

MEASURING PUBLIC PREFERENCES FOR MULTIFUNCTIONAL ATTRIBUTES OF AGRICULTURE IN THE UNITED STATES

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Abstract. The paper examines U.S. citizens' attitudes toward the concept of multifunctional agriculture and their perceptions about its various attributes. While the concept has emerged as a major narrative shaping agricultural policies and WTO trade rules, there are considerable disagreements among researchers and policy-makers about what should be considered legitimate attributes of multifunctional agriculture, preventing WTO negotiations from moving forward. Results show that U.S. citizens rated national food security and environmental services as the most important multifunctional roles of U.S. agriculture, and national food security makes the largest contribution to explaining U.S. citizens' attitudes toward multifunctional agriculture.

Keywords. Doha Round, multifunctional agriculture, national food security, trade liberalization, WTO

JEL Classifications. Q17, Q18

1. Introduction

Multifunctionality in agriculture has emerged in the 1990s as a framework/narrative playing a perceptible role in shaping World Trade Organization (WTO) multilateral trade liberalization talks and farm policy-making processes in developed countries (Potter, 2004). Multifunctional agriculture refers to nonmarket goods and services that agriculture produces with varying degrees of jointness with either farm outputs or farm/rural landscapes. Such nonmarket goods and services typically include 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,

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or groundwater recharge (Abler, 2004; Batie, 2003). Although suspected of disguised protectionism by the proponents of market-oriented reforms, the concept gained considerable legitimacy during the Uruguay Round talks and subsequent international conferences hosted by the Food and Agriculture Organization, the WTO, and the Organization of Economic Cooperation and Development (OECD) in the late 1990s and early 2000s (OECD, 2003; Swinbank, 2001).

Given the wide recognition by major international organizations shaping the global order of agriculture, researchers have examined multifunctional agriculture from diverse disciplines and perspectives such as economics, law, ecology, sociology, political economy, and geography (e.g., Boody et al., 2005; Potter and Burney, 2002; Smith, 2000). In particular, research from the economics perspective examined a sequence of issues that need to be resolved prior to operationalizing the notion of multifunctional agriculture to designing WTO trade rules. These issues are as follows: (1) identifying particular types of multifunctional goods and services on specific geographic scopes (Paarlberg, Bredahl, and Lee, 2002); (2) measuring nonmarket values based on local, regional, or national preferences (Hall, McVittie, and Moran, 2004; Moon and Griffith, 2011; Randall, 2002); (3) evaluating the degree of joint production relationship with either market commodities or farm/rural lands (Abler, 2001; Havlik et al., 2005); (4) assessing whether market failures are involved (i.e., whether underprovided); and (5) measuring transaction costs associated with policies specifically targeted at promoting the production of multifunctional goods and services (Vatn, 2001). Although the five issues listed previously are interconnected with each other, the first two are largely concerned with the general public's (consumers or taxpayers) preferences, and the latter three deal with the supply/production side and policy instrument choice problems.

The first two issues are important as preconditions needed for advancing knowledge on the latter three steps and for eventual implementation to harmonizing WTO trade rules in practice. Nevertheless, there are considerable disagreements among researchers, policy makers, and trade negotiators on what should be considered as legitimate components of multifunctional agriculture, which has hampered the discussions from moving forward (Bennett, van Bueren, and Whitten, 2004; Bergstrom and Ready, 2009; Hall, McVittie, and Moran, 2004; Maudureira, Rambonilaza, and Karpinski, 2007). The disagreements are especially pronounced across the G20, G33, G10, G90, the United States, and the European Union (EU) as has been revealed through the failures of successive Doha ministerial meetings to converge on issue (Moon, 2015).

The primary purpose of this article is to analyze U.S. citizens' preferences about the notion of multifunctional agriculture and their perceptions of the following specific components of multifunctional agriculture including national food security, ecosystem services, farmland amenities, cultural heritage, recreational opportunities, wildlife habitat, and vitality of rural economies. We use cross-sectional data collected by the Ipsos-Observer in 2008 based on

household panels it maintains for research on social issues of significance to our society. The article assesses U.S. citizens' preferences in two steps. First, the article provides descriptive data analysis about their attitudes toward the notion of multifunctional agriculture and their rankings and ratings of the importance of the seven attributes of multifunctional agriculture. Second, the article develops ordered-probit and two-limit Tobit models linking U.S. citizens' overall attitudes toward multifunctional agriculture to their perceived importance of the individual components of multifunctional agriculture, thereby measuring their relative contributions to explaining the variations in attitudes toward multifunctional agriculture. The article aims at generating empirical insights of value to the literature addressing consumers'/taxpayers' preferences particularly from the U.S. perspective and makes a contribution to amassing evidence needed to resolve the disagreements on the debate of what components of multifunctional agriculture should be considered legitimate in WTO multilateral trade negotiations.

2. Importance of Public Preferences in Research on Multifunctional Agriculture

The multifunctional roles of agriculture were officially recognized by the Uruguay Round Agreement on Agriculture (AoA) as manifested in its Preamble, which states: "Commitments under the reform programme should be made in an equitable way among all Members, having regard to NTC [nontrade concerns], 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" (WTO, 1994). The rise of the concept of multifunctional agriculture induced the WTO to devise the so-called traffic light box system (green, blue, and amber boxes) that distinguishes agricultural policies and subsidies based on two criteria: (1) whether they distort trade patterns and (2) whether 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 decisions, thereby minimizing trade distortion.

