How to Quantify the Consumer Value of Environmental Actions

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Breakdown of Environmental Goods Markets

- **The production and consumption of environmental goods are not under the control of identifiable owners who make allocation decisions in response to price signals. Prices provide the wrong incentives, leading to *mechanism failure*. Examples: Water pollution, traffic congestion, ocean fish stocks.**
- **Market prices of environmental goods fail to aggregate and communicate consumer values, leading to *information failure*.**

- **Policy makers evaluating actions to modify the allocation of environmental goods must obtain direct information on consumer valuation of these actions. They turn to environmental economists to provide these values, despite Oscar Wilde's admonition: "An economist is someone who knows the price of everything and the value of nothing."**

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- **Quantifying the value of environmental injury or remediation is critical for Natural Resource Damage Assessment (NRDA), and other actions such as management of ocean fish stocks and forests.**
- **Main Question: What Experimental Designs, Data Requirements, Estimation Methods, and Valuation formulas are available for use in environmental valuation?**

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  - For use losses not priced directly, but priced implicitly through the cost of complements in consumption, such as travel cost to tourist and recreational fishing sites
- Contingent Valuation Method (CVM)
  - For non-use losses whose value is not identified from market behavior, such as determining the value of preserving an endangered species of whale
  - Can also be applied to use losses
  - One member of a large family of direct preference elicitation methods (PEM)

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- **Basic Idea: If two properties, one in a "treatment" area affected by the environmental hazard, the other in an unaffected "control" area, are *identical in all other respects*, then the difference in their selling prices reflects the value consumers place on the hazard.**

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- **Basic Idea: If two properties, one in a "treatment" area affected by the environmental hazard, the other in an unaffected "control" area, are *identical in all other respects*, then the difference in their selling prices reflects the value consumers place on the hazard.**
- **The controls might be properties in a nearby neighborhood, or the same properties at a different time when the hazard is absent, or both.**

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- **Careful attention to experimental design is necessary to isolate the effect of the hazard from possible confounders such as persistent neighborhood differences that are not directly measured, time variation in the overall market, amenities and disamenities other than the hazard.**
- **The "value" measured by HPM is a pecuniary loss, which is not necessarily the same as utility loss expressed in monetary units; when do these value concepts coincide, and when they do not, how do they differ?**

Hedonic Regression

- **To correct for both persistent neighborhood effects and time variation in the overall market, a two-way (panel) experimental design, with control neighborhoods unaffected by the hazard, and before/during observations in both treatment and control neighborhoods, is required.**

- **Model:** y_{wnt} = ✂$_{n}$+☎$_{t}$+✉$_{w}$+x_{wnt}👓+♑$_{wnt}$,

n neighborhood (n= 1 for treated, n = 0 for controls)

t time (t = 0 before hazard, t = 1 during hazard)

y log sales price

w hazard indicator (w = n*t in factual case and w ≡ 0 in counterfactual case).

x measured property and neighborhood attributes

♑ disturbance

Valuation of the Hazard

- **If Gauss-Markov conditions for statistical consistency of OLS are met, then the effect of the hazard on the value of a property in the affected neighborhood with attributes x [the conditional expectation of the effect of treatment on the treated (TT), given x] is given by a *conditional difference-in-difference* (DID),**

$$\boxtimes_1 = E(TT|x) = E(y_{111}|x) - E(y_{010}|x) - E(y_{001}|x) + E(y_{000}|x)$$

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- **Caution: Before/during analysis of the treatment neighborhood alone confounds hazard and time effects. Analysis of the treatment and control neighborhoods solely during the hazard (t = 1) confounds hazard and persistent neighborhood effects.**

Issues in HPM regressions

- Are sales a biased sample of values? Are direct valuations (e.g., assessments) reliable?
- Omitted attributes
- Feedback from hazard to attributes
- Gradients, trends, interactions
- Temporary versus permanent effects
- Does the conditional DID estimator measure consumer welfare change (Willingness-to-Pay (WTP)?
- Are welfare measures beyond mean value needed?

Sales versus Assessed Values

- Properties sold may not be representative of all properties in a neighborhood affected by an environmental hazard, so a sample of sales may be biased by selection. Solution: A bivariate selection model of the classical Heckman type, with a binomial equation determining probability of sale and a hedonic equation for sales price, with correlated errors.
- Assessed values are, ultimately, based on sales data, and consequently are one step removed from the best evidence. The assessment process is murky, and may fail to reflect the effect of the hazard appropriately.

