumers' time and money costs to estimate the bene-

fits from the environmental services. This method is applicable for services which accompany travel costs such as outdoor recreation.

4 Hedonic price method

Hedonic price method is based on the capitalization hypothesis that the difference in residential value is attributed to the characteristics of neighborhood amenities as well as quality of the house. Price of land or residence is regressed on these characteristics to elicit the value of the environmental improvement. Nishizawa, Yoshida and Kato (1991) estimated the value of environmental services provided by Japanese paddy fields at 11.2 trillion yen per year (Table 1).

Table 1 Evaluation of the environmental services of paddy fields by hedonic price method

Per household	(yen/ha · year)	25.41
Total value	(billion yen/year)	11,867

Source: Nishizawa, Yoshida and Kato (1991).
Note: Evaluation in 1985.

5 Contingent valuation method (CVM)

In the CVM, respondents are directly asked through an interview or questionnaire about their willingness-to-pay (WTP) for the environmental improvement or willingness-to-accept compensation (WTA) for the environmental degradation to obtain their environmental valuation.

A hypothetical situation is presented to respondents. Theoretically, any goods and services regardless of the existence of the markets could be evaluated by CVM. Besides, data on surrogate goods and services are not required in CVM. Moreover, you can only infer the use value of the environmental services from information on surrogate goods and services on the one hand, while on the other hand, CVM can capture nonuse value including option value, bequest value and existence value.

1) Option value

Take a recreational site for example. Someone might want the option to visit there for future's recreational activities even if he is not certain whether he will visit there. The value ensuring that the site will be preserved is called the option value.

2) Existence value

Someone might be willing to pay for the conservation of endangered species like finback whales even though he would never go whale watching. He values the fact that finback whales exist. This value is called the existence value.

3) Bequest value

Someone might think that it is worthwhile to preserve rural landscape for the sake of future generations. The value of the preservation for this purpose is called the bequest value.

Economic valuation of environmental services of agriculture by CVM

1 Framework of the CVM survey

1) Outline of the survey

We conducted the mail survey in April, 1996. Sampling process was as follows. Japan was divided into four blocks: Northern, Kanto, Chubu-Kansai (Central), Western. Each block was classified into three areas: urban, flat rural, hilly and mountainous. The number of samples chosen in each of the twelve areas was proportional to the population.

Two thousand questionnaires were mailed as a preliminary survey and thereafter, 13 thousand ones were sent. The number of mailed questionnaires effectively delivered was 14,439. The number of effective replies was 1,837 (12.7%).

2) Design of hypothetical situation

The most crucial part in CVM is the design of the hypothetical situation. First, the environmental services to be evaluated have to be defined. The environmental services provided by Japanese agriculture at the national level were evaluated in the study. The following nine roles were specified.

(1) Preservation of wildlife and ecosystems
(2) Formation of rural landscape
(3) Provision of opportunities for recreational activities
(4) Provision of residential amenities
(5) Stabilization of water flow, and prevention of flood and drought
(6) Moderation of weather
(7) Purification of water
(8) Prevention of soil erosion and landslides
(9) Cleaning the air

We focused on the environmental services and excluded the preservation of traditional culture and the provision of opportunities for environmental education.

Second, the hypothetical changes in the environmental quality and hypothetical payment vehicle have to be specified. The following is the main part of the questionnaire.

"Suppose Japanese agriculture will cease to play the environmental services other than production ten years later, although food supply would be guaranteed. Suppose next, that in order to avoid the above scenario, national and local governments and non-governmental organizations (NGOs) are going to take measures to maintain the environmental services of agriculture. Suppose further that taxes you pay and funds you donate will afford the costs".

Before the above text, the following explanation on the status of Japanese agriculture was attached in order to add the reality to the situation.

"The acreage of farmland under cultivation decreased by 10 % in this decade in Japan. The abandoned farmland has increased by 74%. The environmental services provided by agriculture will dwindle significantly if the decline in agriculture continues".

The hypothetical change in the environmental quality was specified as the transition from the ex-ante quality (Q_0) to the ex-post quality (Q_1). Q_0 is the current level of the environmental services. Q_1 is the situation where there are no environmental services except for the production of foods and agricultural materials. Governments and NGOs would try to main-

tain Q_0.

The hypothetical payment vehicle is the way of paying money for the maintenance at Q_0. The vehicle could be admission fees or taxes. The vehicle was specified as taxes or donation to governments or NGOs in this study.

