Bivariate Ordered Probit Analysis of Public Attitudes Toward Multifunctionality of Agriculture in the U.S.

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Introduction

The concept of multifunctional agriculture has been growing over the last two decades as an ideology profoundly affecting farm policy-making process in developed countries and the WTO (World Trade Organization) multilateral trade liberalization talks (Batie, 2003; Abler, 2004). Multifunctional agriculture is generally defined as nonmarket goods and services that agriculture produces with varying degrees of jointness with either farm outputs or farm/rural landscapes including national food security, rural amenities, recreational opportunities, cultural heritage, viability of rural communities, and a broad range of ecosystem services encompassing nutrient recycling, carbon sink, or groundwater recharge. Although suspected of disguised protectionism by the proponents of market-oriented reforms, the concept has gained legitimacy during the Uruguay Round talks and subsequent international conferences hosted by FAO, WTO, and OECD in the late 1990s and early 2000s (Swinbank, 2001; Losch, 2004; Sakuyama, 2005).

In line with the concept's growing role in guiding multilateral trade talks and in shaping agricultural policies, academic researchers have shown a great deal of interest in investigating a wide range of economic issues related to the multifunctional roles of agriculture. In particular, examining public preferences of and placing monetary value on multifunctional goods and services was considered critical in empirically implementing economic theories/models that incorporate the concept of multifunctional agriculture and became a topic of considerable research interest (Randall, 2002; Hall et al, 2004).

This paper aims at making a contribution to the literature by researching public attitudes toward the concept of multifunctional agriculture in the U.S. and identifying factors that shape such attitudes. We measure public attitudes based on two questions

inquiring about the concept of multifunctional agriculture itself and government intervention to address problems associated with multifunctionality. Two sets of regression models are developed in this article to identify factors shaping attitudes: (i) regressing attitudes against stated rankings and ratings among seven specific nonmarket goods and services of multifunctional agriculture including national food security (degree of food self-sufficiency), ecosystem services, farmland amenities, cultural heritage, recreational opportunities, wildlife habitat, and viability of rural economies; and (ii) regressing attitudes against a set of factors that are hypothesized to be pertinent in explaining attitudes about multifunctional agriculture (i.e., perceptions about food self-sufficiency, farmland preservation programs, family farms, government intervention, free trade, and ecological state of our world). Bivariate ordered probit approach is employed to account for the ordered categorical nature of the dependent variables and potential contemporaneous correlation between the two dependent variables. We use survey data collected nationally in the summer of 2008 using web-based panel maintained by Ipsos-Observer, a professional survey research firm.

Multifunctionality, Trade Talks, and Importance of Public Preference

The multifunctional roles of agriculture were officially recognized by the Uruguay Round Agreement on Agriculture (AoA) as manifested in its Preamble stating "Commitments under the reform programme should be made in an equitable way among all Members, having regard to NTC, including food security and the need to protect the environment; having regard to the agreement that special and differential treatment for developing countries is an integral element of the negotiations." The emergence of the concept of multifunctional agriculture prompted the WTO to institute the so called 'traffic light box system' (green, blue, and amber boxes) that categorizes agricultural policies and subsidies based on two criteria: (i) whether or not they distort trade patterns and (ii)

whether or not they are targeted at supporting the multifunctional roles of agriculture. The box system is designed to permit countries to foster the supply of nonmarket goods and services of agriculture while ensuring that such support is decoupled from production decision, thereby minimizing trade distortion. This creative device fundamentally reshaped the nature of discourse about the way government influences the operation of agricultural market, specifically giving rise to the now widely used terms like decoupling, targeting, devolution, direct payment, and cross-compliance (Potter and Barney, 2002). In brief, the URAA laid the foundation for accomplishing three goals simultaneously: (i) reduced farm subsidies in industrialized countries, (ii) liberalized agricultural trade, and (iii) permitting each country to pursue its own goals with respect to the multiple functions of agriculture.

The Doha Development Round (DDR) was launched with the specific mandate of accomplishing the three goals above through advancing the URAA. With respect to the multifunctional roles of agriculture, the DDR regarded it as an important issue to be negotiated as stated in the Doha Declaration,

> "We take note of the non-trade concerns reflected in the negotiating proposals submitted by Members and confirm that non-trade concerns will be taken into account in the negotiations as provided for in the Agreement on Agriculture"

Yet, the DDR officially broke down in 2008 due to failures to reach agreement between developed and developing countries and within developed countries on the size of reduction in trade-distorting subsidies and on issues largely related to the multifunctional roles of agriculture (i.e., whether to abolish the blue box; whether to expand the scope of the green box; and to what extent to allow sensitive and special products (Josling, 2004; Anania and Bureau, 2005; Blanford and Boisvert, 2005). Specifically, developed countries were concerned about *import-sensitive products* that are particularly more susceptible to competition from foreign countries, while developing countries (e.g., India, China) were insisting that *special products* should be exempt from reductions in protection because of

their importance in development, food security, and rural livelihood. In general, proponents of agricultural multifunctionality argue that the scope of the green box needs to be expanded to accommodate production-linked subsidies, while opponents contend that multifunctional agriculture is a disguised protectionism and the current green box is appropriate to serve the goals related to multifunctional agriculture.