This creative device gave rise to now widely used terms like *decoupling*, *targeting*, *direct payments*, and *cross-compliances*, laying the groundwork for simultaneously accomplishing the following three goals: (1) reduced farm subsidies in industrialized countries and reduced trade barriers in the developing world, (2) liberalized agricultural trade, and (3) permitting each country to pursue its own goals with respect to multifunctional agriculture. The Doha Round was launched with the specific mandate of advancing these three goals. With respect to the multifunctional roles of agriculture, the Doha Round 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” (WTO, 2001, p. 3). Yet, the Doha Round broke down in 2008 because of disagreements between developed and developing countries and also within each group on the size of reduction in trade-distorting subsidies and on issues largely related to the multifunctional roles of agriculture. The disagreements were specifically over whether to abolish the blue box, whether to expand the scope of the green box, and to what extent to allow policy instruments for sensitive and special products (Blandford and Boisvert, 2001). Developed countries were concerned about import-sensitive products that are more susceptible to competition from foreign countries, whereas developing countries were insisting that special products should be exempt from reduction requirements in protection because of their importance in development, food security, and rural livelihood. In general, proponents of agricultural multifunctionality (mostly developed countries) argue that the scope of the green box needs to be expanded to accommodate production-linked subsidies, whereas the opponents (largely middle-income developing countries) contend that the current green box is either overused or abused as a disguised protectionism. Yet another group of countries (food insecure developing countries) advocate for the creation of a development/food security box comparable to the green box. The debate illustrates the wide divergence in the way the notion of multifunctional agriculture is perceived across countries (Moon, 2015).

The upshot is that the lack of clear guidelines regarding what multifunctional roles of agriculture to consider in designing trade rules is hampering multilateral trade talks from progressing beyond the AoA. In practice, the determination of such guidelines would be affected by various forces such as international politics through international organizations (the WTO), domestic political economy (interest groups’ lobbying), and nation-states’ strategic goals about the agricultural sector. In addition, in an economy in which resource allocations are primarily determined by market forces, consumers’/taxpayers’ preferences should play a substantive role in shaping the guidelines on multifunctional agriculture. Indeed, theoretical and empirical research on measuring public preferences and demand for multifunctional agriculture has been growing steadily in developed countries over the last decades. The research, however, falls far short of being able to provide definitive answers to the question of what types of nonmarket goods and services of agriculture should be recognized as legitimate components of multifunctional agriculture, as well as subsequent questions such as whether they are different across countries and whether the values of multifunctional goods and services identified in each country should be measured at the local, regional, or national level (e.g., Bennett, van Bueren, and Whitten, 2004; Hall, McVittie, and Moran, 2004; Hellerstein et al., 2003; Hyytiä and Kola, 2006). When there are convergences on such issues among researchers and policy makers, the WTO may be able to advance trade negotiations on the

Table 1. Multifunctional Goods (Bads) and Services

Positive Externalities/Public Goods	Negative Externalities
Landscape and open-space amenities	Eutrophication
Cultural heritage	Sedimentation and turbidity
Rural economic viability	Drinking water contamination
Domestic food security	Odors from livestock operations
Prevention of natural hazards	Animal welfare
Groundwater resource recharge	Irrigation-overuse, salinization
Preservation of biodiversity	Loss of biodiversity
Greenhouse gas sinks	Greenhouse gas emissions

Source: Abler (2004).

scope of the green box, the magnitudes of subsidies allowed for each country, and the types of policy instruments permitted for each type of multifunctional agriculture in each country.

The EU has been at the center of the debate on multifunctional agriculture, strongly advocating for the concept since its inception in the 1990s. Prior to the emergence of the notion of multifunctional agriculture, the EU used the notion of the European model of agriculture as a conceptual framework in support of agricultural subsidies in the region. Consistent with such a policy environment, the literature on multifunctional agriculture is extensive in Europe reporting the general public's preferences or willingness to pay for a wide range of multifunctional goods and services encompassing agrarian cultural heritage, adequate supply of food, agricultural landscapes, recreational opportunities, social cohesion, biodiversity, soil conservation, and flood control (e.g., Brouwer and Slangen, 1998; Hall, McVittie, and Moran, 2004; Kallas et al. 2007; Madureira, Rambonilaza, and Karpinski, 2007). Policy makers in the United States have seldom accepted the term *multifunctional agriculture* explicitly, but have used the term *farmland preservation programs* to represent policies/programs designed to assist farm producers to promote the production of public benefits associated with farmlands. Thus, despite the reluctance to fully embrace the notion of multifunctional agriculture as the EU does, U.S. farm/rural policies and programs recognize that agriculture produces diverse benefits that are not priced in the market (Bergstrom and Ready, 2009; Boody et al., 2005; Dorfman et al., 2009).

Research in the United States tends to underline such nonmarket goods and services of agriculture as farmland amenities, open space amenities, recreational and tourism opportunities, ecosystem services (flood prevention, groundwater recharge, and nutrient recycling), biodiversity, viable rural communities, and wildlife habitat (Irwin, Nickerson, and Libby, 2003; Kline and Wichelns, 1998; Rosenberger and Walsh, 1997). Abler (2004) identified negative and positive externalities as presented in Table 1. Building on them, this study considers

seven types of multifunctional goods and services including national food security, ecosystem services, farmland amenities, cultural heritage, recreational opportunities, wildlife habitat, and viabilities of rural economies; examines the general public's perceptions of them; and estimates the relative importance of such perceptions in determining their overall attitudes toward the notion of multifunctional agriculture.