- **Omitted attributes: these are swept into the disturbance, and may cause included attributes and the disturbance to be correlated, violating Gauss-Markov assumptions.**
- **Feedback from hazard to attributes: if a decline in values induced by the hazard causes attribute changes (e.g., reduced maintenance, lower income residents), then the causal link from hazard to price is confounded. Instrumental variables may provide a solution.**

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- **Gradients, trends, interactions: Attributes may have a nonlinear effect on price (e.g., age of dwelling), and may interact. The effect of the hazard may have a gradient with distance. There may be time gradients in persistent neighborhood effects.**
- **Temporary versus permanent effects: The price effect of the hazard may be temporary, as consumers learn about its consequences and remediation proceeds.**

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- The DID estimator values all properties in the affected neighborhood at the tastes of the most adverse, leading to an overstatement of WTP.
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- Conclusion: At best, HPM measures pecuniary loss to consumers, and and does not accurately measure WTP when the environmental action directly affects utility.

Are Welfare Measures Beyond Mean Value Needed?

- Policy analysts may need information such as value for the median voter, or the fraction with value above a specified threshold. These require information on the conditional distribution of value, given x.
- In general, one may have price p = g(w,n,t,x,♑), with g a unknown nonlinear, non-additive function of its arguments.

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- **If g is increasing in ♑, *the effect of time on the treated if they were untreated would have been the same as the effect of time was on the untreated*, $F_{nt}(y|x)$ is the observed conditional CDF of y given x for subpopulation nt, with w = n∗t, and $f_{nt}(q|x)$ solves $F_{nt}(y|x) = q$, then**

$$P(TT<c|x) = \int \mathit{1}(f_{11}(q|x)-f_{10}(q|x)-f_{01}(q|x)+f_{00}(q|x) < c)dq$$

- **The conditional quantile functions f_{nt} in this expression can be estimated by kernel methods; see Matzkin (2002).**

Example: HPM Valuation of Air Quality

- **HPM has been used to analyze the value to consumers of clean air, by OLS hedonic regression of log housing prices on dwelling attributes and the level of total suspended particulates (TSP) for cross-sections of cities and neighborhoods. The finding is that a one $\mu g/m^3$ decrease in TSP results in a 0.05% to 0.10% increase in property values.**

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- **Using a nonlinear DID estimator that exploits the interaction of macroeconomic conditions and EPA attainment status to "instrument" for the feedbacks, Chay and Greenstone find that a one $\mu g/m^3$ decrease in TSP results in a 0.4% to 0.5% increase in property values, a much larger consumer value for air quality improvements.**

Travel Cost Method (TCM)

- **User value of a resource that is not directly priced can sometimes be inferred from behavioral response to the cost of complementary market goods.**
- **Example: The price of recreational fishing, absent a user fee, is the dollar and time cost of travel to the fishing site. Consumer reluctance to travel to an injured site reflects the value the consumer places on the injury.**

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- **If travel behavior is the result of utility maximization in a population with heterogeneous tastes, then a *Random Utility Maximization* (RUM) model can be estimated and used to analyze WTP for environmental actions.**

Destination Choice Model

- Suppose consumers choose among recreation sites

  $C = \{1,\ldots,J\}$, taking into account travel cost (c_j), travel time (t_j), site attributes x_j, and environmental condition w_j, to maximize (indirect) utility

  u_j = ✂(I – c_j - 🖹❄t_j) +x_j🙰 + w_j✉ + ♑$_j$ ≡ V_j + ♑$_j$

  where I is income, ❄ is the wage rate, ♑$_j$ is a disturbance, ✂ is the marginal utility of income, 🖹 is the ratio of the disutility of travel time to the disutility of work time, and ✉ measures the effect of the environmental injury.

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- Distributional assumptions on the disturbances lead to parametric choice models; e.g., ♑$_j$ distributed iid Extreme Value Type I yields a RUM model with *multinomial logit* (MNL) choice probabilities

  $$P_C(j) = \exp(V_j)/\sum_{i\in C} \exp(V_i)\ .$$

- **RUM models derived from indirect utility that is linear in income, as above, can be aggregated into a "community" utility function $U(V_1,\ldots,V_J)$ that generates the choice probabilities via Roy's identity, $P_C(j) = -(\partial U/\partial c_j)/(\partial U/\partial I)$, and provides a convenient formula for WTP for an environmental action that changes V_j' to V_j'',**

  WTP = (U(V'') – U(V'))/✂.

