Temporal Insensitivity of Willingness to Pay: How do they evaluate in CVM?

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Abstract: In addition to scope and scale embedding effects, temporal insensitivity of willingness to pay, also known as temporal embedding effect, has been a well known anomaly in eliciting willingness to pay for environmental quality change, especially over time. Stevens et al. (1997) defines two types of temporal embedding effects: strong insensitivity and weak insensitivity to payment schedule. This paper proposes an alternative definition of the temporal insensitivity. Temporal insensitivity implies that a subject in the survey responds consistently to value elicitation questions regardless of payment schemes. The sequential test tests the temporal insensitivity using the oyster reef restoration programs in Chesapeake Bay. Test results show that willingness to pay for the program is insensitive to the payment scheme or to the length of benefit stream of the project. Discount rates imbedded in cost stream vary significantly among the combination of project lengths and payment schemes.

Keywords: Temporal insensitivity of willingness to pay, Temporal embedding effect, Implicit discount rate, Sequential test

1. Introduction

In addition to scope and scale embedding effects, temporal insensitivity of willingness to pay, also known as temporal embedding effect, has been a well known anomaly in eliciting willingness to pay for environmental quality change, especially over time. Stevens et al. (1997) defines two types of temporal embedding effects: strong insensitivity and weak insensitivity to payment schedule. Strong insensitivity to payment schedule indicates the inability of respondents to differentiate between a series of payments and a lump sum payment on the project, and weak insensitivity implies inequality of willingness to pay's between two temporally differentiated payment schemes but abnormally high implicit discount rates.

Kahneman and Knetsch (1992) find evidence of strong insensitivity of median willingness to pay in the study of a toxic waste treatment facility. In their study, respondents showed the same lump sum median willingness to pay (WTP_L) and annual willingness to pay (WTP_t) over a five-year payment scheme. On the other hand, a series of papers (Rowe et al. 1992, Stevens et al. 1997, Ibáñez and McConnell 2001, Bond et al. 2002) has rejected strong insensitivity but found weak insensitivity of willingness to pay with high discount rates ranging from two digits to several thousand percent. In fact, relatively high implicit discount rates have been observed in experimental research as well (Harrison and Johnson, 2002; Harrison et al., 2002; Coller et al., 2002).

Previous literature of temporal insensitivity, however, discovered their findings under too strict assumption on the underlying decision process of a subject. The strong assumption, specifically consistence and homoskedasticity of present value of willingness to pay over the payment schemes, can skip over comparison or identification problem. Furthermore, the definition of weak insensitivity is under debate since there is no consensus about an abnormally "high" discount rate.

In this paper, we propose the concept of temporal willingness to pay and test the temporal consistence and invariance of willingness to pay. Chapter 2 describes the example study of environmental change and the concept of temporal insensitivity of willingness to pay. Chapter 3 provides the context of temporal willingness to pay and methodological development of estimation and test of temporal insensitivity. Chapter 4 shows the application result and Chapter 5 briefly summarizes findings and conclusion.

2. Temporal Insensitivity and Implicit Discount Rates

2.1 Benefit Stream and Cost Stream in Contingent Valuation Study

Environmental projects, by their nature, include temporal dimension of benefits and costs that may or may not be considered by researcher. To provide the context of temporal issue in the contingent valuation study, we start by describing a typical contingent valuation application for environmental change over time.