The bottom line is that the lack of clear guidelines and principles regarding how to incorporate the multifunctional roles of agriculture into the design of trade rules is severely hampering multilateral trade talks from progressing beyond the URAA (Lim, 2005; Schoenbaum, 2005). Specifically, knowledge of the social demand for multifunctional agriculture appears to be critical in fully operationalizing the concept to WTO trade rule-making process (Schmitz and Moss, 2005). While theoretical and empirical research on measuring public preferences and demand for multifunctional agriculture has been growing in recent years (e.g., Randall, 2002; Hellerstein et al, 2003; Bennett et al, 2004; Hall et al, 2004; Hyytia and Kola, 2006; Bergstrom et al, 2010), there seems to be a long way to go before such studies can be utilized in defining the scope of the green box and in determining the size of subsidies permitted for each country.

Research Design

Survey instrument was designed to shed light on the general public's perceptions and attitudes about the multifunctional roles of the U.S. agriculture.[1] The final questionnaire was administered as an online survey in June 2008 to a nationally representative web-based household panel maintained by the Ipsos-Observer, a market research/consulting firm specializing in research of consumer behavior on various social issues. The sample was stratified by geographic regions, household income, education, and age in accordance with the 2000 U.S. Census. Questionnaires were emailed to a sub-

[1] The full survey instrument is available upon request.

sample of 5,000 participants of this panel that was representative of the U.S. population. A total of 1,070 consumers completed the online survey within seven days, accounting for an impressive 39 % response rate. The on line survey elicited sociodemogprahic information including respondents' age, education, income, household size, geographic region, gender, and ethnic background.

The permission-based research approach is often used to explore consumer behavior because it offers two advantages-higher response rate and disclosure of demographic information for nonrespondents as well as respondents, thereby facilitating assessment of potential nonresponse bias. Comparison of socio-demographic characteristics between respondents and nonrespondents shows that males were more likely to choose not to respond (62 % vs. 56 %) and whites were slightly more prone to respond to our survey (87 % vs. 80.6). Other than these two categories, there are no major discrepancies between respondents and nonrespondents, suggesting that there is little reason to be concerned about potential biases due to systematic nonresponses from particular groups of nonrespondents.

The survey instrument consists of sets of questions probing a wide range of issues related to the multifunctional roles of agriculture in the U.S. Specifically, the instrument includes questions eliciting public perceptions about various issues (e.g., family farm, farmland preservation, government intervention in agricultural markets, free trade, ecological state) that are pertinent to better understanding public preferences about about multifunctional agriculture. In order to measure such concepts, some question items were drawn from Variyam, Jordan, and Epperson (1990) investigating citizens' preferences about U.S. farm policies. A set of 15 questions constituting new ecological paradigm (NEP) was incorporated to measure respondents' perceptions of our current state of ecological/environmental conditions (Dunlap and Van Liere, 2008; Dunlap et al, 2000).

Subsequently, the survey instrument asked respondents to consider the current U.S. agriculture with a particular emphasis on the positive and negative externalities associated with it and the role of USDA farm policies in dealing with them (see the Appendix for the entire information box). Further, the information box concisely characterizes the USDA's policy goals as manifested in its strategic plan framework (USDA, 2008).[2] This strategic plan is directly connected with the preservation of the multifunctional roles of the U.S. agriculture. Given this information box, respondents were posed with two questions intended to measure public attitudes toward the multifunctional roles of agriculture in the US : (i) agriculture produces intangible goods and services that are not traded in markets, and (ii) government should compensate farmers for their supply of such intangible goods and services. Respondents were given a seven-point scale ranging from strongly disagree to strongly agree.

Further, the survey instrument includes sets of questions designed to evaluate respondents' perceived rankings/ratings about specific nonmarket goods and services associated with multifunctional agriculture including national food security, cultural heritage, wildlife habitat, recreational opportunities, viable rural economies, farmland amenities. Respondents were asked first to rate the importance of the seven attributes using seven-point scale ranging from strongly disagree to strongly agree, and then to rank them from 1 (most important) to 7 (least important).