  For example, the linear-in-income RUM model with Extreme Value Type I disturbances that produces MNL choice probabilities has a community utility function satisfying a *log sum* formula

  $$U(V) = \log(\textstyle\sum_{i\in C} \exp(V_i)).$$

Issues

- **Accurate measurement of attributes, particularly incremental travel time and cost, is critical**
- **When the RUM model is not linear in income, there is no community utility function and computation of WTP is more difficult; see McFadden (1999), Karlstrom (2001).**
- **The MNL model has been used successfully in many natural resource valuation exercises. Nevertheless, it is restrictive in its implications for substitutability across alternatives, and should always be subjected to specification testing.**
- **The TCM combines nicely with sample designs based on interception of subjects at chosen destinations, but estimation and prediction require correction for sample selection.**

MNL Specification Test (McFadden, 1987)

- First estimate the MNL model; let $P_C(j)$ denote this estimated model. Suppose A is a subset of alternatives, and define $P_A(j) = P_C(j)/ \sum_{i\in A} P_C(i)$. Second, construct an auxiliary variable

$$z_j = 1(j\in A)(\log P_A(j) - \sum_{i\in A} P_A(i) \log P_A(i)) .$$

  (More than one set A and variable z may be constructed.) Third, re-estimate the MNL model with both the original variables and the new auxiliary variables. Do a likelihood ratio test for the significance of the auxiliary variables. If the MNL specification is correct, the auxiliary variables will have no explanatory power.

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- **This test is equivalent to a Lagrange Multiplier test of MNL against the alternative of a Generalized Extreme Value (GEV) model, a family that includes nested MNL models.**

Mixed MNL (MMNL) Model

$$P_C(j) = \int_0^1 \cdots \int_0^1 \frac{e^{V_j(\alpha)}}{\sum_{i \in C} e^{V_i(\alpha)}} \cdot d\alpha,$$

- $V_i(\alpha)$ is a "systematic utility" linear in a vector of functions of observable attributes of alternative i, with coefficients that are specified transformations of a uniform random vector α. Then, MMNL is a "random coefficients" MNL.

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- McFadden and Train (2000) show that any well-behaved RUM-consistent choice probabilities can be approximated uniformly by a RUM-consistent MMNL model.

- **MMNL models offer a consistent foundation for empirical analysis of any behavior that fits the RUM hypothesis.**
- **A convenient specification test for MNL against the specific alternative of MMNL first estimates a MNL model PC(j), then for selected components k of the vector of attributes x_j constructs auxiliary variables**

  $$z_{kj} = (x_{kj} - \sum_{i \in C} x_{ki} P_C(i))^2/2,$$

  re-estimates the MNL model adding these auxiliary variables, and conducts a likelihood ratio test for the exclusion of the auxiliary variables. Significant auxiliary variables are candidates for mixing.
- **This test is equivalent to a Lagrange Multiplier test for MNL against the alternative of MMNL.**

- When the mixing distribution in the MMNL model is approximated by a distribution with finite support, it takes a form common in market research, called the *latent class model*,

$$P_C(j) = \sum_{k=1}^{K} \frac{e^{V_j(\alpha_k)}}{\sum_{i \in C} e^{V_i(\alpha_k)}} \cdot \pi_k ,$$

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- **The mixing probabilities α_k are interpreted as fractional sizes of classes of consumers segmented by tastes.**
- **The latent class model is a *single-hidden-layer feedforward neural network* (with MNL activation functions) and the asymptotic theory of sieves for nonparametric estimation of neural nets applies.**

An Application: Trout Fishing Destination Choice in Montana

- To estimate damage caused by copper mining to recreational fishing in the Clark Fork River Basin in Montana, a sample of 962 fishing trips to Montana rivers, made by 238 anglers, was collected in a household survey conducted by Bill Desvousges and associates at Triangle Economic Research. A total of 59 river fishing sites were studied. Data were collected on fish stocks at each site and other site attributes, and on the travel cost to each site for each angler in the sample. These data have been used by Kenneth Train (1999) to estimate MMNL models for fishing site choice. The following results are adapted from the Train study.

- The study assumes an indirect utility $U = \alpha(a\text{-}c) - w{\cdot}t\beta + z(x,s)\gamma$, where α, β,γ are parameters that can vary randomly over the population. This yields a MMNL model

$$P_C(i) = \int \frac{e^{-\alpha c_i - \beta w \cdot t_i + z(x_i,s)\gamma}}{\sum_{j \in C} e^{-\alpha c_j - \beta w \cdot t_j + z(x_j,s)\gamma}} \cdot F(d\alpha, d\beta, d\gamma) \ ,$$

a = non-wage income, *c* = cost of the alternative, *w* = wage rate, *t* = travel time,
x = vector of other observed attributes of the alternative,
s = a vector of observed characteristics of the consumer,
z(*x*,*s*) = vector of pre-specified functions of the arguments