In 2002, the Chesapeake Bay Foundation commissioned a study to measure the benefits from an oyster reef restoration project in Chesapeake Bay in Maryland (for details, see Haab et al. 2004). The oyster program has the hypothetical restoration target of 10,000 acres for oyster habitat and 1,000 acres for artificial reef. The survey context presented explicitly to respondents that the benefit stream from the ten-year (five-year) project would be increasing number of oysters in accordance with accumulation of reef restoration at the rate of 100 (200) acres and habitat preservation at the rate of 1,000 (2,000) acres per year. Each restoration program employed one of three payment schemes: a one-time (lump sum) payment on next year's state tax, annual payments over the life of the project, and permanent annual payments. Among six designs (2 project lengths and 3 payment schemes), one scenario was randomly offered to respondents. Thus, for example, respondents to the five-year project scenario with one-time payment were presented the following question[1],

> The restoration program is estimated to cost your household a total of **$___**. Your household would pay this as a special one time tax added to next year's State income tax. **If an election were to be held today and the total cost to your household was $___ would you vote for or against the 5 year restoration program** (Check one)?
>
> - ❑ I would vote for the program
> - ❑ I would vote against the program
> - ❑ I do not know whether I would vote for or against the program

2.2 Reviews on Temporal Insensitivity

Let the benefit that the respondent would get in each year be B_t, where t = 1, 2,…, T_B, and the cost that he or she have to pay be C_t, where t = 1, 2,…, T_C. The series of benefit/cost pairs (B_t, C_t) fully describes the project. For facilitating the contingent

[1] For the conservative reason, 'I don't know' response is assumed to be 'vote against' response (Carson et al. 1998, Groothuis and Whitehead 1998). Thus, the response is of binary choice format.

valuation study, respondents are assumed to have a well-defined value of B_t that they can compare with the monetary value of costs[2]. Annual willingness to pay constrained by the current period budget is the theoretical measurement of the well-defined value of the benefit stream, which are derived from either of the time-separable annual utility framework (Stevens et al. 1997) or the time-separable willingness to pay framework (Bond et al. 2002).

Let WTP_t^A be the annual willingness to pay in *t*-th year, then the present value of willingness to pay, *PVWTP*, becomes

$$PVWTP = \sum_{t=1}^{T} WTP_t^A \left(1+r\right)^{-(t-1)} \quad (1)$$

where *r* is the social discount rate. Most contingent valuation applications employed the terminal period of cost stream for aggregating discounted willingness to pay. By the same logic, the monetary value of cost stream is defined by the present value of costs, *PVC*:

$$PVC = \sum_{t=1}^{T} C_t \left(1+r\right)^{-(t-1)} . \quad (2)$$

Now, we have the formal definition of temporal insensitivity of willingness to pay. Let WTP^L be the lump sum willingness to pay for a project (i.e. the present value of willingness to pay in the lump sum payment schedule). The strong insensitivity is defined by $WTP^L = WTP_1^A = WTP_2^A = \cdots = WTP_T^A$, i.e. an infinite discount rate. Strong insensitivity to payment schedule indicates the inability of respondents to differentiate between a series of payments and a lump sum payment on the project. The weak insensitivity is defined by the existence of $WTP^L = PVWTP$ with abnormally high discount rate (Stevens et al. 1997). In their work, Stevens et al. (1997) estimated lump-sum willingness to pay and annual willingness to pay, and derived the implicit discount rate from $WTP^L = PVWTP$ after the test of difference between lump-sum willingness to pay and annual willingness to pay. Bond et al. (2002) calculated the implicit discount rate with the assumption of consistent and homoskedastic willingness to pay across different payment schemes.

[2] For convenience and simplicity, respondents are assumed to have well defined monetary value of benefit stream. In fact, well-defined range of values is enough for comparison and the value of benefit does not have to be a monetary unit. The decision is made by comparing the benefit and cost in terms of the same but any plausible unit.

We have concerns in previous literature, especially about the consistence of willingness to pay across different payment schemes. For example, the difference of lump-sum willingness to pay and annual willingness to pay in Stevens et al. (1997) did not imply the equality of lump-sum willingness to pay and the present value of willingness to pay, which is also valid in Bond et al. (2002) when they estimated the implicit discount rate. Note that the benefit stream can be subjective due to individual confidence in the program, uncertainty of the future, different cognizance about the survey description, etc. The life of benefit stream may also be different in the respondent's perception even though the contingent valuation survey describes explicitly the life of the project. If the willingness to pay varies with different payment schemes, there is a design effect on respondents' response, which is defined as temporal inconsistence of willingness to pay. Without the consistence of willingness to pay, we cannot compare lump-sum willingness to pay and present value of willingness to pay.