[2] The strategic framework includes; (i) Enhancing international competitiveness of American agriculture, (ii) Enhancing the competitiveness and sustainability of rural and farm economies, (iii) Supporting increased economic opportunities and improved quality of life in rural America, (iv) Enhancing protection and safety of the Nation's Agriculture and Food supply, (v) Improving the Nation's Nutrition and Health, and (vi) Protecting and enhancing the Nation's Natural Resource Base and Environment

Data Preview

This section presents preliminary view of collected data on issues useful to enhancing our understanding of public attitudes toward multifunctional agriculture. Figures 1 and 2 show the distribution of responses to the two attitudinal questions shown above: (i) agriculture produces intangible goods and services that are not traded in markets, and (ii) government should compensate farmers for their supply of such intangible goods and services. About 64 percent of respondents agreed to the first question inquiring about the nature of multifunctionality; 8 percent did not agree; and 36 percent was neutral.

Figure 1. Agriculture produces intangible beneifts that cannot be sold.

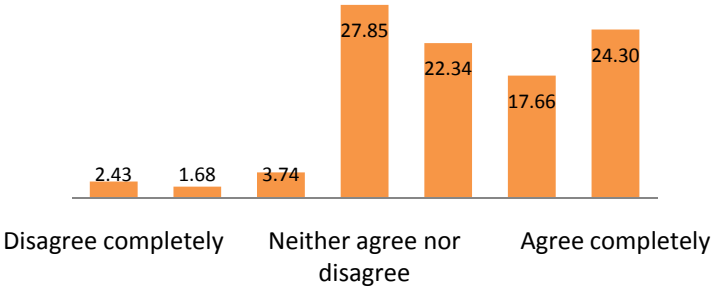
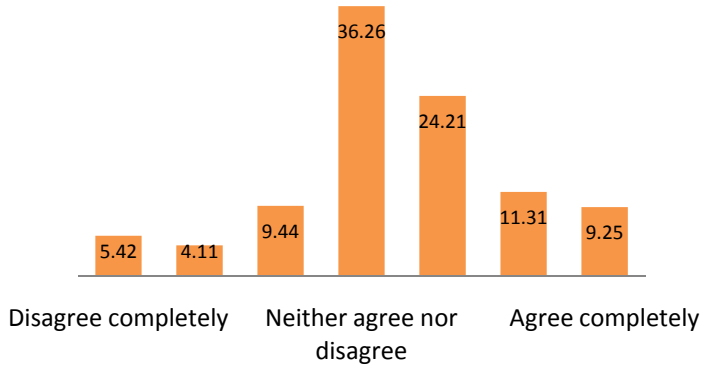


Figure 2. Government should compensate farmers for the intangible beneifts producted by agriculture.

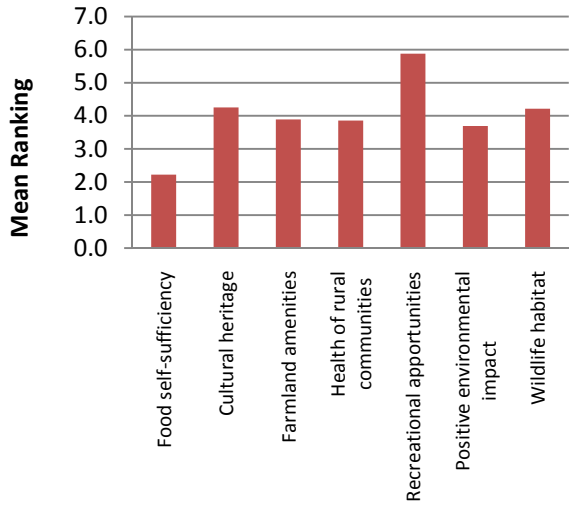


These results suggest that while majority of the US population supports the concept of multifunctional agriculture, yet a substantial portion of respondents (27.85 percent) were

not able to either accept or reject the concept. Less than half of the respondents (44.77 percent) expressed agreement with respect to the second question that focuses on the need for government intervention; nearly 19 percent disagreed; and 36 percent were neutral. Three discrepancies are notable between responses to the first and second questions: (i) the percentage of respondents in agreement declines from 64 percent to 45 percent; (ii) the percentage of respondents in disagreement increases from 8 percent to 19 percent; and (iii) the percentage of respondents neither agreeing nor disagreeing increases from 28 percent to 36 percent. Taken together, these results suggest that government involvement is a more controversial issue than the concept of multifunctional agriculture itself.

