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MARKETING ECOSYSTEM SERVICES FROM AGRICULTURAL LAND: STATED PREFERENCES OVER PAYMENT MECHANISMS AND ACTUAL SALES OF FARM-WILDLIFE CONTRACTS

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MARKETING ECOSYSTEM SERVICES FROM AGRICULTURAL LAND: STATED PREFERENCES OVER PAYMENT MECHANISMS AND ACTUAL SALES OF BIRD HABITAT ON HAYFIELDS

Agriculture conventionally supplies food, fiber and fuel that consumers can purchase through the market. With the right incentives, farmers can also provide ecosystem services such as wildlife habitat, climate regulation, surface water flows and waste absorption and breakdown. Such incentives have so far come almost entirely from government-sponsored programs that rely on financial assistance to farmers to encourage them to alter agricultural practices or input mix to enhance ecosystem services. Programs recently implemented in Costa Rica and Columbia rely on payments by the beneficiaries of the ecosystem services, such as municipal water companies and water users (Pagiola, Landell-Mills et al. 2002). Few of these programs, however, have attempted to establish a market for ecosystem services in which the beneficiaries of such services pay the suppliers their personal values of ecosystem services in an actual market.

Markets for ecosystem services must overcome two major challenges. In order to set prices for ecosystem services at the “right” level, it is imperative to understand consumers’ preferences. Farmland, however, has multiple attributes such as wildlife habitat services and landscape view; the marginal rate of substitution among those attributes must be understood to design marketable products for ecosystem services. Moreover, many ecosystem services are public goods for which traditional markets are ill-suited, because many individuals can receive benefits simultaneously regardless of whether they have paid part of the cost of provision. Therefore, consumers have an incentive to free-ride on others. Evidence from previous research on public goods clearly suggests that under-contribution is typical (Ledyard 1995).[1]

[1] Relying on payment mechanisms that inaccurately reflect contributors’ preferences implies that socially desirable public goods are produced at suboptimal levels and underscores the need for a market mechanism capable of revealing the true demand for ecosystem services.

The overall goal of this study is to explore the potential to establish an actual market in which the public can purchase ecosystem services generated by agricultural land. Specifically, this paper examines the performance of alternative elicitation methods, some of which theoretically reduces individuals' incentives to free-ride on others' payments. The application involves valuation of an ecosystem service, which is a significant area of public policy concern as governments and non-profit organizations, both domestic and international, attempt to introduce market-based mechanism to enhance the provision of ecosystem services (e.g., USDA2007).

Using a choice experiment involving a large-scale mail survey, we first estimate the marginal rate of substitution consumers place on various attributes of farmland including the ecosystem services such land can provide. We then utilize the choice experiment data to compare the marginal utility of income and attributes across elicitation mechanisms and examine their capability to attract participation and revenue, as well as their capacity to reveal a willingness-to-pay that is close to its theoretical true value. We conclude by comparing the results from a hypothetical survey to the outcome of our effort to establish an actual market in which individuals are asked to purchase a share of a farm contract to provide ecosystem service with real money under different payment mechanisms. To the best of our knowledge, this is the first study to examine the performance of different payment mechanisms for provision of ecosystem services using field experiments both within a hypothetical setting and by developing an actual market.

Elicitation Methods of Payments for Public Goods and Tested Hypotheses

Many ecosystem services are public goods for which traditional markets are ill-suited, because many individuals can receive benefits simultaneously regardless of whether they have paid part of the cost of provision. Therefore, consumers have an incentive to free-ride on others. Evidence from previous research on public goods clearly suggests that under-contribution is typical (Ledyard 1995). Relying on payment mechanisms that inaccurately reflect contributors' preferences implies that socially desirable public goods are produced at suboptimal levels and underscores the need for a market mechanism capable of revealing the true demand for ecosystem services.

Controlled economic experiments have shown that individuals will increase donations to a public good project if the payment rules reduce the incentives for individuals to free ride on the contributions of others. Marks and Croson (1998, c.f. Rondeau, Schulze et al. 1999; Poe, Clark et al. 2002) show that individuals will pay dollars into a project if there is a provision point and money back guarantee. Under these conditions, the public good is supplied only if a pre-specified amount of money (the provision point) is raised, and contributors receive their money back if the market fails to raise that amount. Spencer, Swallow et al. 1998 successfully applied the provision point mechanism to water quality monitoring.

We extend this literature in several ways. While most of the previous work focused on the effect of a combination of a provision point and a money-back guarantee, this mechanism is not incentive compatible. In addition to the provision point mechanism, we examine and compare the performance of the pivotal mechanism, which is an incentive compatible mechanism. Theoretically, the pivotal mechanism can serve as a benchmark of true revelation of preferences. We also examine the performance of the uniform price auction, which is not incentive compatible but has a 'fairness' feature that other mechanisms do not have.

Furthermore, although most previous studies compared how the mechanism in question affects how much individuals contribute to a public good, we examine the underlying reasons of why people contribute different amounts. To do so, we utilize a choice experiment and allow quantity of the good as well as the cost to the individual to vary. Using the data from the choice experiment, we can econometrically test whether the mechanism affects marginal utility of income or it also affects the marginal utility of the particular good. We also examine how market participation rate is affected by elicitation methods.