The second estimation problem is the heteroskedasticity across different payment schemes. In parametric estimation, random utility function or willingness to pay function assumes an additive error term with constant variance across different payment schemes. Since estimation models for binary choice normalize parameters by its standard deviation, this assumption leads miscalculation of implicit discount rate if violated.

3. Consistence of Willingness To Pay and Sequential Test

3.1 Theoretical Model

For clear understanding temporal inconsistence and heteroskedasticity of willingness to pay, we introduce a theoretical model of deriving willingness to pay and estimating implicit discount rate. Let U_t be the utility from the benefit B_t at time *t*. Then, for the lump-sum payment scheme, the willingness to pay, i.e. the consumer surplus, for the environmental change is measured by the maximum payment equating two equations below,

$$U_1(x,y)+\delta U_2(x,y)+\delta^2 U_3(x,y)+\delta^3 U_4(x,y)+\cdots \tag{3}$$

$$U_1(x,B_1,y-M_1)+\delta U_2(x,B_2,y)+\delta^2 U_3(x,B_3,y)+\delta^3 U_4(x,B_4,y)+\cdots \tag{4}$$

where equation (3) is the status quo utility stream and equation (4) is the utility stream with environmental change. For simplicity, we assume that income and other characteristic variables are constant over time[3].

With the linearity of utility in income and constant income elasticity, the willingness to pay is

$$WTP^{L} = \frac{1}{\alpha}\left(\Delta U_1 + \delta \Delta U_2 + \delta^2 \Delta U_3 + \cdots + \delta^{T_B - 1} \Delta U_{T_B}\right) \tag{5}$$

where $\Delta U_t = U_t\left(x, B_t\right) - U_t\left(x\right)$ and α is the income elasticity. By the same logic, the willingness to pay with the T_C-period annual payment scheme becomes

$$WTP_1^A + \delta WTP_2^A + \cdots + \delta^{T_C - 1} WTP_{T_C}^A = \frac{1}{\alpha}\left(\Delta U_1 + \delta \Delta U_2 + \delta^2 \Delta U_3 + \cdots + \delta^{T_B - 1} \Delta U_{T_B}\right). \tag{6}$$

Cleary, the present value of willingness to pay, the left-hand side of equation (5) and (6), is discounted up to the life of cost stream and the corresponding benefit stream named by the present value of utility difference, the right-hand side of equation (5) and (6), is the one discounted up to the life of benefit stream.

The consistence of willingness to pay comes from the identical expression of the present value of utility difference. However, the consistence should be tested before deriving the implicit discount rate and concluding temporal insensitivity since the inequality of WTP^L and WTP_t^A does not imply the equality of the present value of utility differences. Previous framework of willingness to pay ($WTP_t = \mathbf{x}_t'\boldsymbol{\beta} + \varepsilon_t$) cannot identify the present value of willingness to pay due to unknown discount factor, which makes it impossible to test the consistence of willingness to pay. Random utility function framework ($\Delta U_t = \mathbf{x}_t'\boldsymbol{\beta} + \varepsilon_t$) also has the complicate problem because the present value of utility difference is discounted up to the life of benefit stream but the present value of cost is the discounted sum up to terminal period of costs.