Figures 3 through 5 present respondents' relative perceptions about seven specific nonmarket goods and services of multifunctional agriculture. First, figure 3 shows the mean ranking of the importance of the seven attributes of multifunctional agriculture. National food security was ranked first with a mean score of 2.1, followed by ecosystem

Figure 3. Mean Ranking of the Importance of nonmarket goods associated with Agriculture



services (3.6), health of rural communities (3.7), farmland amenities (3.9), cultural heritage and wildlife habitat (4.2), and recreational opportunities (5.9). The importance of national

food security is confirmed in figure 2 displaying the percent of the frequency of being ranked first: 61 percent of the respondents chose national food security as ranked first with other attributes ranging from 10 percent for ecosystem services to 3 percent for recreational opportunities. Representing ratings among five nonmarket goods and services of multifunctional attributes (1=strongly disagree; 7=strongly agree), figure 5 reinforces the results of the ranking data: i.e., adequate supply of food was perceived as the most important function of agriculture with a mean score of 5.5, with other functions scoring around 4.5.

Figure 4. Percentage of being ranked first among seven nonmarket goods associated with agriculture

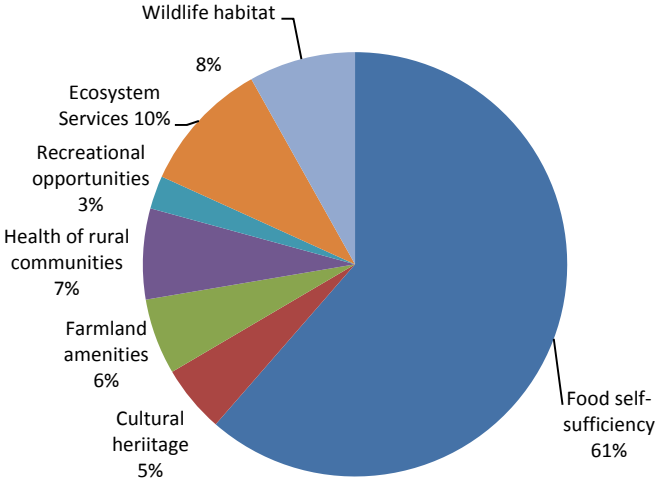
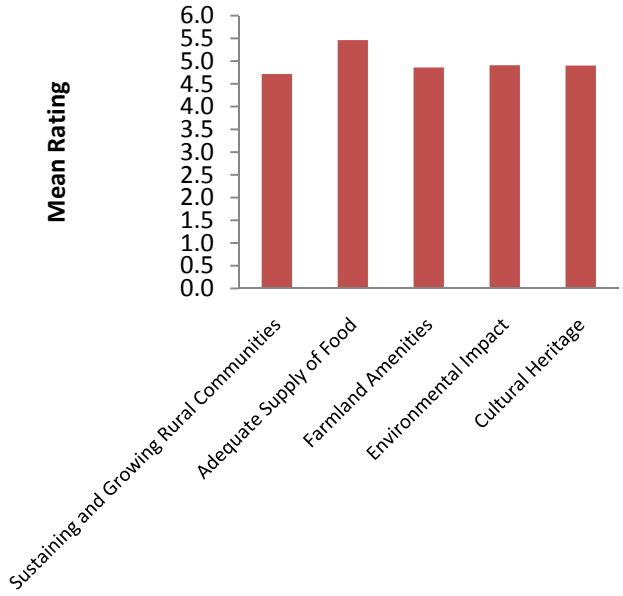


Figure 5. Mean Rating of the Importance of five nonmarket goods associated with agriculture



Model Specification

A major objective of this article is to identify factors driving public attitudes toward multifunctional agriculture. We develop two sets of regression models in this section to accomplish the objective. First, public attitudes are linked to perceived rankings and ratings of the seven nonmarket goods and services associated with the multifunctional roles of agriculture in an effort to shed light on relative contributions of the seven attributes in explaining the variation in public attitudes. Second, public attitudes are regressed against a set of respondents' psychological and socio-demographic characteristics. Psychological characteristics include perceptions about family farms, farmland conservation programs, government involvement in agricultural affairs, and ecological state. Socio-demographics encompass respondents, age, education, income, and geographic regions of residence. The following presents justifications why the four psychological variables are relevant in our

study: government involvement in agricultural markets, family farms, farmland preservation, and environmental/ecological integrity.

Government involvement in agricultural market has been seriously contested and debated since 1980s in the U.S. given the argument of the market-oriented reformers that returns to farm resources (labor and capital) became comparable to those in nonagricultural sectors. The market-oriented reformers indicate that government intervention should be replaced with risk management tools, while advocates of traditional government support argue that farming sector is not viable without government involvement because of intrinsic uncertainties in farm production and prices (Tweenten, 2002). We hypothesize that respondents who are in favor of government involvement are more likely to be willing to endorse the government to spend taxes for supporting agriculture.