More specifically, we compare four payment mechanisms applied in field experiments: 1) voluntary contribution mechanism (VCM), 2) provision point with a money-back guarantee and proportional rebate of excess contributions (PR), 3) uniform-price, multi-buyer auction (UPA) and 4) pivotal mechanism (PM). VCM has no provision point but has a money-back guarantee a pre-specified amount of money is not raised. Under PR, the public good is supplied only if a pre-specified amount of money (the provision point) is raised, and contributors receive their money back if the market fails to raise that amount. Under a multi-buyer auction, everyone who is willing to pay above a certain “price” will pay a price such that the total sum will be enough to cover the cost for a farmer to change harvest practices. Under a pivotal mechanism only those consumers whose payments make a difference in the provision of the good would pay. The pivotal mechanism is incentive compatible and is used as the baseline. In this research, a provision point relates to the minimum of total offers that are required to implement a contract to provide the ecosystem service.

Habitat for Grassland Nesting Birds: An Application

The ecosystem service in question in this study is habitat for a grassland-nesting bird called the Bobolink (*Dolichonyx oryivorus*). Yellow and black Bobolinks establish ground nests in hay fields from mid-May into early June. Their visibility and entertaining character, combined with evidence that many birds, including bobolinks, are experiencing population declines (Sauer, Hines et al. 2004), make the bird a leading candidate to attract public interest in efforts to manage farmland for vulnerable wildlife. Previous studies have established that hay harvesting conducted during the birds' five to six week nesting period is devastating to fledgling success (e.g., Mitchell, Smith et al. 2000). A fairly moderate shift in the harvest schedule could provide significant refuge for nesting birds while causing some losses of the quantity and quality of the hay harvested. If a market developed that paid farmers acceptable compensation to protect grassland birds, then farmers would have an incentive to add an ecosystem service to their revenue base while enhancing environmental quality for wildlife.

Choice experiment

As a precursor to establishing a market for this ecosystem service generated by hayfields, we measure the residents' preferences by employing a choice experiment (CE). CE is based on random utility theory and attempts to understand the individuals' preferences over the attributes of scenarios. The combinations of attributes comprise specific scenarios that are selected from a set of possible scenarios. Unlike the contingent valuation method that focuses on a precise scenario, CEs ask each individual to choose from alternative scenarios, i.e., bundles of attributes. They have been used in marketing, transportation, psychology, and more recently, in the environmental economics literature (Adamowicz, Boxall et al. 1998). They are useful as a method of eliciting values and preferences for ecosystem services, as a given resource often provides multiple ecosystem services.

CE was designed to elicit preferences relating to changing hayfield management to protect grassland birds. Before the CE questions, we first presented information on how hayfields in their community provide habitat to Bobolinks and other grassland birds. We described what Bobolinks are, reasons why their population is in decline and how residents can help farmers make wildlife protection a part of farmers' business plan. We also explained other benefits of hayfields such as its potential role in preventing invasive species.

We then presented a hypothetical setting of an opportunity for the respondents to purchase a 'farm-wildlife contract'. The setting was described as follows:

- Ecologists have identified farms in Jamestown with Bobolink habitats.
- The farmers are willing to enter into farm-wildlife contracts to include wildlife in their business plan. Under the contract, the Jamestown residents would pay a farmer to protect nesting birds during the breeding season by delaying harvest and restoring inactive fields.
- The total contract cost depends on the characteristics of the farm. Different farmers may face different costs, even if they provide wildlife and landscape amenities on the same number of acres.
- The residents in Jamestown are asked to pay for a share of farm-wildlife contracts.

Respondents were asked to compare several sets of farm-wildlife contracts, each of which was characterized by four attributes and its cost (Table 1). 'Acres of managed hay fields' was presented as one attribute. However, in fact it is a composite attribute with two elements, acres and the expected number of bobolink fledglings. These two elements are positively (but not perfectly) correlated: the larger the area of managed hay fields, the higher the expected number of bobolink fledglings. In designing the CE, the number of bobolink fledglings was treated as an independent, two-level attribute. For example, 10 acres of managed hayfields can result in either 15-25 bobolink fledglings (low) or 30-45 bobolink fledglings (high). The second attribute, acres of restored fields, also with four levels, was included because from our discussions with the local farmers we saw an opportunity in restoring abandoned fields into actively managed hayfields, which would in the long run provide additional habitat for grassland birds. 'View' was a two-level attribute—a parcel either has a view from a major road or not. 'Tour', a two-level attribute, is a private good character of a farm-wildlife contract, where the contract either includes an invitation to an expert-led bird walk or not. Finally, 'cost' is an eight-level attribute. In the fifth of the six questions, the cost became a composite attribute: we gave a 10% or a 20% discount for the 'both' option. In designing the CE, the level of discount was treated as an independent, two-level attribute. We also included a sixth question where only one contract was offered; the respondents were asked whether or not he/she would be willing to purchase that contract. The attributes, their levels and the methods of describing each one were constructed based on information obtained from focus group meetings and through consultation with an avian biologist and were tested and refined during pretesting.

The respondents were asked to compare six pairs of farm-wildlife contracts that differ in land size of managed hayfields for bobolink habitat and other characteristics. Each contract was characterized by four characteristics and its cost (Table 1). Respondents were asked to make decisions on six, independent sets of farm-wildlife contracts. The first five questions had two alternative contracts, while the sixth question only included one contract. Individuals were asked to choose among 'do nothing', two alternative farm-wildlife contracts, or 'both' (in the first five questions only) and if both, which farm-wildlife contract they still preferred. In the fifth question, we gave a 10% or a 20% discount for the 'both' option, while fixing the 'tour' option to 'invited to a bird walk.' We also included a sixth question where only one contract was offered; the respondents were asked whether or not he/she would be willing to purchase that contract.