In this paper, we directly specifies the present value of utility difference in the right-hand side of equation (5) or (6) as a function of the set of full benefit stream and

[3] The random utility at each period varies depending on the individually perceived benefit stream and time-evolving characteristics of respondents. Although respondents are assumed to have constant covariates, linear additive specification of the model requires strong assumptions about the temporal properties of the error terms.

current individual specific covariates. The value of the benefit stream, which we name temporal willingness to pay (*TWTP*), is now defined by

$$\begin{aligned} TWTP &\equiv \frac{1}{\alpha}\left(\Delta U_1 + \delta\Delta U_2 + \delta^2\Delta U_3 + \cdots + \delta^{T_B-1}\Delta U_{T_B}\right) \\ &= f\left(\pi, x, \beta\right) + \varepsilon \end{aligned} \tag{7}$$

where $\pi = \{B_1, B_2, ..., B_{T_B}\}$ is the benefit stream of the environmental project. The error term, ε_i, may be conditional on the project type and payment schemes. Instead of calculating the present value of annual willingness to pay's stream, temporal willingness to pay assumes that respondents construct the willingness to pay from the view of the entire benefit stream. This may be a reasonable and realistic valuation structure of how individual respondent think of an environmental project proposed in a survey. Since temporal willingness to pay is a lump-sum value that an individual may have at the time of survey, temporal willingness to pay does not require the researcher to sum the discounted errors across time or impose restrictions on the temporal relation of multi-period error terms[4]. In addition, temporal willingness to pay formulation is flexible in the functional form of the systematic component.

Contrary to previous literature, we define consistence and homoskedasticity of willingness to pay across payment schemes by temporal insensitivity of willingness to pay. From the temporal willingness to pay, the temporal consistence of willingness to pay is defined by

$$TWTP^l = TWTP^k \tag{8}$$

where *l* and *k* represent different payment scheme. Temporal insensitivity of willingness to pay indicates that respondents have a consistent valuing mechanism that is not influenced by outside factors such as the payment scheme.

3.2 Choice Probability and Estimation Model

Respondents vote for the proposed project in contingent valuation study when the temporal willingness to pay is greater than the value of the cost stream for a project that

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[4] Temporal willingness to pay may be time-dependent in the sense that it can vary depending on the timing of the survey. However, Carson et al. (1997) show that CV estimates exhibited no significant sensitivity to the timing of interviews.

is typically defined by the present value. With the linear model specification for the temporal willingness to pay and the functional assumption of the error term, the conditional probability that a respondent will vote for a program *k* given the payment version *j* is defined by

$$P(\text{vote for } k \mid j) = P\left(TWTP_{j,k} \geq PVC_j\right) = P\left(\mathbf{x}'\boldsymbol{\beta}_{j,k} + \varepsilon_{j,k} \geq \phi_j C_j\right) \tag{9}$$

where $\phi_j C_j = \sum_{t=1}^{T_C} C_j \left(1+r\right)^{-(t-1)}$, the discount factor is $\phi_1 = 1$ for a lump sum payment scheme(*j = 1*), $\phi_2 = \left(1 + r - \left(1+r\right)^{-T_C - 1}\right)/r$ for annual payment over T_C years (*j = 2*), and $\phi_3 = \left(1+r\right)/r$ for perpetual payment (*j = 3*) when the discount rate is positive. The probability of vote against is defined as the complement to the probability of vote for. Generally, the variance of the error term is conditional on the project version (*k*) and payment scheme (*j*).

When temporal willingness to pay is consistent but heteroskedastic across different payment schemes, we can estimate the model using dummies for cost variable, which is named by rescaled model. The rescale factor is the variance of one sub-sample (e.g. lump-sum payment) and the model estimates the relative variances of the other groups (e.g. annual payment). The positive standard deviation is defined by $\sigma_j = \sigma \exp\left(\lambda' d_j\right)$, where σ is the standard error of lump-sum payment scheme. If $\lambda = 0$, i.e. homoskedastic error term, then we can estimate the model simply by combining data without rescale factor.