Double-bounded dichotomous choice was employed to reveal respondents' WTP. In a dichotomous choice questionnaire, the respondent would say yes or no to a value arbitrarily chosen by the researcher. Respondents encountered two steps of dichotomous choice (Fig. 1).

Table 2 summarizes the results of responses to each value. Those who answered "no" in both steps were asked why. If their choice was that "The multifaceted services should be maintained in other ways, although I acknowledge their importance", the samples were omitted and designated as "Protest No".

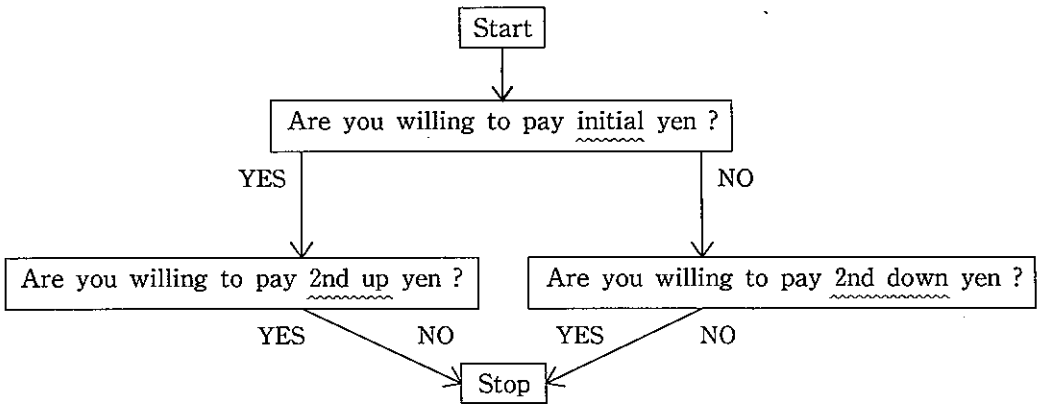

Fig. 1 Flowchart of the Double-Bounded Dichotomous Choice CVM

3) Relative importance of environmental services

Table 3 shows the relative importance of nine environmental services evaluated by respondents. (5) Stabilization of water flow, and prevention of flood and drought and (1) Preservation of wildlife and ecosystems got the highest scores. Services relevant to the living environment such as (7) Purification of water, (9) Cleaning the air and (8) Prevention of soil erosion and landslides were also well appreciated. (2) Formation of rural landscape, (3) Provision of opportunities for recreational activities, and (4) Provision of residential amenities received low scores. The difficulty of classification among these three services might have resulted in the low scores.

Is there any difference in the relative importance among three areas, i.e., urban, flat rural, and hilly and mountainous? In the urban areas, (1) Preservation of wildlife and ecosystems, (7) Purification of water, and (9) Cleaning the air received higher scores than in other areas. In the flat rural areas, (2) Formation of rural landscape and (5) Stabilization of water flow, and prevention of flood and drought received a higher appreciation. In hilly and mountainous areas, (8) Prevention of soil erosion and landslides was given a higher valuation.

Table 2 Responses to each presented value

Initial (2nd up/down)	yy[1]	yn	ny	nn	Total	pn[2]
5,000(10,000/2,000)	123 (47.1%)	73 (28.0%)	50 (19.2%)	15 (5.7%)	261 (100.0%)	59
10,000(20,000/5,000)	95 (44.0)	66 (30.6)	44 (20.4)	11 (5.1)	216 (100.0)	60
30,000(50,000/10,000)	51 (28.5)	50 (27.9)	68 (38.0)	10 (5.6)	179 (100.0)	77
50,000(100,000/30,000)	38 (21.4)	59 (32.4)	53 (29.1)	31 (17.0)	182 (100.0)	81
100,000(200,000/50,000)	24 (18.5)	38 (29.2)	36 (27.7)	32 (24.6)	130 (100.0)	106
300,000(500,000/100,000)	18 (12.3)	26 (17.8)	64 (43.8)	38 (26.0)	146 (100.0)	99
	350 (31.4%)	312 (28.0%)	315 (28.3%)	137 (12.3%)	1114 (100.0%)	482

Notes 1) yy: initial bid = yes, 2nd up bid = yes.
yn: initial bid = yes, 2nd up bid = no.
ny: initial bid = no, 2nd down bid = yes.
nn: initial bid = no, 2nd down bid = no.
2) Protest No.