Fishing Site Attributes

Variable	Description	Mean	Std. Dev.
Trout Stock	Hundreds of fish per 1000' of stream	1.773	1.468
Aesthetics	Rating on a scale of 0 to 3 (highest), from Montana River Information System	1.386	0.86
Logsize	Log of number of USGS blocks that contain the site	2.649	0.684
Camp-grounds	Number of campgrounds per USGS block	0.195	0.198
Access	Number of State designated access areas per USGS block	0.172	0.305
Major	Site rated as a major fishing area by the Angler's Guide to Montana	0.559	0.501
Restricted	Number of restricted species at the site (e.g., mandated catch/release) during some times of the year	0.339	0.902
Trip Cost	Travel cost to the site, including the variable cost of driving and the value of time spent driving (calculated at 1/3 the angler's wage)	$89.22	$35.24

Table 3. MMNL Model of Fishing Site Choice with Independent Random Parameters

Variable	Parameter Distribution	Distribution of Coefficient			Probability Positive	Elasticity (at Median Coefficient)
		10 Pctle	Median	90 Pctle		
Trout Stock	Log Normal *Std. Error*	0.015 *0.014*	0.056 *0.034*	0.207* *0.070*	1.0	0.098
Aesthetics	Log Normal *Std. Error*	0.152* *0.060*	0.452* *0.103*	1.342* *0.159*	1.0	0.616
Trip cost	Log Normal *Std. Error*	-0.032* *0.004*	-0.091* *0.006*	-0.253* *0.030*	0.0	-7.945
Major	Normal *Std. Error*	-1.795* *0.401*	1.018* *0.289*	3.831* *0.642*	0.68	0.56
Camp-grounds	Normal *Std. Error*	-2.005* *0.693*	0.116 *0.323*	2.237* *0.591*	0.53	0.022
Access	Normal *Std. Error*	-3.369* *0.715*	-0.950* *0.361*	1.470* *0.392*	0.31	-0.161
Restricted	Normal *Std. Error*	-1.651* *0.305*	-0.499* *0.131*	0.653* *0.171*	0.29	-0.166
Logsize	Fixed *Std. Error*	0.9835* *0.108*	0.9835* *0.108*	0.9835* *0.108*	1.0	0.967

Applications of discrete choice models to economic policy problems often call for estimation of Willingness-to-Pay (WTP) for policy changes. When the MMNL model is independent of non-wage income, Hicksian and Marshallian consumer surplus coincide, and mean WTP has a convenient exact *expected log sum* form in before (V°) and after (V') systematic utilities

$$\text{WTP} = E_{\alpha,\beta,\gamma} \frac{1}{\alpha} \log\left(\frac{\exp(V_1') + \ldots + \exp(V_J')}{\exp(V_1^{\circ}) + \ldots + \exp(V_J^{\circ})} \right) .$$

- When the indirect utility function is *not* linear and additive in non-wage income, McFadden (1999) gives bounds that will sometimes suffice for policy analysis, and develops monte carlo markov chain methods for numerical calculation of exact WTP. Karlstrom (1999) simplifies these calculations.

- The Montana trout fishing study estimated WTP for increased trout stocks:

WTP for 100 more fish per 1000' of stream	Distribution of WTP for Individual Anglers			Population Average WTP
	10 Pct	Median	90 Pct	
Estimate *Standard Error*	$0.12 *0.08*	$0.62 *0.23*	$3.27 *0.53*	$1.44 *0.28*

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- For the MNL model, choice-based sampling can be corrected simply by adding variables to the model, typically alternative-specific constants.
- The theory of estimation from endogenous samples can be extended to endogenously recruited panels and other sample selection problems, with generalized formulas for likelihood and for WTP simulation (McFadden, 1997)

Contingent Valuation Method (CVM)

- **One method to obtain consumer's WTP for an environmental action is to just ask them. This is called CVM in environmental economics, *conjoint analysis* in market research, *preference scaling* in psychology. Term the whole family of techniques *Preference Elicitation Methods* (PEM).**

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- **PEM can be used to elicit beliefs, perceptions, and attitudes as well as preferences.**
- **PEM is the only method available for measuring WTP for environmental actions that have no use component linking value to behavior, such as saving an endangered species. PEM can also be employed to estimate direct and indirect use values.**