3.3 Sequential Test for the Temporal Insensitivity

A sequential test proposed by Swait and Louviere (1993) for combining data from different data sources provides a context for testing consistency and homoskedasticity of temporal willingness to pay[5]. The null hypothesis of the sequential test for consistence and homoskedasticity of temporal willingness to pay across payment schemes is:

$$H_0 = \begin{Bmatrix} \beta_l = \beta_m \\ \sigma_l = \sigma_m \end{Bmatrix} \tag{10}$$

[5] Haab et al. (1999) employed the sequential test in the contingent valuation study and found that correcting heteroskedasticity provided statistically consistent willingness to pay under real and hypothetical formats.

where β is the parameter set of the temporal willingness to pay function, and *l* and *m* indicate payment schemes. The composite hypothesis tests the consistence of temporal willingness to pay ($H_0^A = \{\beta_l = \beta_m\}$) without restriction on variances across payment schemes in the first stage. The model under the null hypothesis is rescaled model. Rejection of the first hypothesis indicates that the value of the environmental project varies depending on the payment scheme.

Conditional on the failure to reject the first hypothesis, the second step is to test homoskedasticity across payment schemes ($H_0^B = \{\sigma_l = \sigma_m\}$). The unrestricted model in the second stage is the scaled model in the first stage. The restricted model in the second stage is the pooled model stacking all samples across payment schemes with equal parameters in temporal willingness to pay and dummies for payment scheme.

3.4 Implicit Discount Rates from the Consistent Willingness To Pay

If both stages of the sequential test fail to be rejected, the implicit discount rate is derived simply from pooled data across payment schemes. Let $\tilde{\phi}_j$ be the normalized estimate for cost of payment scheme *j*. The implicit discount rate is the solution to the nonlinear function

$$\frac{\tilde{\phi}_2}{\tilde{\phi}_1} = \left(\frac{1+r_{1,2}}{r_{1,2}}\right)\left[1-\frac{1}{\left(1+r_{1,2}\right)^{T_C}}\right] \tag{11}$$

when we have lump-sum and annual payment schemes. With lump-sum payment and perpetual annual payment schemes, the implicit discount rate is

$$r_{1,3} = \frac{\tilde{\phi}_1}{\tilde{\phi}_3 - \tilde{\phi}_1}. \tag{12}$$

If the first hypothesis fails to be rejected but the second hypothesis is rejected, the implied discount rate is derived from rescaled model,

$$\frac{\tilde{\phi}_2}{\tilde{\phi}_1} = \frac{1}{\exp\left(\hat{\lambda}_2 d_2\right)}\left(\frac{1+r_{1,2}}{r_{1,2}}\right)\left[1-\frac{1}{\left(1+r_{1,2}\right)^{T_C}}\right] \tag{13}$$

for lump-sum payment scheme and annual payment scheme, or

$$\frac{\tilde{\phi}_3}{\tilde{\phi}_1} = \frac{1}{\exp\left(\hat{\lambda}_3 d_3\right)}\left(\frac{1+r_{1,3}}{r_{1,3}}\right) \tag{14}$$

for lump-sum and perpetual-type payment schemes. Note that temporal willingness to pay is still time-consistent in spite of the heteroskedastic error term.

4. An Application to Oyster Reef Restoration Program

To test the temporal sensitivity of willingness to pay and to estimate implicit discount rate, we apply the temporal willingness to pay and sequential test to the oyster reef restoration project in the Chesapeake Bay. As described before, the mail survey consisted of a split-sample design with two temporal versions of the hypothetical project (A for the five-year project and B for the ten-year project) and three types of payment scheme (1 for lump-sum payment, 2 for annual payment, and 3 for perpetual type). The estimation model assumed a normal distribution for the error term.

Table 1 shows estimation results for the five-year project. FEE1, FEE2A and FEE3 represent payment vectors for one-time, annual payment for five years and perpetuity-type payment, respectively. The first three columns of Table 1 exhibit the estimation result for individual payment scheme. The other columns show the result of rescaled and pooled models for several combinations of payment schemes. Temporal willingness to pay for five-year project ranged US$263~277. Table 2 provides test statistics for the sequential test on the five-year project. With 95% confidence, LR test failed to reject the consistence and heteroskedasticity of temporal willingness to pay of five-year project.