There is a sentiment among some people that farmland represents an important national asset that needs to be protected from poorly considered development plans (Libby, 2002). In support of this sentiment, there is a broad range of farmland preservation programs/policies at federal, state, and local government levels. Such farmland preservation programs are in recognition of the various ecological and amenity services associated with actively farmed land (Hellerstein et al, 2002). We anticipate a positive relationship between respondents' perceptions about the farmland preservation programs and willingness-to-pay taxes.

Concern has been growing about corporate-style farms increasingly replacing family farms (Rosset, 2000). USDA recognizes the protection of family farms as one of its missions in acknowledgment of the benefits that they offer to our society in the form of fostering diversity (ownership, cropping systems, landscape, biological organization, culture and traditions), environmental benefits, and empowerment and community responsibility. We hypothesize that respondents who sympathize that family farms should be preserved would

be more likely to be willing to endorse the government to use tax monies to support agriculture.

Another important attribute of multifunctional agriculture is environmental/ecological conservation (Antle and Valdivia, 2006; Antle and Stoorvogel, 2006). In fact, agri-environmental programs of the USDA has been expanding rapidly in recent years as demonstrated in the creation of conservation security payment (CSP) and environmental quality incentive payment (EQIP) on working agricultural landscapes in contrast to conservation reserve program (CRP) of 1980s which was targeted at idling highly erodible land. We used revised version of NEP (new ecological paradigm) to measure consumers' perceptions about ecological issues (Dunlap and Van Liere, 2008; Dunlap et al, 2000). Revised NEP consists of 15 questions measuring five aspects of environmental attitudes: (i) reality of limits to growth; (ii) anti-anthropocentrism; (iii) the fragility of nature's balance; (iv) rejection of the idea that humans are exempt from the constraints of nature; and (v) the possibility of an eco-crisis or ecological catastrophe (Kotchen and Reiling, 2000). From these 15 question items, we developed an index consisting of seven question items reflecting optimistic views.

Table 1 shows question items used to construct indices measuring respondents' attitudes toward multifunctionality of agriculture and perceptions about each of the four attributes along with summary statistics.

Bivariate ordered probit model

The dependent variables in this study (attitudes toward multifunctionality of agriculture) are measured with a seven-point agree/disagree scale where the intervals between adjacent categories are not equal. Ordered probit model is appropriate for such ordered non-interval data. Further, the two dependent variables (the first focusing on the nature of multifunctional agriculture and the second asking about the need for government

intervention) may be contemporaneously correlated through error terms. Hence, we use bivariate ordered probit model as presented below,

$y_{1i}^{*} = \boldsymbol{\beta}_1^{'}\boldsymbol{x}_{1i} + \varepsilon_{1i}$
$y_{2i}^{*} = \boldsymbol{\beta}_2^{'}\boldsymbol{x}_{2i} + \varepsilon_{2i}$,

$y_{ki} = j\ if\ \mu_{k,j} < y_{ki}^{*} < \mu_{k,j+1}$, k=1,2, and j=0,1,…, 6,

The observed attitude toward the statement agriculture produces intangible benefits that cannot be sold is represented by y_{1i}^{*} and the observed attitude toward the statement that government should compensate farmers for the intangible benefits produced by agriculture is represented by y_{2i}^{*}. The $\mathbf{x}$ is a vector of exogenous variables and the $\boldsymbol{\beta}$ is corresponding vectors of parameters that are estimated along with the threshold values (μ) for each equation. The random error terms ε_{1i} and ε_{2i} are assumed to be distributed identically and independently across individuals in accordance with the standard normal distribution. The key to capturing the tradeoff between attitudes is to correlate the random error terms and a standard normal bivariate distribution function is specified as:

$\emptyset(\cdot) = \emptyset(\varepsilon_{1i}, \varepsilon_{2i}, \rho_{12})$,

where ρ_{12} presents the correlation between the random error terms. The joint probability of a respondent answering in any of the seven categories is,