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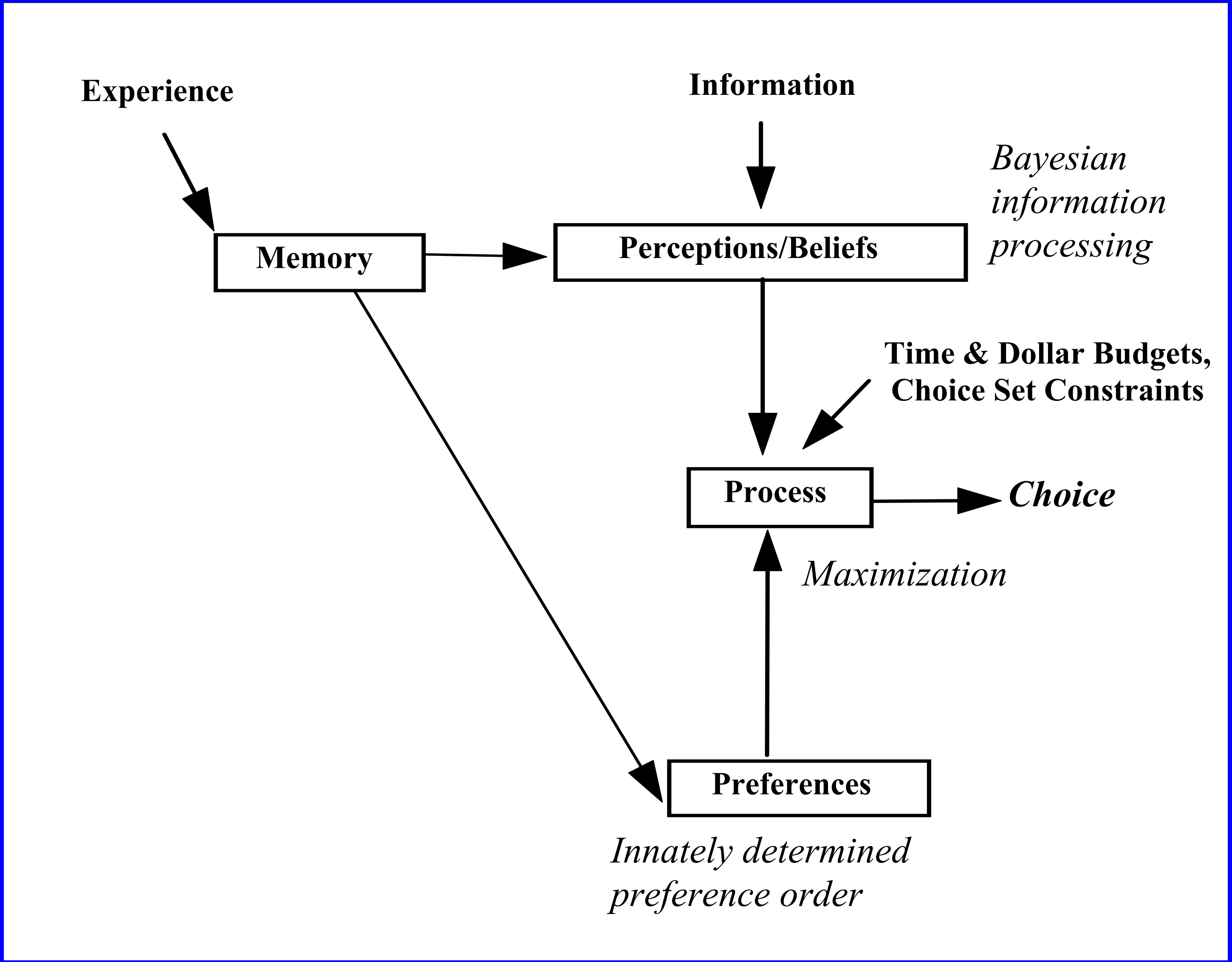
- **Statistical:** How to estimate WTP when an experimental design and elicitation protocols are employed to reduce response bias.
- **Psychological:** Choice behavior is more context and perception dependent, and less relentlessly self-interested, than the economist's standard model. PEM must overcome cognitive anomalies that may also be present in real market behavior, but in real markets are less conspicuous and more likely to be controlled by precautionary behavioral rules and market discipline.

Economists' Standard Model of Choice Process



Assumption: CVM responses fit the standard choice model

- CVM elicits WTP in an

  open-ended format (How much? ______), or

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- **CVM may elicit WTP for actions that vary by scope and extension, or may elicit preferences among different actions.**
- **A CVM experiment is an *economic game* between the observer and the subject, with two critical features other than elicitation format:**
  - **Implementation Frame: Link between subject's response and subjective probability of action**
  - **Payment Vehicle: Form of payment, conditions for payment, link to subject's response.**

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- **Example: "UNESCO is considering an action to rescue antiquities that will otherwise be flooded by the Three Gorges Project in China. You are one of five thousand individuals being surveyed to determine if this project is worthwhile. The probability the action will be taken is proportional to the survey plurality for the project at its actual cost K. If the action is taken, its cost will be paid through increased prices on goods you purchase that are imported from China, and will not depend on your response." [Decisive and decoupled *if* the prompts are believed.]**

r	**response (e.g., the threshold for a "Yes" response in a referendum elicitation)**
F(K)	**Complementary CDF giving subject's beliefs about responses of others surveyed**
g(K)	**density giving subject's beliefs about actual cost**
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The game has a trivial Nash equilibrium where the subject chooses r to maximize this payoff, and

$$\nabla_r \text{Payoff} = ((V - h(r,r))g(r) - \int_{K \leq r}(\nabla_r h(K,r))g(K)dK)/5000$$