[*Table 1~2 located here*]

Table 3 and Table 4 also provide estimation results for the data pooled over five and ten-year restoration programs[6]. The expected temporal of willingness to pays were $216~234 for five-year project and $181~198 for ten-year project in combined data. Table 3, however, shows that the temporal willingness to pay for the ten-year project is

[6] We assumed consistence and homoskedasticity of temporal willingness to pay of different projects. Thus, the difference between five- and ten-year projects is estimated by the dummy for the project version.

statistically indistinguishable from that of the five-year project. Indifference of temporal willingness to pay across project versions implies that respondents may evaluate the project based on the final status of the environment but do not care how fast the project is implemented. Table 4 demonstrates that temporal willingness to pay for the oyster reef program is consistent except one case of combining lump-sum payment and perpetuity-type payment schemes. The rejection of hypothesis may be due to problematic features of data violating monotonic probability (Cooper and Loomis 1992, Kanninen, 1995). Except the case of rejecting the first stage hypothesis, for which the second stage test was not necessary, the sequential test could not reject the homoskedastic error terms across payment schemes.

[*Table 3~4 located here*]

Test results of oyster reef restoration program support that temporal willingness to pay for the oyster reef programs was insensitive, i.e. consistent and homoskedastic, to the payment scheme provided by researcher. Based on the sequential test results, Table 5 shows the implicit discount rate from parameter estimates of payment. Implicit discount rates ranged from 20% to 130%. Estimated discount rates were still relatively high but much lower than previous studies. Similar to hyperbolic discounting (e.g., see Cropper and Laibson 1999), the short term discount rate (or near-term discount rate, r_{1A}) was larger than the long term discount rate (or distant-term discount rate, r_{13}) for the five-year project only.

[Table 5 located here]

7. Conclusions

In spite of the simple concept of temporal insensitivity of willingness to pay, previous studies derived the temporal insensitivity and implicit discount rate under restrictive assumption that the present value of willingness to pay is identical across different payment schemes. However, identification of present value of willingness to pay and estimation of the discount rate from different payment schemes rely critically on the consistent and homoskedastic present value of willingness to pay in payment context. Especially, inconsistence present value of willingness to pay leads to inability of deciding temporal insensitivity.

In this paper, we constructed the model of temporal willingness to pay and redefined the temporal insensitivity by consistence and homoskedasticity of temporal willingness to pay. The temporal insensitivity of willingness to pay implies the consistent valuing behavior of respondents with different payment schemes. Using the sequential test, we tested the consistence and homoskedasticity of the temporal willingness to pay for oyster reef programs in Chesapeake Bay. The test results showed that the temporal willingness to pay for the project was statistically identical across different payment types. In holding the payment scheme constant, however, temporal willingness to pay did not vary significantly across project versions. Homoskedasticity of the error distribution across payment schemes supported the use of pooled data over payment schemes to derive implicit discount rates. Estimated discount rates were relatively high but lower than that of previous studies. Implicit discount rates varied significantly across payment schemes and project versions.

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Table 1: Estimation Results for Five-Year Project