3. Survey Design and Administration

The survey instrument was designed to shed light on the general public's perceptions of and attitudes toward multifunctional roles of U.S. agriculture.¹ The questionnaire was administered as an online survey in June 2008 to a nationally representative web-based household panel maintained by a market research/consulting firm (the Ipsos-Observer) 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 e-mailed to a subsample 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 7 days, accounting for a response rate of 24%. The online survey elicited sociodemographic profiles including respondents' age, education, income, household size, geographic region, gender, and ethnic background. The Ipsos-Observer survey discloses demographic information for nonrespondents and respondents, thereby facilitating assessment of potential nonresponse bias. Comparison of sociodemographic characteristics between respondents and nonrespondents shows that males were more likely to choose not to respond (62% vs. 56%) and whites were slightly more likely to respond to the survey (87% vs. 80.6%). The difference in the two characteristics between the survey sample and the analytic sample is less than 7 percentage points and hence may not cause significant bias. Other than these two categories, there are no discrepancies between respondents and nonrespondents, suggesting that there is little reason to be concerned about biases attributable to systematic nonresponses from particular groups of nonrespondents.

The survey instrument consists of two broad sets of questions. The first set presents a box of information about current U.S. agriculture with a particular emphasis on the positive and negative externalities and the role of U.S. Department of Agriculture (USDA) farm policies in dealing with them (see Appendix). The information box concisely characterizes the USDA's policy goals as manifested in its strategic plan framework (USDA, 2008). This strategic plan is directly connected with the preservation of the multifunctional roles of U.S. agriculture. Given this information box, the survey asked two questions intended

1 The full survey instrument is available on request.

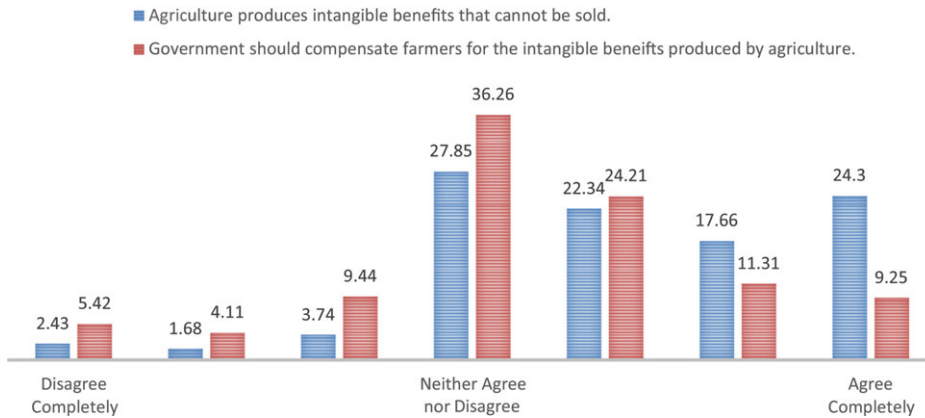


Figure 1. Two Attitudinal Questions on Multifunctional Agriculture

to measure public attitudes toward the multifunctional roles of agriculture in the United States: (1) agriculture produces intangible goods and services that are not traded in markets, and (2) government should compensate farmers for their supply of such intangible goods and services. Respondents were given a 7-point scale ranging from strongly disagree (= 1) to strongly agree (= 7). Because the respondents' responses are contingent on the information box, the results of this study should be interpreted within this context. The second set of questions is 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, and farmland amenities. Respondents were first asked to rank the importance of the seven attributes using the 7-point scale ranging from strongly disagree to strongly agree, and then to rate them from 1 (least important) to 7 (most important).

4. Descriptive Data Analysis of U.S. Citizens' Preferences

This section presents descriptive data analysis that can shed light on U.S. citizens' attitudes toward multifunctional agriculture. Figure 1 shows the distribution of responses to the two attitudinal questions: (1) agriculture produces intangible goods and services that are not traded in markets, and (2) government should compensate farmers for their supply of such intangible goods and services. A substantial percentage of respondents (64%) sided with that statement, whereas 28% of respondents were neutral. Less than 8% disagreed that agriculture produces intangible nontradable benefits. Less than half of the respondents (45%) agreed with the need for government compensation, whereas nearly 19% disagreed and 36% were neutral. Three discrepancies are notable in the distribution of responses between the first and second questions: (1) the

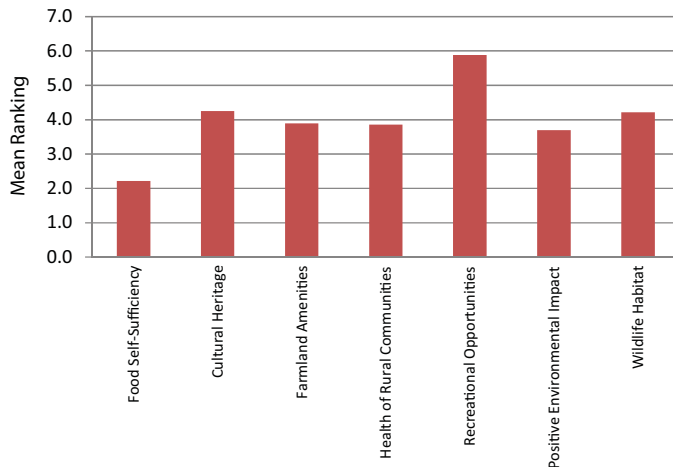


Figure 2. Mean Ranking of the Importance of Nonmarket Goods of Agriculture (1 = most important; 7 = least important)

percentage of respondents in agreement declines from 64% to 45%, (2) the percentage of respondents in disagreement increases from 8% to 19%, and (3) the percentage of respondents neither agreeing nor disagreeing increases from 28% to 36%. Taken together, these results suggest that government involvement, specifically monetary compensation, is a more controversial issue than the concept of multifunctional agriculture itself; that is, although U.S. citizens may recognize the multifunctional roles of agriculture and see that there are market failures, they may not necessarily be in favor of direct government intervention aimed at correcting such market failures.