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- **If the payment vehicle is decoupled but V is above [below] the support of g, the subject has an incentive to overstate [understate] V.**

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- **If the bids are drawn from a continuous positive density h(K), then mean WTP from a referendum sample $n = 1,\ldots,N$ with y_n an indicator for "Yes" has an unbiased estimator $\sum_n y_n / h(K_n)N$. This can be extended to parametric or nonparametric conditional mean WTP (Lwebel, Linton, McFadden, 2002).**

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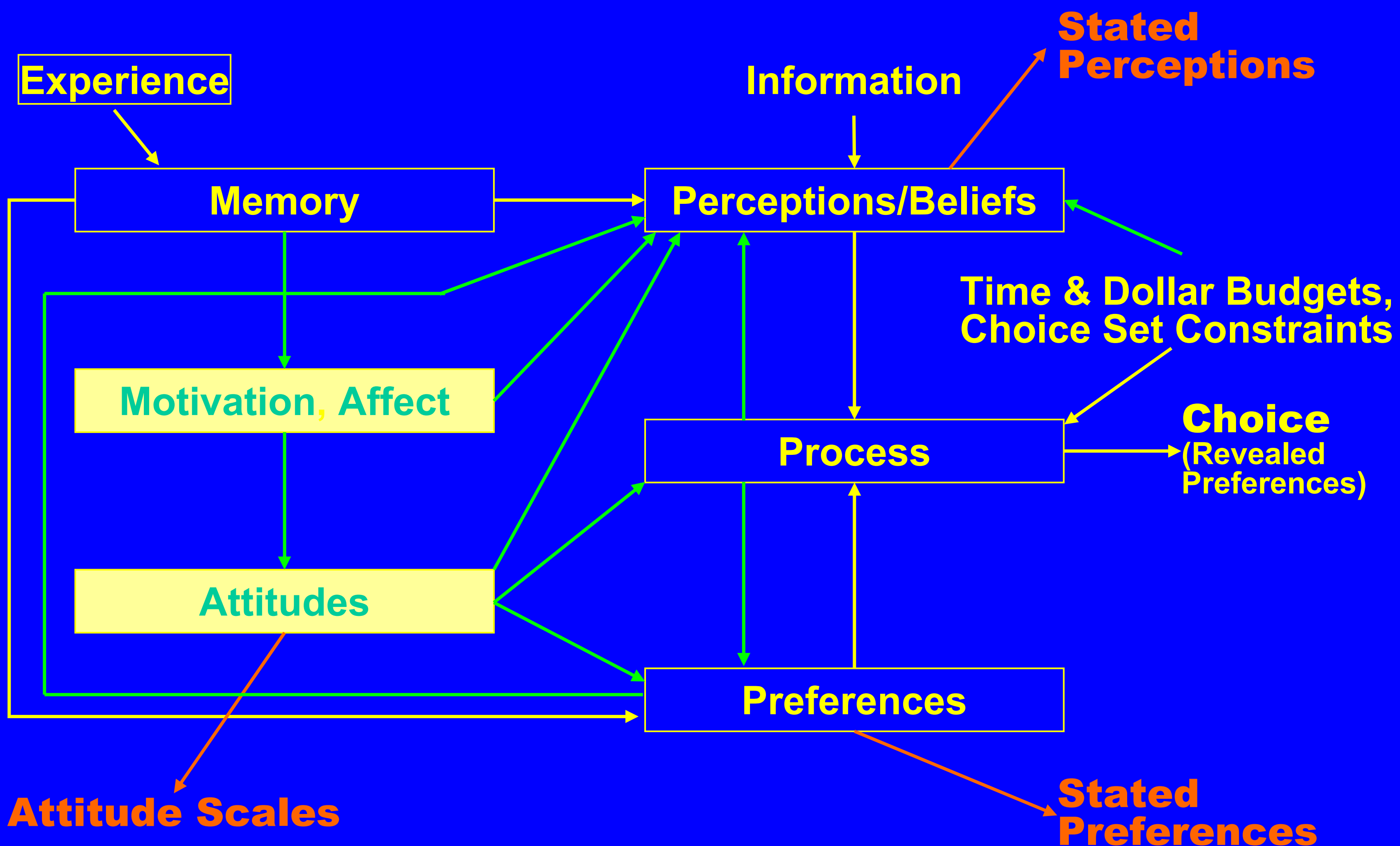
- Precautionary behavioral rules, social interaction, and market discipline limit cognitive anomalies in familiar, repetitive real markets. They are more visible in unfamiliar, experimental non-market settings.
- CVM for familiar goods can mimic market behavior well (Carson, 1996). CVM for unfamiliar goods, such as existence values for endangered species, is more vulnerable to cognitive anomalies.