	Split Sample			1+2+3		1+3		1+2	
	A1	***A2***	***A3***	***Scaled***	***Pooled***	***Scaled***	***Pooled***	***Scaled***	***Pooled***
Const	-0.8726 (1.0970)	2.1975 (1.2577)	0.9891 (1.4054)	0.2993 (0.8034)	0.4940 (0.6379)	-0.3034 (0.9232)	-0.0230 (0.6874)	-0.0082 (0.6664)	0.3011 (0.7991)
RE	-0.5018* (0.2050)	-0.1448 (0.1674)	-0.3698 (0.2059)	-0.3956* (0.1390)	-0.2759* (0.1053)	-0.4685* (0.1732)	-0.3510* (0.1384)	-0.4227* (0.1564)	-0.3031* (0.1267)
HS	0.2077 (0.1367)	-0.0918 (0.1477)	0.0296 (0.0864)	0.0734 (0.0848)	0.0355 (0.0628)	0.1196 (0.0977)	0.0605 (0.0687)	0.1247 (0.1069)	0.0775 (0.0983)
SEX	0.1370 (0.2842)	0.5178 (0.3229)	-0.0473 (0.3483)	0.2607 (0.2124)	0.2028 (0.1684)	0.2163 (0.2481)	0.1795 (0.2059)	0.2597 (0.2419)	0.2585 (0.2038)
AGE	0.0429* (0.0121)	0.0074 (0.0130)	-0.0053 (0.0105)	0.0229* (0.0080)	0.0140* (0.0062)	0.0282* (0.0093)	0.0164* (0.0070)	0.0342* (0.0095)	0.0254* (0.0086)
EDUC	-0.0226 (0.0504)	-0.1074 (0.0624)	0.0554 (0.0673)	-0.0114 (0.0393)	-0.0100 (0.0317)	0.0097 (0.0449)	0.0224 (0.0358)	-0.0421 (0.0390)	-0.0458 (0.0375)
FEE1	0.0033* (0.0015)	—	—	0.0041* (0.0012)	0.0032* (0.0010)	0.0041* (0.0014)	0.0034* (0.0012)	0.0037* (0.0013)	0.0029* (0.0012)
FEE2A	—	0.0059 (0.0042)	—	0.0063 (0.0042)	0.0064* (0.0029)	—	—	0.0049 (0.0045)	0.0058 (0.0032)
FEE3	—	—	0.0152* (0.0072)	0.0108 (0.0065)	0.0103* (0.0046)	0.0092 (0.0076)	0.0112* (0.0052)	—	—
Scale Factors	—	—	—	0.4645	—	—	—	0.4850	—
				0.4266	—	0.5620	—	—	—
N	101	83	73	257		174		184	
Mean ln(*L*)	-0.5635	-0.5852	-0.5566	-0.5992	-0.6015	-0.5900	-0.5930	-0.5913	-0.5951

* significant at 95% confidence level.
SEX is a dummy variable that is one for female. *HS*, *AGE* and *EDUC* are the size of household, age and education variables. *RE* is an ordinal variable for ranking the role of oysters among food, economy, environment and fish habitat. *RE* = 1 represents that respondent thinks environment is the most important role oysters play in the Chesapeake Bay.