Figures 2–4 present respondents' relative perceptions of seven specific nonmarket goods and services of multifunctional agriculture. First, Figure 2 shows the mean ranking of the importance of the seven attributes of multifunctional agriculture (1 = most important; 7 = least important). Food self-sufficiency (national food security) was ranked first with a mean score of 2.1, followed by ecosystem 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 3 displaying the percent of the frequency of being ranked first: 61% of the respondents chose national food security as the most important attribute with other attributes ranging from 10% (ecosystem services) to 3% (recreational opportunities). Representing ratings (not rankings) among five nonmarket goods and services of multifunctional attributes (1 = least important; 7 = most important), Figure 4 reinforces the results of the ranking data; that is, adequate supply of food (national food security) was perceived as the most important multifunctional attribute of the U.S. agricultural sector with a mean score of

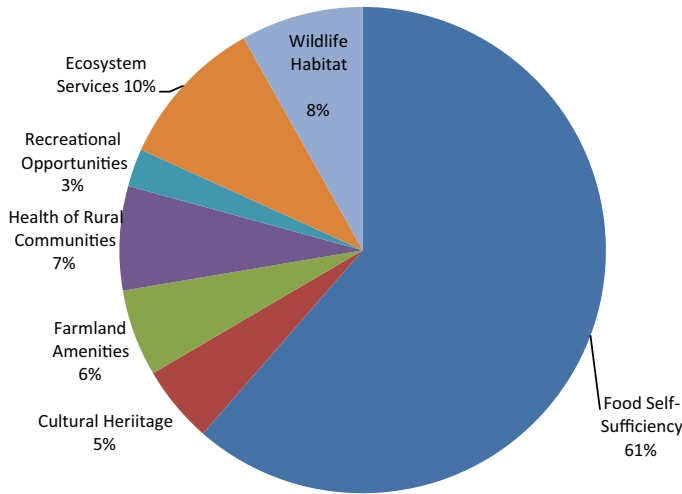


Figure 3. Percent of Respondents Who Ranked Each of the Seven Nonmarket Goods and Services as Their First

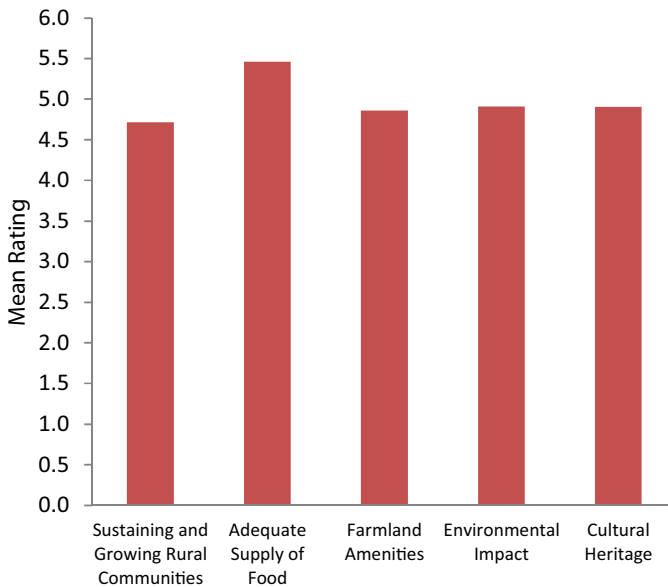


Figure 4. Mean Ratings of the Importance of Five Nonmarket Goods and Services Associated with Agriculture (1 = least important; 7 = most important)

5.5, with other attributes scoring around 4.5. Other than that, the ratings data do show that there is not much variation in U.S. citizens' preferences among different types of multifunctional goods and services. This invariability is notable given that the rankings data represent the results when respondents had to rank,

whereas for the ratings data respondents were asked to simply rate various multifunctional goods and services using the scale of 1 = least important and 7 = most important without necessarily placing them on relative terms. Given the greater flexibility of the rating method for respondents in expressing their preferences, the ratings data are likely to be a more appropriate measure of U.S. citizens' preferences among various multifunctional goods and services than the rankings data. Regardless of the differences in the methods, the overriding finding is that U.S. citizens perceive securing sufficient capacity for agricultural production as the most important multifunctional role of the agricultural sector.

5. Regression Model Specifications

This section specifies regression models to identify factors shaping U.S. citizens' attitudes toward the notion of multifunctional agriculture. We use the following two attitudinal questions on multifunctional agriculture as dependent variables in this study: (1) agriculture provides intangible benefits that cannot be sold, and (2) government should compensate farmers for the intangible benefits produced by agriculture. The first question measures the degree of U.S. citizens' agreement/disagreement with the statement that agriculture produces nonmarket benefits to our society, and the second question measures the degree of U.S. citizens' agreement/disagreement with the statement that government should play a role in promoting the provision of such nonmarket benefits. Given the ordinal nature of the measurements of the two variables (1 = strongly disagree; 7 = strongly agree), we use ordered probit models for estimation. The structural equation for ordered probit model could be written as

$$y_i^* = \mathbf{x}_i\beta + \varepsilon_i, \quad (1)$$

where y_i^* is a latent variable representing i th individual's attitude toward multifunctional agriculture, \mathbf{x}_i is a vector of independent variables, and $\varepsilon_i \sim N(0, 1)$. The relationship between latent and observed ordinal variables can be described as

$$\begin{aligned} y_i = 1, & \quad \text{if } y_i^* \leq \mu_1, \\ y_i = 2, & \quad \text{if } \mu_1 < y_i^* \leq \mu_2, \\ y_i = 3, & \quad \text{if } \mu_2 < y_i^* \leq \mu_3, \\ & \dots \\ y_i = 7, & \quad \text{if } \mu_6 \leq y_i^*, \end{aligned} \quad (2)$$

where the μ 's are unknown "threshold" parameters that determine the spacing between the seven categories of y .