Experience
Memory
Motivation, Affect
Attitudes
Attitude Scales
Information
Stated
Perceptions
Perceptions/Beliefs
Time & Dollar Budgets,
Choice Set Constraints
Process
Choice
(Revealed
Preferences)
Preferences
Stated
Preferences

Effect	Description
Availability/Saliency	Use readily retrieved information, ignore background information
Anchoring	Responses are influenced by cuescontained questions
Context	Previous experience and interviewer interaction color perception
Primacy/Recency	Initial and recently experienced events are the most salient
Framing/Reference Point	Question format changes saliency of different aspects of task
Recall	Anticipation is distorted by biased recall of past experience
Status Quo	Current status and history are privileged
Superstition	Elaborate causal structures are attached to coincidences
Processing of information	Systematic statistical errors
Regression	Causality and permanence are attached to past fluctuations, and regression to the mean is underestimated
Prospect	The likelihoods of low probability events are misjudged, and treated either as too likely or as zero
Representativeness	High conditional probabilities induce overestimates of unconditional probabilities
Construal ot task	Optimization anomalies
Rule-Driven	Motivation and self-control induce strategic responses
Saliency	The most salient aspects of the question are overemphasized
Social/Projection	Responses conform to social norms and the self-image the subject wishes to project to others
Temporal	Temporally inconsistent time discounting

Anchoring in Referendum CVM
(Green, Jakowitz, Kahneman, McFadden, 1998)

What value would your household place on saving about 50,000 seabirds each year from offshore oil spills?

- Several million seabirds living off Pacific coast
- Few people see them
- Small oil spills kill estimated 50,000+ seabirds per year
- Solutions to prevent deaths expensive, extra funds required
- Usually not possible to force tanker companies to pay
- Public money would have to be spent yearly to save the birds

Design of the Experiment

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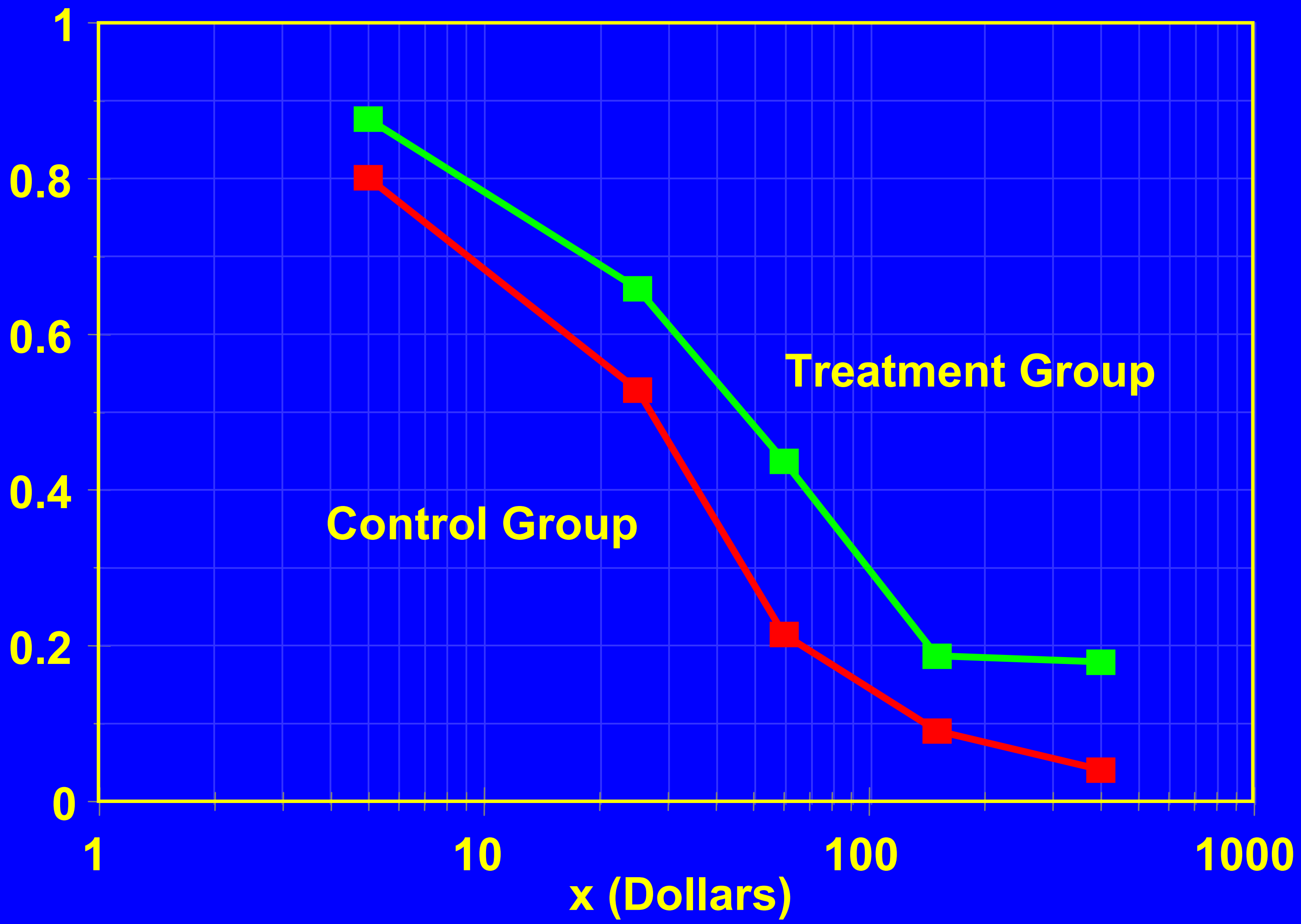
- In addition to the CVM question on seagulls, subjects were asked about height of tallest redwood tree, gasoline consumption per month, annual rainfall at the wettest spot.
- Experimental design: Subjects were divided into control and treatment groups. Control groups, surveyed first, were asked open-ended questions. From their responses, rounded-off approximations to the 25, 50, 75, 90, and 95 quantiles were calculated. Five treatment groups were asked referendum questions, with prompts at randomly assigned quantiles. Differences between control and treatment groups show the effect of elicitation format and of anchoring to the prompts.