The scenarios were constructed from a 4^2x2^3x8x2 orthogonal main-effects design using SAS. In total, we had 256 pairs of farm-wildlife contracts for comparisons and 32 single farm-wildlife contract questions. However, to make the choice task manageable for each individual, the design was blocked into groups, depending on the question and the treatment.

Treatments

The residents were randomly divided into two major groups with seven subgroups in total, each with a different treatment. The residents were first split into two groups. The first group was further divided into four subgroups Voluntary Contribution Mechanism (VCM), Proportional Rebate (PR), Uniform Price Auction (UPA) and Pivotal Mechanism (PM). These four subgroups were asked to make a decision under a hypothetical referendum for a tax increase to implement the contract. They then received four more questions, this time based on one of these four mechanisms.

The second group was further divided into three subgroups. Each group was assigned to one of the following three payment mechanism: Proportional Rebate (PR), Uniform Price Auction (UPA) and Pivotal Mechanism (PM). Other sections of the survey were identical for all the residents. Details of each mechanism are provided in Appendix xx.

Importantly, the treatments were randomly assigned to the residents and the structure and the design of the choice experiments was the same for all treatments. Descriptive statistics of the demographic characteristics show that there were no systematic differences among the treatment groups (Table 2).

Survey Design and Implementation

To develop the survey, the research team first held two focus groups in Massachusetts. There were approximately eight people in each focus group. We took the information learned from these and developed a draft of our survey. This survey was then pretested at the Division of Motor Vehicles in Wakefield, Rhode Island. Those completing this survey were timed to test the length of taking the survey and they were asked questions upon completion to find any difficulties in taking the survey. The survey was revised based on the feedback received and was pretested again in a similar manner. This process was repeated several more times. Individual's reactions to different mechanisms' explanations and examples of were carefully studied in each case. The final survey was then created based on both the focus groups and the pretesting of earlier versions.[2]

The final survey was collected between October to December 2006 following the Dillman's Tailored Design Method (Dillman 2000), in which mailings were done as following: 1) initial letter explaining what the survey was about and when it should be coming, 2) initial mailing of the survey, 3) a reminder postcard to those that did not respond, 4) a second survey and 5) a final reminder letter. Each mailing of the survey included a cover letter and stickers in which to seal the completed survey for mailing. We had a total of 224 different versions (32 blocks x 7 treatments) of the survey, which were randomly assigned to individuals. Special care was taken to assure that individuals received the same version of the survey in each mailing.

The sampling frame used for the survey was all available addresses of Jamestown residents purchased through a commercial databank. If there were more than one adult per address with the same family address, we selected one individual randomly. At the end, the surveys were sent to 2893 households.

The response rate was 38.2% after accounting for undelivered surveys (Table 3). There were no systematic differences in response rates among the four mechanisms. Type 2 surveys had a slightly lower response rate compared to Type 1 surveys, but we did not find any systematic

[2] The survey was composed of five sections. The first section included questions about their past and present community, as well as questions about their opinion on farms and their wildlife. The second section included choice questions which asked which farm contract, if any, the survey respondents would purchase. In the third section, individuals were asked about their opinions on farmland amenities. The fourth section asked individuals about their opinions on wildlife conservation efforts. The final section consisted of demographic questions about the respondent and their household.

differences in demographic variables between type 1 group and the type 2 group. Using demographic variables available in the original database, the mean age was slightly higher for the respondents compared to non-respondents, but there were no systematic differences in income or gender.

Model Specification and Estimation

The CE structure with different treatments can be analyzed using a random utility model (Hanneman 1984; Adamowicz, Boxall et al. 1998). The choice of a scenario represents a discrete choice from a set of alternatives. For each alternative i $(i \in A, B, neither, both)$ under treatment *m* $(m \in VCM, PR, UPA, PM, Type1, Type2)$ is represented with an indirect utility function that contains a deterministic component (V_{im}) and a stochastic component (e_{im}). The overall indirect utility of alternative i in the k^{th} occasion under treatment *m* is represented as $U_{im} = V_{im} + \varepsilon_{im}$. An individual will choose alternative i if $U_{im} > U_{jm}$ for all $j \neq i$. Since the utilities include a stochastic component, the probability of choosing alternative i is described as

$$\Pr\left(i\ chosen\right) = \Pr\left(V_{im} + \varepsilon_{im} > V_{jm} + \varepsilon_{jm}, \quad \forall j \in C, j \neq i\right) ,$$

where C is the set of all possible alternatives.

Assuming a type I extreme value distribution for the error terms and independence between choice scenarios and individuals, the probability of choosing alternative i becomes

$$\Pr(i) = \frac{e^{\lambda_m V_i}}{\sum_{j \in C, j \neq i} e^{\lambda_m V_j}}$$

where λ_k is the scale parameter for treatment *m*. We employ conditional logit to estimate these parameters (later version of the paper will include results from a panel mixed logit model.)