In a subsequent analysis, we construct a single dependent variable by summing up the responses to the attitudinal questions and use it as an overall index of the general public's attitude toward the notion of multifunctional agriculture. Given the 7-point scale used to measure respondents' attitudes for each question, the

constructed variable would range from 2 (the lowest value) to 14 (the highest value). The index variable is then bounded by the lower end and higher end, indicating that it is censored at the two ending points, and we use two limit Tobit models to estimate the model integrating the two dependent measures. The observed index variable, y_i , is related to y_i^* by

$$\begin{aligned} y_i &= 2, & \text{if } y_i^* \leq 2 \\ y_i &= y_i^*, & \text{if } 2 \leq y_i^* \leq 14, \text{ and} \\ y_i &= 14, & \text{if } 14 \leq y_i^*. \end{aligned} \quad (3)$$

Independent variables in this study include two sets: (1) U.S. citizens' perceptions of the five components of multifunctional agriculture (vitality of rural communities, national food security, farm amenities, environmental services, recreational opportunities) and (2) sociodemographic profiles of respondents such as age, education, income, gender, race, and geographic origin. Our interest is in examining the relative contribution of the five components in explaining the variations of the dependent variables. Table 2 shows question items used to construct indices measuring respondents' attitudes toward multifunctionality of agriculture and perceptions about the five components of multifunctional agriculture along with summary statistics.

Given that the regression models include two sets of explanatory variables (perception variables and sociodemographic profiles), the former may mediate the effects of the latter. That is, if sociodemographic profiles are important in explaining respondents' attitudes toward multifunctional agriculture, the effect may be either direct or mediated by the perception variables. To incorporate the possibilities of such mediating relationships, we follow Baron and Kenny (1986) and estimate three regression models: model A including only sociodemographic profiles, model B including only the perception variables, and model C including both sets of variables. If a significant effect of a sociodemographic profile in model A remains unchanged in model C, then the effect is direct on the dependent variable. If the mediation hypothesis holds valid, then sociodemographic profiles' effects would be embedded in the effects of the perception variables, and their coefficients will become statistically insignificant or the size of the coefficients would become substantially smaller in model C that includes both perceptions and sociodemographic profiles. The comparison of estimated parameters and standard errors (SEs) among models A, B, and C will permit us to determine the presence/absence of mediating relationships.

6. Results

This section presents the ordered probit estimates measuring the effects of sociodemographic profiles (model A), the effects of perceived attributes of multifunctional agriculture (model B), and the effects of both sets of variables (model C) on attitudes toward multifunctional agriculture. The dependent

Table 2. Description and Summary Statistics of Variables Used in Estimation

Variable	Description	Mean	Standard Deviation
Attitudes toward multifunctional agriculture ^a	1. Agriculture provides intangible benefits that cannot be sold.	5.16	1.44
	2. Government should compensate farmers for the intangible benefits produced by agriculture.	4.40	1.45
Vitality of rural communities ^b	Sustaining and growing rural communities is the most important function that agriculture performs in addition to producing products for sale.	4.72	1.32
National food security ^b	Ensuring an adequate supply of food (national food security) is the most important service that agriculture produces in addition to producing products for sale.	5.46	1.28
Farmland amenities ^b	Farmland and open space amenities are the most important services that agriculture produces in addition to producing products for sale.	4.86	1.30
Environmental services ^b	Positive ecological services are the most important function that agriculture produces in addition to producing products for sale.	4.91	1.33
Farm cultural heritage ^b	Preservation of our farming cultural heritage is the most important function that agriculture performs in addition to producing products for sale.	4.90	1.43
Female	1 if subject female; 0 if male	0.44	0.50
Age	Age, in years	48.96	16.00
BS degree	1 if subject had some college education or more; 0 otherwise	0.52	0.50
Household size	The number of household members	2.90	1.36
Income	Household income Less than \$20,000 = 1, \$20,000~\$39,999 = 2, \$40,000~\$59,999 = 3, \$60,000~\$99,999 = 4, more than \$100,000 = 5	3.28	1.24
Geographic regions	Dummy variable (yes = 1, no = 0)		
	Northeast	0.19	
	Midwest	0.24	
	South	0.33	
	West	0.24	
Ethnic background	1 if respondent is white; 1 otherwise	0.85	0.35

^aThe scale includes 1 = strongly disagree; 7 = strongly agree.

^bThe scale includes 1 = least important; 7 = most important.

variable in Table 3 is the extent of agreement with the statement that agriculture produces intangible benefits that cannot be traded in markets. Results from model A show that sociodemographic characteristics including gender, age, race, college education, and regional dummy (midwestern residence) were statistically significant. Females are more likely to exhibit favorable attitudes toward the notion of multifunctional agriculture than male respondents, and respondents who are older, white, college educated, and living in the Midwest are more likely to do so than those who are younger, nonwhite, not college educated, and living in regions other than the Midwest. Income did not show any systematic covariation with the attitudes toward nontradable benefits of agriculture.