$$Prob(y_{i,j}) = \Phi\left[\left(\mu_{1,j+1} - \boldsymbol{\beta}_1^{'}\boldsymbol{x}_{1i}\right), \left(\mu_{2,j+1} - \boldsymbol{\beta}_2^{'}\boldsymbol{x}_{2i}\right), \rho_{12}\right]$$
$$-\Phi\left[\left(\mu_{1,j} - \boldsymbol{\beta}_1^{'}\boldsymbol{x}_{1i}\right), \left(\mu_{2,j+1} - \boldsymbol{\beta}_2^{'}\boldsymbol{x}_{2i}\right), \rho_{12}\right]$$
$$-\Phi\left[\left(\mu_{1,j+1} - \boldsymbol{\beta}_1^{'}\boldsymbol{x}_{1i}\right), \left(\mu_{2,j} - \boldsymbol{\beta}_2^{'}\boldsymbol{x}_{2i}\right), \rho_{12}\right]$$
$$-\Phi\left[\left(\mu_{1,j} - \boldsymbol{\beta}_1^{'}\boldsymbol{x}_{1i}\right), \left(\mu_{2,j} - \boldsymbol{\beta}_2^{'}\boldsymbol{x}_{2i}\right), \rho_{12}\right]$$

where, Φ(.) is the cumulative density function. Given the joint probability, the ßs, μs, and ρ are obtained by maximizing the following log-likelihood function:

$L(\boldsymbol{\beta}, \boldsymbol{\mu}, \rho) = \sum_{i=1}^{I}\sum_{j=0}^{6} I_{ij}\, logProb(y_{i,j})$,

where I_{ij} an indicator function that equals one if individual i chooses j and zero otherwise.

Estimation Results

Table 2 shows estimation results for the regression model linking public attitudes toward multifunctional agriculture to perceived rankings among the seven attributes of food self-sufficiency, farmland amenities, viability of rural communities, wildlife habitat, recreational opportunities, and cultural heritage. Food self-sufficiency, farmland amenities, environmental impact, and wildlife habitat turned out to have a statistically significant effect on the first attitudinal question, while cultural heritage was the only significant variable for the second attitudinal question. The results indicate that, for example, respondents who rank food self-sufficiency high are likely to be more recognizant of the concept of multifunctional agriculture than those ranking it lower. Table 3 presents marginal effects associated with each variable in the rankings model. Food self-sufficiency had the largest impact with the value of marginal effect (-0.092), indicating that when ranking of food self-sufficiency increases by one, the probability of accepting the concept of multifunctional agriculture increases by 9. 2 percent, followed by ecosystem services (7.9 percent), farmland amenities (5 percent), and wildlife habitat (4.5 percent). Table 4 presents estimation results for ratings data among five nonmarket goods and services including food self-sufficiency, wildlife habitat, viability of rural economies, farmland amenities, and ecosystem services. Food self-sufficiency and ecosystem services had a statistically significant effect on the first attitudinal question, while none of the five variables were significant in the second attitudinal question. Table 5 shows marginal effects of each variable in the ratings model, confirming the substantial impact of food self-sufficiency (0.292) and ecosystem services (0.091). In sum, these two regression models

commonly demonstrate the importance of national food security (food self-sufficiency) in shaping the general public's attitude toward the concept of multifunctional agriculture.

Table 6 presents estimation results for regression models linking public attitudes toward multifunctional agriculture to perceptions about family farms, farmland preservation, government involvement, ecological state, and free trade along with socio-demographic characteristics. Perceptions about farmland preservation and free trade had a statistically significant effect on the first attitudinal question: i.e., respondents in support of farmland conservation programs and opposed to the idea of free trade in agriculture are more likely to agree to the concept of multifunctional agriculture. Perceptions about government intervention, family farms, farmland conservation, and ecological state were exerting a statistically significant impact on the second attitudinal question: i.e., respondents not favorable to government involvement in agricultural markets, having optimistic view of our environment/ecology, and in support of family farms are predisposed not to agree to the idea of government in charge of addressing problems associated with the supply of multifunctional outputs. Socio-demographics and geographic regions had a significant effect in explain public attitudes toward multifunctional agriculture. Particularly, respondents with higher education and income have a predisposition to support the concept of multifunctional agriculture. Consumers living in Midwest were more likely to be in agreement with the multifunctional roles of agriculture, while people in the South are more likely to support government intervention to address the problems of multifunctional agriculture.

Conclusions

This study was designed to shed light on public attitudes toward the concept of multifunctional agriculture and government intervention to compensate farmers for the supply of multifunctional outputs. Survey data were collected in the summer of 2008 using

web-based panel maintained by Ipsos-Observer. Collected data reveals three major findings between the first and second attitudinal questions: (i) the percentage of respondents in agreement declines from 64 percent to 45 percent; (ii) the percentage of respondents in disagreement increases from 8 percent to 19 percent; and (iii) the percentage of respondents neither agreeing nor disagreeing increases from 28 percent to 36 percent. Further, data show that respondents rank food self-sufficiency as the most important function of multifunctional outputs, remotely followed by ecosystem services. Bivariate ordered probit analyses show that respondents' perceptions (rankings and ratings) about food self-sufficiency and ecosystem services are the two most significant factors shaping public attitudes toward multifunctional agriculture.