The general form for the deterministic component is

$$V_{im} = \alpha_{im} + \beta_m (Y - C_{im}) + \gamma_m (Z_{im}) \quad (1)$$

where α_{im} is a vector of alternative specific constants and treatment effects on the base utility of the neither and both alternatives; Y represents the respondent's income; C_{im} represents the cost of alternative i under treatment m; and Z_{im} represents a vector of all other attributes of alternative i under treatment m, which include acres of managed hayfields, expected fledglings saved (high or low), acres of hayfields restored, farm landscape view and invitation to bird walk in 2007. The subscript m is included because even though all the attributes were common across the treatments, we capture the treatment effect using interaction terms between each treatment and the attribute. β_m and γ_m are parameters capturing the marginal utility of income and the marginal utility of all other attributes of a farm-wildlife contract for alternative i under treatment m.

We report two versions of the model, one without treatment effects and the other with treatment effects. Each version was estimated in linear and quadratic forms, with and without income effects on β_m.[3]

[3] In any single sample, the scale parameter cannot be identified and thus is assumed to be one. In separate samples or across separate data types, however, one can compute the relative scale parameter, which accounts for the difference in the variation of the unobserved effects or error variance heterogeneity. Since each type of treatment should be consistent with random utility theory and the choices are being made over the same types of situations, we can also combine the data sets and examine the relative scale effects. Combining data adds information for model estimation; using Swait and Louviere (1993), we can test whether the differences in the estimates across treatments are due to differences in marginal utility of income, marginal utility of farm-wildlife contract attributes, or the variance of the unobserved components, or all of them. In our application, the data from all treatments are pooled. Normalizing the scale factor for one of the treatments set to unity, we can estimate the relative scale parameter along with other parameters in the equation.

Hypotheses

Using the above model, we compare the elicitation methods from four aspects: if and how elicitation methods affect respondents' choices and preferences; willingness-to-pay for ecosystem services and other attributes market participation rate; and total revenue collection. Here we lay out the hypotheses to be tested.

If there is no treatment effect from different elicitation methods, then all the alternative specific constants α_m, as well as all the parameters β_m and γ_m that are interacted with specific treatments that capture the effects of the treatments are jointly equal to zero (hypothesis 1).

Next, we examine the more specific process through which elicitation mechanisms may affect preferences. If respondents treat monetary costs differently under certain elicitation mechanisms, then we expect each elicitation mechanism to yield different estimates of β_m, the marginal utility of income (hypothesis 2). On the other hand, if respondents treat attributes of the farm wildlife contracts differently under different elicitation methods, then the estimates of γ_m, the marginal utility of attributes, will differ (hypothesis 3). Johnston et al. (1999) have shown that substitution effects may arise between how the public good is financed and the attributes of the good. Therefore, there is a potential that elicitation methods with different incentives to curve freeriding may change the marginal utility of an attribute.

Respondents also may react to the treatment by a fixed effect on their overall utility for a given utility. This effect can be represented as a shift in the intercept of the willingness-to-pay function (Swallow 1994). In model (1), this effect is identified by the interaction terms between each treatment and alternative specific constants, in particular for "neither" alternative (hypotheses 4 and 5).

Respondents may react to different elicitation methods such as PR, UPA and PM differently if they had an experience with an alterative method immediately prior to the method in question that can serve as a reference. In our sample, respondents who received Type 1 of the survey was asked to make a choice under a hypothetical referendum for a tax to implement farm-wildlife contract. We test whether or not this reference mechanism makes a difference in treatment effects (hypothesis 6).

Next, using the estimates for marginal utility of income and of attributes, we estimate and compare the willingness-to-pay for each attribute. Since UPA, PR, and PM all have incentives to curve freeriding, such as a provision point with a money-back guarantee if not enough money is offered, we hypothesize that these three mechanisms reveal higher WTP compared to VCM. Moreover, PM is the only incentive compatible mechanism, so we expect PM to reveal a higher WTP for attributes. Finally, since respondents under UPA only need to pay the smallest offer that is enough to reach the provision point, there might be an incentive to bid a smaller offer than their true value. We therefore hypothesize the following:

VCM<UPA<PR<PM (hypothesis 7).

On the other hand, UPA has a 'fairness' aspect that PR does not have, which may affect the market participation rate. We hypothesize the ranking of the mechanisms in terms of participation rate as follows:

VCM<PR<UPA<PM (hypothesis 8).

Results from Choice Experiment

The conditional logit model results in both the linear and quadratic forms are as expected (Table 4).[4] In all four variants of the model, all five non-monetary attributes have positive and

4

significant coefficients. The coefficients on area of managed hayfields and area of restored fields get slightly smaller as these areas increase. The coefficient on cost is negative and significant, as expected. The quadratic model (columns 3 and 4) outperforms the linear model (columns 1 and 2) but produces qualitatively similar results.

The results of the conditional logit model with variables interacted with elicitation methods are generally consistent with the model without the interaction terms (Table 5). The base category is referendum tax. In all three variants of the model, all five non-monetary attributes have positive coefficients. The coefficient on the binary variable indicating high bobolink habitat is insignificant in columns (2) and (3). This result may be reflecting the possibility that since this variable and acres of managed hayfields were presented as a combined attribute in the CE questions, the respondents may not have paid attention to high and low levels of bobolink fledglings and instead focused their attention on the area. The coefficients on area of managed hayfields and area of restored fields get slightly smaller as these areas increase. The coefficient on cost is negative and significant, as expected.