Among the nonmarket attributes, two attributes (Ensuring an adequate supply of food and Environmental Services) were positively and significantly associated with attitudes toward multifunctional agriculture, whereas the attribute of farmland amenities was marginally significant. That is, respondents who perceive agriculture as providing the service of ensuring national food security, environmental benefits, or farmland amenities were more likely to agree that U.S. agriculture provides nontradable intangible benefits. Respondents' perceptions about vitality of rural community and cultural heritage did not contribute to explaining U.S. citizens' attitudes toward multifunctional agriculture. Model C includes both sets of demographic and nonmarket attributes of agriculture, so it could be used to test the hypothesis of mediation. Estimates of model C show that there are some changes in the estimates of sociodemographic profiles. For example, white becomes insignificant in model C ($\beta = 0.100$, $SE = 0.097$ from $\beta = 0.199$, $SE = 0.095$ in model A), indicating that the effect of race is largely mediated by the perception variables. The effect of education (BS degree) changes slightly between $\beta = 0.330$, $SE = 0.069$ (in model A) and $\beta = 0.297$, $SE = 0.070$ (in model C), suggesting that college education has a largely direct effect on attitudes toward multifunctional agriculture, but not mediated by the perception variables. The effect of age changes from $\beta = 0.010$, $SE = 0.002$ (in model A) to $\beta = 0.005$, $SE = 0.002$ (in model C), indicating that the effect is reduced by half in the full model and that it is partially mediated by the perception variables. Lastly, the effect of gender changes from $\beta = 0.113$, $SE = 0.066$ (in model A) to $\beta = 0.017$, $SE = 0.068$ (in model C), indicating that it is largely mediated by the perception variables.

Table 4 shows the estimated results for the dependent variable representing respondents' attitudes toward governmental compensation for the intangible benefits produced by agriculture. Model A shows that gender, age, and income were statistically significant: females are more likely to exhibit favorable attitudes than males toward the notion of compensating farm producers for the nonmarket goods and services that agriculture produces; the older the respondent, the less likely he or she is in favor of government compensation. Two income categories above \$60,000 household income were negatively associated with governmental compensation. Results from model B show

Table 3. Ordered Probit Estimation Results: Attitudes toward the Notion of Multifunctional Agriculture

Variable	Model A	Model B	Model C
Constant	1.071*** (0.207)	- 0.592*** (0.181)	- 1.037*** (0.252)
Vitality of Rural Community		0.024 (0.035)	0.038 (0.036)
Food Security		0.284*** (0.031)	0.262*** (0.032)
Farmland Amenities		0.066* (0.037)	0.060 (0.037)
Environmental Services		0.137*** (0.033)	0.146*** (0.034)
Cultural Heritage		0.030 (0.033)	0.038 (0.034)
Female	0.113* (0.066)		0.017 (0.068)
Age	0.010*** (0.002)		0.005** (0.002)
BSDegree	0.330*** (0.069)		0.297*** (0.070)
Hhsize	0.008 (0.025)		- 0.002 (0.025)
Income2	- 0.036 (0.128)		- 0.157 (0.130)
Income3	- 0.027 (0.127)		- 0.039 (0.129)
Income4	- 0.127 (0.124)		- 0.153 (0.126)
Income5	0.151 (0.134)		0.193 (0.137)
Midwest	0.137 (0.099)		0.230** (0.101)
South	0.138 (0.093)		0.079 (0.095)
West	0.034 (0.100)		0.016 (0.102)
White	0.199** (0.095)		0.100 (0.097)
Threshold parameter 1	0.244*** (0.056)	0.253*** (0.058)	0.260*** (0.059)
Threshold parameter 2	0.580*** (0.073)	0.601*** (0.076)	0.616*** (0.077)
Threshold parameter 3	1.675*** (0.087)	1.771*** (0.090)	1.823*** (0.093)
Threshold parameter 4	2.269*** (0.090)	2.428*** (0.094)	2.501*** (0.096)
Threshold parameter 5	2.778*** (0.093)	3.016*** (0.098)	3.101*** (0.101)

Table 3. Continued

Variable	Model A	Model B	Model C
Number of observations	1,070	1,070	1,070
Log likelihood	-1,701	-1,598	-1,573
Pseudo- R^2	0.021	0.080	0.094
Chi-squared statistic	71.101***	277.070***	325.660***

Notes: Asterisks (*, **, and ***) denote significance at 10%, 5% and 1%, respectively. Numbers in parentheses are standard errors.

that four attributes of multifunctional agriculture including vitality of rural community, farmland amenities, environmental services, and cultural heritage exert significant influences on U.S. citizens' attitudes toward government compensation for multifunctional agriculture. When respondents perceive agriculture as performing the services of helping rural communities to maintain economic vitality and providing farmland amenities, environmental services, and cultural heritage, they are predisposed to be more in agreement with government compensation designed to promote the provision of such services of the farm sector. However, national food security was conspicuously insignificant with large SE, indicating that respondents who perceive national food security as an important service of agriculture are not likely to be more supportive of government compensation for promoting multifunctional agriculture. This is intriguing and in contrast with the result of the previous ordered probit model (in Table 3). Given that there was a significant association between perceived national food security and the degree of agreement with the notion of multifunctional agriculture, a plausible explanation is that U.S. citizens may perceive that U.S. agriculture is strong and competitive internationally so that it does not need additional monetary public support or there are alternative ways of helping agriculture (other than direct government compensation) to fulfill its task of ensuring national food security. Regarding the hypothesis of mediation, the effect of gender was partially mediated by the perception variables with the coefficients and SEs changing from $\beta = 0.300$ (SE = 0.065) to $\beta = 0.201$ (SE = 0.066); the effects of income were largely mediated by the perception variables with the changes from $\beta = -0.230$ (SE = 0.122) and $\beta = -0.222$ (SE = 0.131) to $\beta = -0.187$ (SE = 0.124) and $\beta = -0.168$ (SE = 0.134), respectively.