Seabird Prob(WTP > x)



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• The effect of a one dollar increase in the prompt is to increase mean response by 28 cents.

• Anchoring effects for WTP are qualitatively similar to anchoring effects for unfamiliar estimation tasks, suggesting that similar cognitive processes may be involved.

Willingness-to-Pay to Save 50,000 Off-Shore Seabirds per Year

Distribution	Open-Ended	Starting Point Bid				
		$5	$25	$60	$150	$400
$0-4.99	19.8%	12.2%	8.5%	0.0%	8.3%	12.0%
$5-24.99	27.3%	67.4%	25.5%	41.7%	29.2%	22.0%
$25-59.99	31.4%	12.2%	53.2%	14.6%	27.1%	20.0%
$60-149.99	12.4%	8.2%	8.5%	41.7%	16.7%	18.0%
$150-399.99	5.0%	0.0%	2.1%	2.1%	18.8%	10.0%
$400+	4.1%	0.0%	2.1%	0.0%	0.0%	18.1%
Sample size	121	49	47	48	48	50
P(Open-Ended Response>Bid)		80.2%	52.9%	21.5%	9.1%	4.1%
(Std. Error)		5.7%	7.1%	5.9%	4.1%	2.8%
P(Anchored Response>Bid)		87.8%	66.0%	43.8%	18.8%	18.0%
(Std. Error)		4.7%	6.9%	7.2%	5.6%	5.4%
Median Response	$25.00	$10.00	$25.00	$25.00	$43.00	$50.00
(Std. Error)	$6.03	$2.33	$1.16	$14.04	$10.87	$23.41
Mean Response (a)	$64.25	$20.30	$45.43	$49.42	$60.23	$143.12
(Std. Error)	$13.22	$3.64	$12.61	$6.51	$8.59	$28.28

	Coefficient	Std. Error
Marginal effect of starting point bid	0.284	0.32
K-J Interquartile Anchoring Index	0.273	0.136
Nonparametric referendum mean (b)	$167.33	$76.90
Referendum multiplier	2.60	1.31
Parametric referendum mean	$265.59	$138.96
Referendum multiplier	4.13	2.32

a. One observation of $2,000,000 is excluded from the calculation of the open-ended mean. If the open-ended mean WTP of $64.25 is representative of all California adults, then the total state WTP for protecting 50,000 seabirds is $1.49 bil., or $29,800 per bird.

b. The upper bound to the distribution is assumed to equal the largest anchored response, $1000. The reported std. error is the RMSE at the maximum possible bias, given the upper bound to the distribution.

Conclusions

- **HPM, TCM, and CVM form a battery of useful econometric methods for quantifying values of environmental goods for use in policy analysis of environmental actions and resource allocation decisions.**
- **All three methods deserve continuing scientific scrutiny, have room for improvement, and should be employed cautiously and with a critical eye.**