Comparing the coefficients on the non-monetary attributes between models without controlling for elicitation methods (Table 4) and with controlling (Table 5), we find that the coefficient on areas of managed hayfields do not change (0.027) but those on other attributes do change, suggesting the possibility that elicitation methods may have an effect on marginal utility of certain attributes but not on others. The attribute whose coefficient increased the most was 'invited to bird walk', which is the private good attribute. Since the omitted category is referendum tax, the results suggest that other mechanisms are pulling the average down. On the other hand, the coefficient on view from major road' decreased, which suggests that other elicitation methods are pulling the average up. Indeed, although the estimates are insignificant, the interaction terms between ‘view from a major road’ and PR, UPA and PM are positive, while the interaction terms between ‘invited to a bird walk’ and PR, VCM, and PM are negative. Although this trend is statistically inconclusive, the substitution effects among non-monetary attributes of elicitation methods that give incentives to reduce free-riding requires further investigation.

Results of hypotheses tests

Table 6 summarizes the likelihood ratio tests of hypotheses related to effects of different elicitation methods. The first test on treatment effects is rejected with a high significance level (hypothesis 1). The elicitation methods jointly affect the estimated coefficients in the utility model. Next we investigate the source of the treatment effects. We reject hypothesis 2 that marginal utility of income is unaffected by elicitation methods. In fact, we reject this hypothesis for all four elicitation mechanisms when tested individually (2a-2d). (The base category is referendum tax).

To the contrary, we cannot reject the rest of the hypotheses tests. Specifically, the test results suggest that the elicitation methods do not jointly affect marginal utility of farm-wildlife contracts attributes (hypothesis 3), nor do they shift utility level (hypotheses 4 and 5). Having a reference mechanism prior to the elicitation method in question also has no effect on marginal utility of income and non-monetary attributes.

Based on inspection of these hypotheses tests and the relevant coefficients in Table 5 (column 3), we conclude that the main impact of these elicitation methods come through changes in marginal utility of income.

Given this finding, we next compute the marginal utility of income across elicitation methods (Table 7). The coefficients range from -0.035 to -0.028. Surprisingly, the ranking of the mechanisms in this aspect was VCM>PM>PR>UPA. While the ranking of PM, PR and UPA is consistent with hypothesis 7, the differences in the estimates are not statistically significant. More importantly, respondents with VCM revealing the lowest marginal utility of income. The coefficient estimates between VCM and UPA, and VCM and PR were statistically different at the 10% significance level. One possible reason may be that respondents are used to VCM, which is the approach taken by most donations. Other elicitation methods, including PR, UPRA and PM, are new to most respondents, and thus may have resulted in a lower marginal utility of income (higher absolute value).

Participation rate

Among those who responded to the survey, 97 respondents (10%) said they would not purchase any contract. In contrast, 78 respondents (8%) said they would purchase one or both contracts for all six questions with varying levels of attributes and costs. The rest of the respondents said they would purchase one or both contracts in at least one out of the six questions but not all of them.

When we break down the participation rate (# of respondents choosing to purchase at least one contract / total # of respondents) for each elicitation mechanism, we find that the participation rate for VCM, PR, UPA and PM are 93%, 89%, 92% and 88%, respectively. Therefore the ranking is VCM>UPA>PR>PM. While our intuition that the participation rate may be higher for UPA than PR seems to fit with the data (hypothesis 8), this result again raises a question about how people perceived VCM and PM.

Market Experiment

In spring 2007, we launched the Nature Services Exchange of Jamestown, a marketplace for an ecosystem-service, first by establishing actual farm wildlife contracts with farmers and then selling shares of those contracts to consumers. The Exchange was open to the public for five weeks from the last week of March through April 30, 2007. The deadline was forced by the timing of arrival and breeding of bobolinks in Jamestown, RI. Each farm wildlife contract was tied to one or more of the payment mechanisms. Since we set a type of a provision rule for all the contracts, whether each contract remains effective during the breeding season depended on the market outcome under each mechanism. Residents were assigned to one of the farm-wildlife contracts, each of which was tied to one or more elicitation methods. If the resident was present in the mailing list for the fall 2006 survey, we assigned the same elicitation method as before. Otherwise, new residents were randomly assigned to one of the three methods.

In the next version of this paper, we will compare the actual consumer behavior across alternative methods and also to their willingness to pay as estimated in the survey choice experiment.

References

Pagiola, S., J. Bishop, and N. Landell-Mills, eds. 2002. *Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development*. London: Earthscan.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, Results and Analysis 1966-2003. Version 2004.1. USGS Patuxent Wildlife Reasearch Center, Laurel, MD.

References

Adamowicz, W., P. Boxall, et al. (1998). "Stated preference approahces for measuring passive use values: Choice experiments and contingent valuation." American Journal of Agricultural Economics **80**: 64-75.

Fry, C., E. Uchida, et al. (2007). Summary Report: Working Frams and Wildlife in Jamestown, RI: 2006 Survey of Jamestown Residents. Kingston, University of Rhode Island.

Hanneman, W. M. (1984). "Welfare evaluations in contingent valuation experiments with discrete responses." American Journal of Agricultural Economics **73**(3): 332-41.

Ledyard, J. O. (1995). Public goods: A survey of experimental research. Handbook of Experimental Economics. J. H. Kagel, Roth, A.E. Princeton NJ, Princeton University Press**:** 111–194.

Marks, M. and R. Croson (1998). "Alternative rebate rules in the provision of a threshold public good: An experimental investigation." Journal of Public Economics **67**(2): 195-220.

Mitchell, L. R., C. R. Smith, et al. (2000). Ecology of grassland breeding birds in the northeastern United States – a literature review with recommendations for management. . Ithaca, NY, Cornell University.