Table 5 shows estimated results from the two-limit Tobit model. In this model, all five of the perception variables (environmental services, national food security, vitality of rural community, farmland amenities, and cultural heritage) exert significant influence on the overall attitudes toward the notion of multifunctional agriculture. The result indicates that the general public's perception that U.S. agriculture produces such specific benefits along with marketable commodities contributes to the formation of a more favorable

Table 4. Ordered Probit Estimation Results: Attitudes toward Government Compensation

Variable	Model A	Model B	Model C
Constant	1.788*** (0.202)	-0.765*** (0.174)	-0.266 (0.244)
Vitality of Rural Community		0.183*** (0.034)	0.162*** (0.035)
Food Security		-0.005 (0.031)	0.033 (0.032)
Farmland Amenities		0.103*** (0.036)	0.122*** (0.037)
Environmental Services		0.165*** (0.033)	0.152*** (0.033)
Cultural Heritage		0.089*** (0.032)	0.102*** (0.033)
Female	0.300*** (0.065)		0.201*** (0.066)
Age	-0.005** (0.002)		-0.013*** (0.002)
BSDegree	-0.101 (0.067)		-0.097 (0.069)
Hhsize	0.034 (0.024)		0.015 (0.025)
Income2	0.038 (0.126)		-0.029 (0.128)
Income3	-0.137 (0.125)		-0.126 (0.127)
Income4	-0.230* (0.122)		-0.187 (0.124)
Income5	-0.222* (0.131)		-0.168 (0.134)
Midwest	-0.095 (0.098)		-0.043 (0.099)
South	0.105 (0.092)		0.062 (0.093)
West	-0.061 (0.099)		-0.085 (0.100)
White	0.094 (0.093)		0.024 (0.095)
Threshold parameter 1	0.307*** (0.045)	0.333*** (0.048)	0.342*** (0.049)
Threshold parameter 2	0.753*** (0.058)	0.808*** (0.062)	0.832*** (0.064)
Threshold parameter 3	1.789*** (0.068)	1.941*** (0.073)	1.996*** (0.075)
Threshold parameter 4	2.494*** (0.074)	2.749*** (0.081)	2.827*** (0.083)
Threshold parameter 5	3.014*** (0.082)	3.378*** (0.092)	3.478*** (0.095)

Table 4. Continued

Variable	Model A	Model B	Model C
Number of observations	1,070	1,070	1,070
Log likelihood	-1,781	-1,660	-1,632
Pseudo-R ²	0.015	0.082	0.097
Chi-squared statistic	53.902***	295.940***	351.960***

Notes: Asterisks (*, **, and ***) denote significance at 10%, 5% and 1%, respectively. Numbers in parentheses are standard errors.

attitude toward the notion of multifunctional agriculture. We computed their marginal effects and standardized coefficients so that we could compare the magnitudes of the effects across the five perceived attributes of multifunctional agriculture (Table 6). It shows that environmental services had the strongest effect (0.49), followed by national food security (0.43), vitality of rural community (0.35), farmland amenities (0.29), and cultural heritage (0.25).

7. Conclusions

This study was designed to shed light on public attitudes toward two issues: (1) the concept of multifunctional agriculture and (2) government intervention to compensate farmers for the supply of multifunctional goods and services in the United States. Survey data were collected in the summer of 2008 using the web-based panel maintained by the Ipsos-Observer. The data reveal three major differences between the first and second attitudinal questions. First, the percentage of respondents in agreement declines from 64% to 45%. Second, the percentage of respondents in disagreement increases from 8% to 19%. Third, the percentage of respondents neither agreeing nor disagreeing increases from 28% to 36%. The findings suggest that the issue of compensating farmers through the government for their role in promoting multifunctional agriculture is more controversial than the concept itself. They further show that U.S. citizens consider ensuring national food security as the most important attribute of the multifunctional role of the U.S. agricultural sector.

Regression analyses show that U.S. citizens' attitudes toward multifunctional agriculture are most strongly influenced by perceived importance of environmental services and national food security, followed by vitality of rural community and farmland amenities, and lastly by cultural heritage. The results indicate that whether U.S. citizens consider U.S. agriculture as contributing to ensuring national food security and to producing positive environmental services would play an important role in determining their overall attitudes toward the notion of multifunctional agriculture. The importance of environmental aspects in the formation of public attitudes is plausible considering that various dimensions of agricultural production are linked with the management of environmental

Table 5. Two-Limit Tobit Models Estimation Results

Variable	Model A	Model B	Model C
Constant	8.34*** (0.46)	2.75*** (0.32)	2.78*** (0.46)
Vitality of Rural Community		0.29 (0.07)***	0.27*** (0.07)
Food Security		0.33*** (0.06)	0.34*** (0.06)
Farmland Amenities		0.21*** (0.07)	0.22*** (0.07)
Environmental Services		0.39*** (0.06)	0.38*** (0.06)
Cultural Heritage		0.16** (0.06)	0.18*** (0.06)
Female	0.64*** (0.15)		0.32** (0.13)
Age	0.01 (0.00)		-0.01** (0.00)
BSDegree	0.31* (0.16)		0.25* (0.13)
Hhsize	0.07 (0.06)		0.03 (0.05)
Income2	0.04 (0.30)		-0.22 (0.25)
Income3	-0.24 (0.30)		-0.22 (0.24)
Income4	-0.53* (0.29)		-0.45* (0.24)
Income5	-0.12 (0.31)		-0.01 (0.26)
Midwest	0.09 (0.23)		0.27 (0.19)
South	0.37* (0.22)		0.20 (0.18)
West	0.02 (0.23)		-0.03 (0.19)
White	0.45** (0.22)		0.19 (0.29)
Sigma	2.45*** (0.06)	2.05*** (0.05)	2.02*** (0.18)
Number of observations	1,070	1,070	1,070
Log likelihood	-2,395.1	-2,202.3	-2,188.7
Pseudo-R ²	0.0084	0.0882	0.0939
Chi-squared statistic	893.5***	2,284.5***	3,799.3***

Notes: Asterisks (*, **, and ***) denote significance at 10%, 5% and 1%, respectively. Numbers in parentheses are standard errors.