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Table 1. Description and summary statistics of variables used in estimation.

Variable	Description	Mean	Alpha	St. Dev.
Attitudes Toward Multifunctional Agriculture	1. Agriculture provides intangible benefits that can not be sold	5.16		1.44
	2. Government should compensate farmers for the intangible benefits produced by agriculture	4.40		1.45
Government Intervention in Agricultural Markets	1. The government should reduce their involvement in agriculture to a level comparable with other sectors of the economy	4.25	0.727	1.59
	2. Farmers should compete in a free market without government support	4.18		1.61
	3. Government should guarantee a minimum price to farmers for their products	3.36		1.75
Family Farms	1. The family farm should be preserved because it is a vital part of our cultural heritage	5.32	0.871	1.48
	2. Obtaining greater efficiency in food production is more important than preserving the family farm	3.30		1.59
	3. Government should have a special policy to ensure that family farms survive	4.94		1.58
Farmland Preservation	1. Farmland should be protected from urban sprawl	5.43	0.712	1.35
	2. There should be no developmental restrictions on the use of farmland	4.80		1.44
Environmental/Ecological Issues	1. The earth has plenty of natural resources if we just learn to develop them.	3.35	0.893	1.65
	2. Humans have the right to modify the natural environment to suit their needs	3.49		1.82
	3. Humans were meant to rule over nature	3.39		1.64
	4. The balance of nature is strong enough to cope with the impacts of modern industrial nations	4.00		1.63
	5. Human ingenuity will ensure that we do not make the earth unlivable	3.81		1.64
	6. Humans will eventually learn enough about how nature works to	3.33		1.87
		3.55		1.49

Table 2. Bivariate Ordered Probit Model Results for Ranking Data.

	Dependent Variable	
Variable	Attitude toward Multifunctional Agriculture	Attitude toward Government Intervention
Constant	2.792***	1.348***
	(0.550)[a]	(0.523)
Food Self-sufficiency	-0.115***	0.032
	(0.027)	(0.027)
Cultural Heritage	-0.024	-0.060**
	(0.029)	(0.029)
Farmland Amenities	-0.063**	0.015
	(0.031)	(0.029)
Recreational Opportunities	0.022	0.018
	(0.029)	(0.030)
Environmental Impact	-0.098***	-0.040
	(0.028)	(0.027)
Wildlife Habitat	-0.057**	0.021
	(0.027)	(0.025)
Threshold Parameter		
μ_1	0.163***	0.186***
	(0.040)	(0.031)
μ_2	0.428***	0.551***
	(0.062)	(0.048)
μ_3	1.461***	1.560***
	(0.090)	(0.066)
μ_4	2.083***	2.367***
	(0.096)	(0.078)
μ_5	2.676***	3.217***
	(0.102)	(0.121)
Correlation, ρ	0.091***	
	(0.018)	
Number of observation	1,070	
Log likelihood	-3311.901	

Note: Double and triple asterisks (*) denote statistical significance at the 5% and 1% levels, respectively.

[a] Values in parentheses are standard errors.

Table 3. Marginal effects of the seven nonmarket goods and services associated with agriculture in the Bivariate Ordered Probit Model

	Equation		
Variable	Intangible Benefits	Governmental Compensate	Both
Food Self-sufficiency	-0.092	-0.002	-0.094
Cultural Heritage	-0.019	0.004	-0.016
Farmland Amenities	-0.050	-0.001	-0.051
Recreational Opportunities	0.017	-0.001	0.016
Environmental Impact	-0.079	0.003	-0.076
Wildlife Habitat	-0.045	-0.001	-0.047

Table 4. Bivariate Ordered Probit Models Results for Ratings Data

	Dependent Variable	
Variable	Attitude toward Multifunctional Agriculture	Attitude toward Government Intervention
Constant	-0.152	0.624***
	(0.201)	(0.187)
Sustaining and Growing Rural	-0.028	0.050
Communities	(0.033)	(0.032)
Adequate Supply of Food	0.286***	-0.049
	(0.027)	(0.031)
Farmland Amenities	0.043	0.056
	(0.036)	(0.037)
Environmental Impact	0.090***	0.033
	(0.029)	(0.033)
Cultural Heritage	0.023	0.038
	(0.033)	(0.035)
Threshold Parameter		
μ_1	0.215***	0.167***
	(0.051)	(0.027)
μ_2	0.534***	0.511***
	(0.071)	(0.043)
μ_3	1.679***	1.499***
	(0.090)	(0.059)
μ_4	2.356***	2.308***
	(0.094)	(0.070)
μ_5	3.006***	3.202***
	(0.098)	(0.118)
Correlation, ρ	0.022	
	(0.019)	
Number of observation	1,070	
Log likelihood	-3269.760	

Note: Double and triple asterisks (*) donote statistical significance at the 5% and 1% levels, respectively.