Pagiola, S., N. Landell-Mills, et al. (2002). Market-based Mechanisms for Forest Conservation and Development. Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development. S. Pagiola, J. Bishop and N. Landell-Mills. London, UK, Earthscan Publications Ltd.

Poe, G. L., J. E. Clark, et al. (2002). "Provision point mechanism and field validity tests of contingent valuation." Environmental and Resource Economics **23**(1): 105-131.

Rondeau, D., W. D. Schulze, et al. (1999). "Voluntary revelation of the demand for public goods using a provision point mechanism." Journal of Public Economics **72**(3): 455-470.

Sauer, J. R., J. E. Hines, et al. (2004). The North American Breeding Bird Survey, Results and Analysis 1966-2003. . Laurel, MD, USGS Patuxent Wildlife Reasearch Center.

Spencer, M., S. Swallow, et al. (1998). "Valuing water quality monitoring: A contingent vaaluation experiment involving hypothetical real payments." Agricultural and Resource Economics Review **27**(1): 28-42.

Swinton, Scott, Frank Lupi, G. Philip Robertson, and Douglas A. Landis. 2006. Ecosystem services from agriculture: Looking beyond the usual suspects. *American Journal of Agricultural Economics* 88 (5): 1160–1166.

Table 1. Farm-wildlife contract attributes and their levels used in choice experiment questions

Attribute	Description	Levels
Acres of managed hayfields & expected fledglings saved 	A farmer will **delay the mowing and harvesting** on a hayfield of a specified size. This is **expected to save the specified number of Bobolink fledglings in 2007**. Different farms may have different expected number of fledglings saved, even if they have the same number of acres. In reality, we will count the number of singing males to estimate how many fledglings have survived in 2007. For your reference, one acre is about 75% of a football field.	Acres: 10, 25, 40, 55 Fledglings: high or low (number corresponded to level of acres)
Acres of hayfields restored 	A farmer will **restore an inactive field to active hay production**. This would create new habitat for Bobolinks and other wildlife, reduce the number of invasive species and create more scenic farm views. **Mowing and harvesting will not be delayed on these acres.**	0, 10, 20, 30 acres
Farm landscape views 	A parcel may or may not be located along a major road so that you can view birds from the roadside.	View / No view
Bird walk in 2007 	Residents who paid some amount towards a farm wildlife contract will be invited to a bird walk led by expert birders in June 2007.	Invited / Not invited
Cost to your household this year 	This is the proposed amount that you are asked to pay this year towards a farm wildlife contract with this farm.	$10, $20, $35, $45, $60, $75, $85, $105

Source: Authors' survey.

Table 2. Descriptive statistics of demographic characteristics, by auction mechanism.

Variable	Voluntary Contribution Mechanism (VCM)	Proportional Rebate (PR)	Uniform Price Auction (UPA)	Pivotal Mechanism (PM)
Age	57 (13.50)	57 (11.92)	57 (13.26)	56 (12.50)
Gender (proportion male)	0.45 (0.50)	0.46 (0.58)	0.43 (0.50)	0.43 (0.50)
Proportion with children under 18	0.27 (0.44)	0.26 (0.44)	0.24 (0.43)	0.33 (0.47)
Number of years living in Jamestown	18 (16.21)	20 (16.71)	20 (14.96)	19 (15.53)
High education (proportion college graduate or higher)	0.84 (0.37)	0.81 (0.39)	0.81 (0.39)	0.82 (0.39)
Income (thousand U.S. dollars)	105.10 (69.41)	113.98 (68.82)	108.61 (68.14)	121.40 (70.05)

Source: Authors' data.

Note: Based on a series of group mean comparison t-tests, the means were not statistically significantly different at the 5% significance level for all the above variables. The mean income level was statistically different at the 10% significance level between VCM and PM groups. The proportion of households with children under 18 was statistically different at the 10% significance level between UPA and PM groups.

Table 3. Summary of treatments and response rate, by survey type and auction mechanism.

		Responses	Mailed	Response rate* (%)
Total		993	2983	38.2
	Type 1	701	2024	35*
	Referendum+VCM	176	505	35*
	Referendum+PR	179	507	35*
	Referendum+UPA	174	506	34*
	Referendum+PM	171	506	34*
	Type 2	292	959	30*
	PR	94	319	29*
	UPA	100	320	31*
	PM	98	320	31*
By Mechanism				
	VCM	176	505	35*
	PR	273	826	33*
	UPA	274	826	33*
	PM	269	826	33*

Source: Authors' data.

Notes: *Raw response rates and does not take into account of undelivered mails. After accounting for undelivered mails, the overall response rate was 38 percent. Type 1 includes two stated-preference questions before presenting four questions under a specific mechanism; Type 2 includes six questions all under the same mechanism. VCM=Voluntary Contribution Mechanism; PR=Proportional Rebate; UPA=Uniform Price Auction; PM=Pivotal Mechanism.

Table 4. Estimation results from conditional logit model estimation.