Table 6. Marginal Effects and Standardized Coefficients from the Two-Limit Tobit Model

Variable	Marginal Effect	Standardized Coefficient
Constant	2.74*** (0.45)	
Vitality of Rural Community	0.26*** (0.07)	0.35
Food Security	0.33*** (0.06)	0.43
Farmland Amenities	0.22*** (0.07)	0.29
Environmental Services	0.37*** (0.06)	0.49
Cultural Heritage	0.18*** (0.06)	0.25
Female	0.32** (0.13)	0.16
Age	-0.01** (0.00)	-0.16
BSDegree	0.25* (0.13)	0.12
Hhsize	0.03 (0.05)	0.03
Income2	-0.22 (0.24)	-0.09
Income3	-0.22 (0.24)	-0.09
Income4	-0.44* (0.24)	-0.20
Income5	-0.01 (0.25)	0.00
Midwest	0.27 (0.19)	0.11
South	0.19 (0.18)	0.09
West	-0.03 (0.19)	-0.01
White	0.19 (0.18)	0.07
Scale factor	0.98	

Notes: Asterisks (*, **, and ***) denote significance at 10%, 5% and 1%, respectively. Numbers in parentheses are standard errors.

and natural resources and the general public is well aware of such linkages. Furthermore, U.S. farm bills typically include a significant share of USDA budgets for subsidizing farm producers' efforts for environmental conservation.

However, the estimated importance of national food security in explaining U.S. citizens' attitudes toward multifunctional agriculture is unexpected in view of the fact that the food self-sufficiency rate is nearly 120% in the United States and that

therefore the general public may afford to be complacent about the capability of the U.S. food supply system to feed them today and in the future. National food security is considered typically as an issue of importance in developed net food-importing countries like Japan, Korea, or Norway, which have very low food self-sufficiency rates ranging from 23% to about 50% because of the high production cost structures in these countries. National food security is also an immensely important issue in net food-importing developing countries in sub-Saharan Africa or South Asia, which suffer from food insecurity arising from the inability of low-income households living with less than \$1 per day to gain access to food. Furthermore, these developing countries might be disproportionately at greater risk than developed countries in times of food shortages at the global scale given the severely underdeveloped infrastructure of their agricultural sectors.

That U.S. citizens perceive national food security as an important function of agriculture may explain the tolerance of consumers, taxpayers, or voters about agricultural protection that has been pervasive in the United States during the second half of the 20th century. Political economy theories (public choice model; Mark Olson's collective action hypothesis) take a particular position on the role of the general public in the debate on farm subsidies. They theorize that the general public does not have strong incentives to protest against agricultural protection given the costs imposed on the public are insignificant (thinly spread over a large number of consumers and taxpayers). Such a theorization about the role of the general public may be misleading when considering the support the general public renders to national food security as the most important function of the agricultural sector, as demonstrated in this study. That is, the general public may have been tolerant of farm subsidies not because the costs of farm subsidies on individual consumers/taxpayers are small, but because they do support subsidizing and strengthening their agricultural sectors. Consistent with the previously discussed reasoning, Kerr (2010) recognizes that the demand for support of agriculture may come from consumers and producers and that a new economic model should be developed to facilitate discourses on how to best incorporate consumers' concerns/interests into WTO trading rules.

In closing, this study suggests that national food security is an issue of significance not only to net food-importing developed and developing countries, but also to net food-exporting and agriculturally competitive countries like the United States. The current WTO trade rules (AoA) concerning multifunctional agriculture as contained in the traffic light box system emphasize environmental/ecological services, farm amenities, or rural development. The central feature of the AoA is the green box enabling member countries to use decoupled policies and promote such functions. Although the AoA mentions the significance of food security, policy options available to food insecure developing countries such as special and differential treatment provisions are transitory and concessionary when compared with the green box. That explains why countries within the developing world have been demanding the creation of a food security

box (analogous to the green box) during the Doha negotiations so that they can maintain the flexibility to choose the types of policy instruments that would fit their specific needs of strengthening the infrastructure for agricultural production. The importance of national food security as shown in this study suggests that it could be a legitimate component of multifunctional agriculture that can be accepted universally across countries at different developmental stages, at least from the general public's perspective.

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Appendix

Less than 2% of the U.S. population is currently engaged in farm production. Although the United States both imports and exports food, the United States 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 because of adverse weather).²

Intensively managed farming practices using pesticides, fertilizers, and herbicides can negatively affect the environment, polluting groundwater 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 groundwater 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 that open space provides, and that it also enriches our culture by continuing the farming heritage.

Therefore, U.S. agriculture not only produces 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. Although 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. Although the cost of these programs/subsidies varies 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.

2 The information box in this article tried to convey the state of the global food economy as realistically as possible in consideration that more than 800 million people today suffer from chronic lack of access to nutritious food and a sufficient amount of food and that the Doha Round is still in a stalemate because of WTO member countries' unwillingness to give up their agricultural interests. Under such a situation, the most reliable way of improving food security is to encourage domestic agricultural production.