[a] Values in parentheses are standard errors.

Table 5. Marginal Effects of the five nonmarket goods associated with agriculture

	Equation		
Variable	Intangible Benefits	Governmental Compensate	Both
Sustaining and Growing Rural Communities	-0.029	-0.003	-0.032
Adequate Supply of Food	0.292	0.003	0.295
Farmland Amenities	0.044	-0.003	0.040
Ecosystem services	0.091	-0.002	0.089
Cultural Heritage	0.023	-0.002	0.021

Table 6. Bivariate Ordered Probit Models of Public Attitudes about Multifunctional Agriculture.

Variable	Dependent Variable	
	Attitude toward Multifunctional Agriculture	Attitude toward Government Intervention
Government Intervention	0.010	-0.064***
	(0.008)	(0.007)
Family Farm	-0.026	0.125***
	(0.015)	(0.014)
Farmland Preservation	0.046***	0.037***
	(0.011)	(0.011)
Ecological Issues	-0.002	0.012***
	(0.004)	(0.004)
Free Trade	0.065***	0.007
	(0.014)	(0.014)
Female	-0.072	0.103
	(0.070)	(0.076)
Education	0.277***	-0.077
	(0.098)	(0.103)
Income	0.159**	0.009
	(0.068)	(0.073)
Ethnic		
White	Base	Base
Black	-0.314**	0.285
	(0.152)	(0.176)
Asian	-0.159	0.121
	(0.193)	(0.177)
Other	0.354**	-0.104
	(0.159)	(0.154)
Region		
West	Base	Base
North East	0.051	0.172
	(0.103)	(0.115)
Mid West	0.244**	0.084
	(0.100)	(0.103)
South	0.144	0.209**
	(0.088)	(0.090)
Threshold Parameter		
μ_1	0.105***	0.259***
	(0.025)	(0.042)
μ_2	0.301***	0.722***
	(0.040)	(0.061)
μ_3	1.231***	1.918***
	(0.063)	(0.080)
μ_4	1.849***	2.860***
	(0.069)	(0.090)
μ_5	2.452***	3.855***
	(0.076)	(0.136)
Correlation	0.038*	
	(0.020)	
Number of observation	1,070	
Log likelihood	-3217.827	

Table 5. Marginal effects of perceived attributes underlying multifunctionality.

	Equation	
Variable	Intangible Benefits	Governmental Compensate
Government involvement	0.017	0.0027
Family farms	-0.044	-0.005
Farmland conservation	0.078	-0.002
Ecological state	-0.004	-0.001
Free trade	0.110	-0.000

Appendix

Less than 2% of the U.S. population is currently engaged in farm production. While the U.S. both imports and exports food, the U.S. is essentially self-sufficient in terms of being able to produce the food it needs for its population. However, some other countries are not so lucky and have a strategic goal of achieving a socially acceptable minimum level of self-sufficiency in terms of food production. This minimum level is desired in order to promote national food security (defined as an access to a sufficient amount of food in crises such as war and disruptions in crop supply due to adverse weather).

Intensively managed farming practices using pesticides, fertilizers, and herbicides can negatively impact the environment, polluting ground and surface water. However, when these negative effects are controlled, the U.S. agricultural system is able to produce a wide range of positive effects on the environment including ground water purification, reduction of carbon in the atmosphere, increase in wildlife habitat areas, and recycling nutrients back into the soil. Some people also believe that farmland increase the amount of open space in the country with the aesthetics and amenities open space provides. And that it also enriches our culture by continuing the farming heritage.

Therefore, U.S. agriculture produces not only products for sale (e.g., market commodities such as corn and soybeans), but also provides us with intangible benefits (such as national food security, positive environmental impact, open space, and cultural heritage) that cannot be traded in markets. While farmers are not paid for providing these intangible goods and services, everyone in our society is able to experience agriculture's direct and indirect benefits. Further, people may attach value to the mere existence of farms in our country. Although it is difficult to place a monetary value or price on these intangible goods and services, people would sorely miss these intangible benefits if they were not there.

U.S. agricultural policies have played an important role in shaping today's agriculture. The policies include programs/subsidies that offset the negative environmental effects of farming, enhance rural economies, and boost farm incomes. These policies are at least partly in place in recognition of the intangible goods and services agriculture provides to our society. While the cost of these programs/subsidies vary year by year, the U.S. government spends on average approximately [$X billion], which translates into about [$Y] per each person 20 years and older per year.