	(1)	(2)	(3)	(4)
ASC_NO	-1.097	-0.886	-1.084	-0.899
	(11.84)***	(6.18)***	(9.40)***	(5.23)***
ASC_both	0.069	-0.236	0.164	-0.155
	(0.85)	(1.84)*	(1.95)*	(1.17)
ASC_NO_income		-0.002		-0.002
		(2.00)**		(1.45)
ASC_both_income		0.003		0.003
		(2.96)***		(3.04)***
Area of managed hayfields	0.015	0.014	0.027	0.027
	(10.42)***	(10.29)***	(8.76)***	(8.82)***
High bobolink population	0.073	0.074	0.072	0.072
	(1.93)*	(1.95)*	(1.87)*	(1.87)*
Area of restored fields	0.022	0.023	0.035	0.035
	(10.60)***	(10.71)***	(8.31)***	(8.24)***
View from major road	0.109	0.109	0.110	0.109
	(4.64)***	(4.61)***	(4.57)***	(4.56)***
Invited to bird walk	0.079	0.081	0.091	0.093
	(3.30)***	(3.38)***	(3.74)***	(3.81)***
Cost	-0.021	-0.024	-0.032	-0.036
	(26.24)***	(14.84)***	(19.63)***	(11.27)***
Cost x income		0.000		0.000
		(1.55)		(1.47)
(Area of managed hayfields) ^{2}			-0.000	-0.000
			(4.52)***	(4.64)***
(Area of restored fields)^2			-0.000	-0.000
			(3.51)***	(3.37)***
cost^2			0.000	0.000
			(7.84)***	(4.79)***
cost^2 x income				-0.000
				(1.05)
Observations	16480	16480	16480	16480
Log likelihood	-4926	-4888	-4883	-4846
Pseudo R2	0.138	0.144	0.145	0.152
Income	No	Yes	No	Yes
Quadratic	No	No	Yes	Yes

Notes: Absolute value of z statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. Estimation results from conditional logit model estimation with mechanism variables

	(1)	(2)	(3)
ASC_NO	-1.090	-0.850	-0.932
	(7.02)***	(4.45)***	(3.87)***
ASC_both	-0.090	-0.405	-0.224
	(0.73)	(2.54)**	(1.19)
ASC_NO_inc		-0.002	-0.002
		(2.16)**	(1.78)*
ASC_both_inc		0.003	0.003
		(2.96)***	(3.14)***
ASC_NO_m_vcm	0.070	0.080	0.163
	(0.30)	(0.34)	(0.48)
ASC_NO_m_pppr	-0.107	-0.125	0.073
	(0.54)	(0.63)	(0.26)
ASC_NO_m_upa	-0.223	-0.229	0.076
	(1.11)	(1.14)	(0.27)
ASC_NO_m_pm	0.065	0.055	-0.018
	(0.33)	(0.28)	(0.06)
ASC_both_m_vcm	-0.018	0.004	-0.201
	(0.09)	(0.02)	(0.67)
ASC_both_m_pppr	0.241	0.234	0.116
	(1.44)	(1.38)	(0.49)
ASC_both_m_upa	0.270	0.296	0.015
	(1.58)	(1.73)*	(0.06)
ASC_both_m_pm	0.229	0.223	0.239
	(1.34)	(1.29)	(0.99)
Acres of managed hayfields	0.015	0.015	0.027
(acres)	(10.47)***	(10.35)***	(7.05)***
High bobolink habitat	0.075	0.075	0.113
(highbobo)	(1.96)*	(1.96)*	(1.59)
Acres of restored fields	0.022	0.023	0.027
(restore)	(10.51)***	(10.65)***	(4.74)***
View from major road	0.110	0.111	0.085
(view)	(4.66)***	(4.70)***	(2.03)**
Invited to birdwalk	0.080	0.084	0.133
(tour)	(3.36)***	(3.49)***	(3.16)***
(Acres of managed hayfields)^2			-0.000
			(4.50)***
(Acres of restored fields)^2			-0.000
			(3.21)***
Cost	-0.016	-0.017	-0.029
	(10.68)***	(7.30)***	(7.75)***
Cost x income		0.000	0.000
		(0.51)	(0.85)
Cost^2			0.000
			(4.37)***

Cost^2 x income			-0.000
			(0.86)
cost_m_vcm	-0.005	-0.001	-0.000
	(1.89)*	(0.36)	(0.06)
cost_m_pppr	-0.008	-0.010	-0.012
	(3.05)***	(2.71)***	(2.86)***
cost_m_ppprA	0.002	-0.001	0.003
	(0.82)	(0.28)	(0.64)
cost_m_upa	-0.011	-0.011	-0.011
	(4.25)***	(3.37)***	(2.74)***
cost_m_upaA	0.002	0.002	0.004
	(1.06)	(0.89)	(0.82)
cost_m_pm	-0.011	-0.012	-0.011
	(4.24)***	(3.04)***	(2.54)**
cost_m_pmA	0.006	0.002	0.003
	(3.40)***	(0.43)	(0.65)
costinc_m_vcm		-0.000	-0.000
		(1.66)*	(1.71)*
costinc_m_pppr		0.000	0.000
		(0.83)	(0.64)
costinc_m_ppprA		0.000	0.000
		(0.85)	(0.99)
costinc_m_upa		0.000	-0.000
		(0.11)	(0.17)
costinc_m_upaA		0.002	0.000
		(0.19)	(0.02)
costinc_m_pm		0.000	0.000
		(0.33)	(0.13)
costinc_m_pmA		0.000	0.000
		(1.17)	(1.21)
acres_m_vcm			0.000
			(0.09)
acres_m_pppr			0.005
			(0.95)
acres_m_ppprA			-0.009
			(1.67)*
acres_m_upa			0.001
			(0.12)
acres_m_upaA			0.002
			(0.39)
acres_m_pm			-0.005
			(1.06)
acres_m_pmA			0.003
			(0.61)
highbobo_m_vcm			-0.116
			(0.83)
highbobo_m_pppr			0.017
			(0.12)
highbobo_m_ppprA			0.057
			(0.34)