Table 3 Relative importance of each services evaluated by respondents

Function	Average	Urban	Flat	Hilly and Mountainous
Preservation of wildlife and ecosystems	0.191	0.204	0.185	0.184
Formation of rural landscape	0.089	0.076	0.098	0.093
Provision of opportunities for recreational activities	0.052	0.055	0.048	0.054
Provision of residential amenities	0.026	0.026	0.028	0.024
Stabilization of water flow, and prevention of flood and drought	0.194	0.191	0.201	0.190
Moderation of weather	0.061	0.064	0.061	0.059
Purification of water	0.158	0.165	0.155	0.155
Prevention of soil erosion and landslides	0.109	0.093	0.110	0.123
Cleaning the air	0.120	0.128	0.115	0.116
Total	1.000	1.000	1.000	1.000

2 Analysis of CVM

This study adopted the maximum likelihood model developed by Hanemann *et al.* (1989) to estimate individuals' WTP from the double-bounded dichotomous choice questionnaire. The logarithm-logistic distribution was employed as the probability distribution function. The rate of saying "yes" (P) is modeled in equation (1).

$$P = \{1+\exp(-\alpha_0-\alpha_1 \ln T-\beta X)\}^{-1} \quad (1)$$

Where T is the value presented to the respondent, X is the vector of respondent's characteris-

tics, αs are parameters and β is the vector of parameters to be estimated. Parameters are estimated by the maximum likelihood method.

3 Results

Table 4 summarizes the estimation results. The vector of X consists of respondent's income (INC) and dummies. D_1 is one if the respondent lives in the urban area, and zero otherwise. D_2 is one if the respondent lives in the hilly and mountainous areas, and zero otherwise.

Coefficients on T and INC are significantly different from zero at 1% level. Coefficient on D_1 is significantly different from zero at the significance level of 0.05 and negative, implying that WTP in the urban area is lower than in other areas. Coefficient on D_2 is not significant.

WTP per household per year was calculated next. The mean WTP was estimated by integrating the equation (1). The median WTP was calculated by setting P=0.5. The median WTP was 39,587 yen in the urban area, 51,663 yen in the flat rural area, and 46,505 yen in the hilly and mountainous areas. The weighted mean of median WTP was 41,546 yen. The mean WTP was 98,063 yen in the urban area, 117,144 yen in the flat rural area, and 109,311 yen in the hilly and mountainous areas, the weighted mean of the mean WTP was 101,225 yen.

Table 4 Estimation results of the equation (1)

Explanatory variables	Coefficients (t-value)
Constant Terms	7.9774 (13.335**)
T : Log of presented value	−1.0676 (−29.202**)
D1 : 1 if the respondent lives in urban area, 0 otherwise	−0.28655 (−2.2061*)
D2 : 1 if the respondent lives in hilly and mountainous area, 0 otherwise	−0.087673 (−0.65497)
INC : Log of the respondent's income	0.54949 (7.1536**)
n	1288
−lnL	−1904.9
Percent correct predictions	38.7%

Notes: **significant at 1% level, *significant at 5% level.

Table 5 Estimation of willingness to pay for environmental services of Japanese agriculture

Area	WTP per household (yen/year) median WTP	mean WTP	Total WTP (billion yen/year)
Urban	38,587	98,063	31,023
Flat rural	51,663	117,144	3,994
Hilly/mountainous	46,505	109,311	6,054
Weighted average	41,546	101,225	41,071[1)]

Total of three areas.

Total willingness-to-pay (TWTP) was calculated by multiplying WTP per household by the number of households. Whether the median WTP or mean WTP is to be used is controversial. In this survey, 30% of the respondents who were presented 300,000 yen said "yes". Their WTP would be underestimated if the median WTP were to be chosen. Therefore, the mean WTP was employed. TWTP value was 3.1 trillion yen in the urban area, 399 billion yen in the flat rural area, 605 billion yen in the hilly and mountainous areas. Consequently, TWTP was 4.1 trillion yen per year as a whole (Table 5).

Concluding remarks

The multifaceted services provided by Japanese agriculture were evaluated by CVM. Based on our study, it is estimated that the Japanese evaluate the total environmental services of agriculture in their country at as much as 4.1 trillion yen a year. The value is equivalent to one-third of agricultural output (11.3 trillion yen, 1994), and is larger than the value for rice production (3.8 trillion yen, 1994).

The results of our study should be used with caution. We estimated the value of external economies or positive externalities of agriculture. Agricultural activities do cause external diseconomies or negative externalities including the degradation of water and air quality by agrochemicals and bad smell from livestock raising. These external diseconomies of agriculture should be accounted for as costs when the desirable level of public support for the agricultural sector is determined.

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SESSION 3

Technological Issues after the Green Revolution