Table 3: Estimation Results for Five and Ten-Year Projects

	Split Sample			**1+2+3**		**1+3**		**1+2**	
	AB1	***AB2***	***AB3***	***Scaled***	***Pooled***	***Scaled***	***Pooled***	***Scaled***	***Pooled***
Const	-1.0353 (0.7997)	1.3334 (0.9163)	1.1250 (0.8959)	-0.0422 (0.6104)	0.2748 (0.4772)	-0.5469 (0.7104)	-0.0615 (0.5691)	-0.3877 (0.6948)	-0.0870 (0.5859)
	0.2757 (0.1936)	-0.0821 (0.4350)	-0.0198 (0.2183)	0.1686 (0.1640)	0.1038 (0.1336)	0.2127 (0.1749)	0.1361 (0.1419)	0.2264 (0.1841)	0.1904 (0.1714)
RE	-0.2667* (0.1327)	-0.1177 (0.1454)	-0.1781 (0.1320)	-0.2293* (0.0999)	-0.1595* (0.0760)	-0.2361* (0.1160)	-0.1632 (0.0903)	-0.2522* (0.1132)	-0.1901* (0.0950)
HS	0.0421 (0.0812)	-0.1169 (0.0977)	-0.0620 (0.0678)	-0.0353 (0.0601)	-0.0426 (0.0447)	-0.0037 (0.0684)	-0.0300 (0.0508)	-0.0074 (0.0717)	-0.0179 (0.0615)
SEX	0.0567 (0.1992)	0.1954 (0.2202)	-0.3929 (0.2289)	0.0324 (0.1541)	-0.0192 (0.1184)	-0.0195 (0.1802)	-0.0911 (0.1446)	0.1220 (0.1700)	0.0960 (0.1431)
AGE	0.0316* (0.0077)	0.0004 (0.0086)	-0.0057 (0.0077)	0.0182* (0.0057)	0.0102* (0.0043)	0.0231* (0.0066)	0.0134* (0.0051)	0.0248* (0.0066)	0.0178* (0.0056)
EDUC	0.0351 (0.0374)	-0.0068 (0.0393)	0.0426 (0.0419)	0.0369 (0.0287)	0.0251 (0.0222)	0.0468 (0.0338)	0.0376 (0.0272)	0.0270 (0.0319)	0.0166 (0.0265)
FEE1	0.0048* (0.0011)	—	—	0.0053* (0.0009)	0.0041* (0.0008)	0.0051* (0.0010)	0.0043* (0.0009)	0.0051* (0.0010)	0.0042* (0.0008)
FEE2A	—	0.0059 (0.0041)	—	0.0082* (0.0040)	0.0072* (0.0027)	—	—	0.0081* (0.0041)	0.0081* (0.0029)
FEE2B	—	0.0096 (0.0059)	—	0.0090 (0.0052)	0.0084* (0.0035)	—	—	0.0079 (0.0054)	0.0082* (0.0039)
FEE3	—	—	0.0068 (0.0048)	0.0063 (0.0049)	0.0076* (0.0032)	0.0035 (0.0057)	0.0077* (0.0036)	—	—
Scale Factors				0.4744	—	—	—	0.4750	—
				0.5495	—	0.6813	—	—	—
N	202	165	152	519		354		367	
Mean ln(*L*)	-0.5902	-0.6007	-0.5865	-0.6096	-0.6115	-0.6080	-0.6117	-0.6030	-0.6064

* significant at 95% confidence level.
FIVE is a dummy indicator that equals one if individual *i* receives the five-year restoration plan and zero otherwise.

Table 2: Consistence and Homoskedasticity of *TWTP* (Five-Year Project)

	1+2+3	**1+3**	**1+2**
LR1	15.75	10.23	6.61
LR2	1.16	1.02	1.43

Table 4: Consistence and Homoskedasticity of *TWTP* (Five and Ten-Year Projects)

	1+2+3	**1+3**	**1+2**
LR1	17.84	13.75*	5.95
LR2	1.93	—	2.49

* Rejected with 90% confidence.

Table 5: Implicit Discount Rates

	1+2+3	**1+3**	**1+2**
Five-Year Project			
† $\mathbf{r_{13}}$	0.46	0.45	—
‡ $\mathbf{r_{1A}}$	0.94	—	0.98*
§ $\mathbf{r_{3A}}$	0.22	—	—
Five and Ten-Year Projects			
† $\mathbf{r_{13}}$	1.20	—	—
‡ $\mathbf{r_{1A}}$	1.29	—	1.02
‡ $\mathbf{r_{1B}}$	0.96	—	1.05
§ $\mathbf{r_{3A}}$	0.87	—	—
§ $\mathbf{r_{3B}}$	N/A	—	—
†† $\mathbf{r_{AB}}$	0.43	—	1.31

N/A indicates that coefficient of Perpetuity is less than that of other payment schedule.
* One of coefficients of FEE is not significantly different from zero.
† Calculated using coefficients of one time and perpetuity in pooled data.
‡ Calculated using coefficients of one time and annual in pooled data.
§ Calculated using coefficients of annual and perpetuity in pooled data.
†† Calculated using coefficients of 5 and 10 year annual payments in pooled data.