highbobo_m_upa	0.018
	(0.12)
highbobo_m_upaA	-0.183
	(1.09)
highbobo_m_pm	-0.021
	(0.15)
highbobo_m_pmA	-0.118
	(0.70)
restore_m_vcm	0.021
	(2.76)***
restore_m_pppr	0.007
	(0.87)
restore_m_ppprA	-0.009
	(1.03)
restore_m_upa	0.016
	(1.95)*
restore_m_upaA	0.001
	(0.08)
restore_m_pm	0.014
	(1.74)*
restore_m_pmA	-0.003
	(0.38)
view_m_vcm	-0.087
	(1.00)
view_m_pppr	0.112
	(1.25)
view_m_ppprA	0.007
	(0.06)
view_m_upa	0.131
	(1.42)
view_m_upaA	-0.085
	(0.78)
view_m_pm	0.019
	(0.21)
view_m_pmA	-0.045
	(0.42)
tour_m_vcm	-0.095
	(1.07)
tour_m_pppr	-0.026
	(0.29)
tour_m_ppprA	0.065
	(0.62)
tour_m_upa	0.006
	(0.06)
tour_m_upaA	-0.093
	(0.85)
tour_m_pm	-0.072
	(0.81)
tour_m_pmA	-0.096
	(0.89)

Observations	16480	16480	16480
Log likelihood	-4896	-4851	-4794
Pseudo R2	0.143	0.151	0.161
Income	No	Yes	Yes
Quadratic	No	No	Yes

Notes: Absolute value of z statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 6. Likelihood ratio tests of hypotheses regarding responses to elicitation methods.

Null Hypothesis	Log-likelihood of a restricted model	LR Chi-squared	Degrees of Freedom	Prob > Chi-squared
1) Elicitation method does not affect preference parameters (All coefficients interacted with a mechanism are jointly equal to zero)	-4846	103.37	57	0.0002
2) Marginal utility of income is the same under all elicitation methods (all coefficients on cost specific to mechanisms are jointly equal to zero.)	-4815	41.62	14	0.0001
2a) Voluntary contribution mechanism	-4797	5.16	2	0.0757
2b) Proportional Rebate	-4802	15.34	4	0.0040
2c) Uniform Price Auction	-4803	16.70	4	0.0022
2d) Pivotal Mechanism	-4802	15.83	4	0.0033
3) Marginal utility of farm-wildlife contracts attributes is the same across elicitation methods (all coefficients on attributes specific to mechanisms are jointly equal to zero.)	-4814	38.54	35	0.3125
4) Elicitation methods do not shift utility level (Alternative specific constants associated with mechanisms are all jointly equal to zero)	-4796	3.43	8	0.9046
5) Elicitation method does not shift utility level of the no response (No-choice alternative specific constants associated with mechanisms are all jointly equal to zero)	-4795	0.37	4	0.9850
6) A reference mechanism does not affect how elicitation methods affect marginal utility of income and attributes.	-4806	30.45	27	0.2942

Notes: Log-likelihood of the unrestricted model is -4794, with 72 parameters. (from Table 3, last column). Log-likelihood of the unrestricted model for the last hypothesis is -4791 with 78 parameters.

Table 7. Comparison of marginal utility of income across elicitation methods.

Mechanism	Coefficient estimate
Voluntary Contribution Mechanism	-0.028 (11.33)
Proportional Rebate	-0.034 (-11.75)
Uniform Price Auction	-0.035 (-12.13)
Pivotal Mechanism	-0.033 (-11.74)

Note: The estimated z-statistics in parentheses were calculated using the delta method. The absolute value of coefficient estimate for VCM is higher than UPA and PR at the 10% significance level.

Table 8. Comparison of willingness-to-pay estimates for each attribute across elicitation mechanisms (US Dollars).

	Pooled	Voluntary Contribution Mechanism	Proportional Rebate	Uniform Price Auction	Pivotal Mechanism
Acres of managed hayfields	0.76*** (9.35)	0.74*** (5.35)	**0.81*** (6.66)**	0.64*** (5.39)	0.54*** (4.40)
High bobolink habitat	2.49* (1.86)	0.55 (0.13)	3.46 (0.97)	3.71 (1.04)	2.40 (0.66)
Acres of restored fields	1.06*** (9.00)	**1.49*** (6.16)**	0.87*** (4.23)	1.08*** (5.25)	1.12*** (5.39)
View from major road	3.77*** (4.49)	-0.20 (-0.08)	5.70* (2.56)	**6.08** (2.68)**	3.14 (1.38)
Invited to bird walk	3.22*** (3.79)	0.58 (0.22)	3.21 (1.44)	**3.85* (1.69)**	2.22 (0.98)
10 acres with view and bird walk*	14.61*** (9.45)	7.83* (2.29)	**17.06*** (6.06)**	16.33*** (5.88)	10.81*** (3.85)

Note: The estimated z-statistics in parentheses were calculated using the delta method. Bolded cells indicate the mechanism with the highest WTP. Model on Table 5, column (3) (without the treatment specific ASCs) were used.

* A typical farm-wildlife contract sold in the market this year is 10 acres of managed hayfields, with a view and a tour.