WELFARE ECONOMICS
FOR CONSUMER AND ENVIRONMENTAL PRODUCTS AND SERVICES

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Background: "Welfare Economics in Product Markets" (with Kenneth Train),
UC Berkeley Working Paper, March 2019 https://eml.berkeley.edu/~train/prodmarkets.pdf

Applied Welfare Economics for Consumer and Environmental Products and Services

- Typical applications –
  - Prospective regulation for consumer products (e.g., vehicle emissions, seatbelt reliability), or Retrospective redress for product defects
  - Prospective regulation of hazardous waste disposal, or Retrospective harm from environmental hazards (e.g., beach contamination)
  - Prospective benefits of blocking mergers of dominant firms, or Retrospective harm from supplier collusion

- Products and services include directly marketed goods (e.g., beverages, vehicles), goods priced indirectly through complements and substitutes (e.g., beach holidays priced through their travel cost and time), non-use goods that leave no discernable trace in market behavior (e.g., bleaching of coral reefs in remote sanctuaries)

Valuing Consumer and Environmental Products/Services

- Attributed to Oscar Wilde: *An economist is someone who knows the price of everything and the value of nothing*.
  - Mr. Wilde is too kind, we don't know the price of everything.
- What in fact <u>do</u> economists mean when they talk about the **Value** of a unit of a product or service?
- Adam Smith (1776) *Wealth of Nations*:
  - ***Value-in-Use (VIU)***, the benefit a consumer obtains from consuming the unit, denominated in monetary terms.
  - ***Value-in-Exchange (VIE)***, or ***price***, a measure of benefit forgone, or *opportunity cost*, when the consumer buys the unit.
  - **"Higgling and bargaining in the market [achieves] rough equality [at the margin] between value-in-use and value-in-exchange."**

From Value-in-Exchange to Value-in-Use

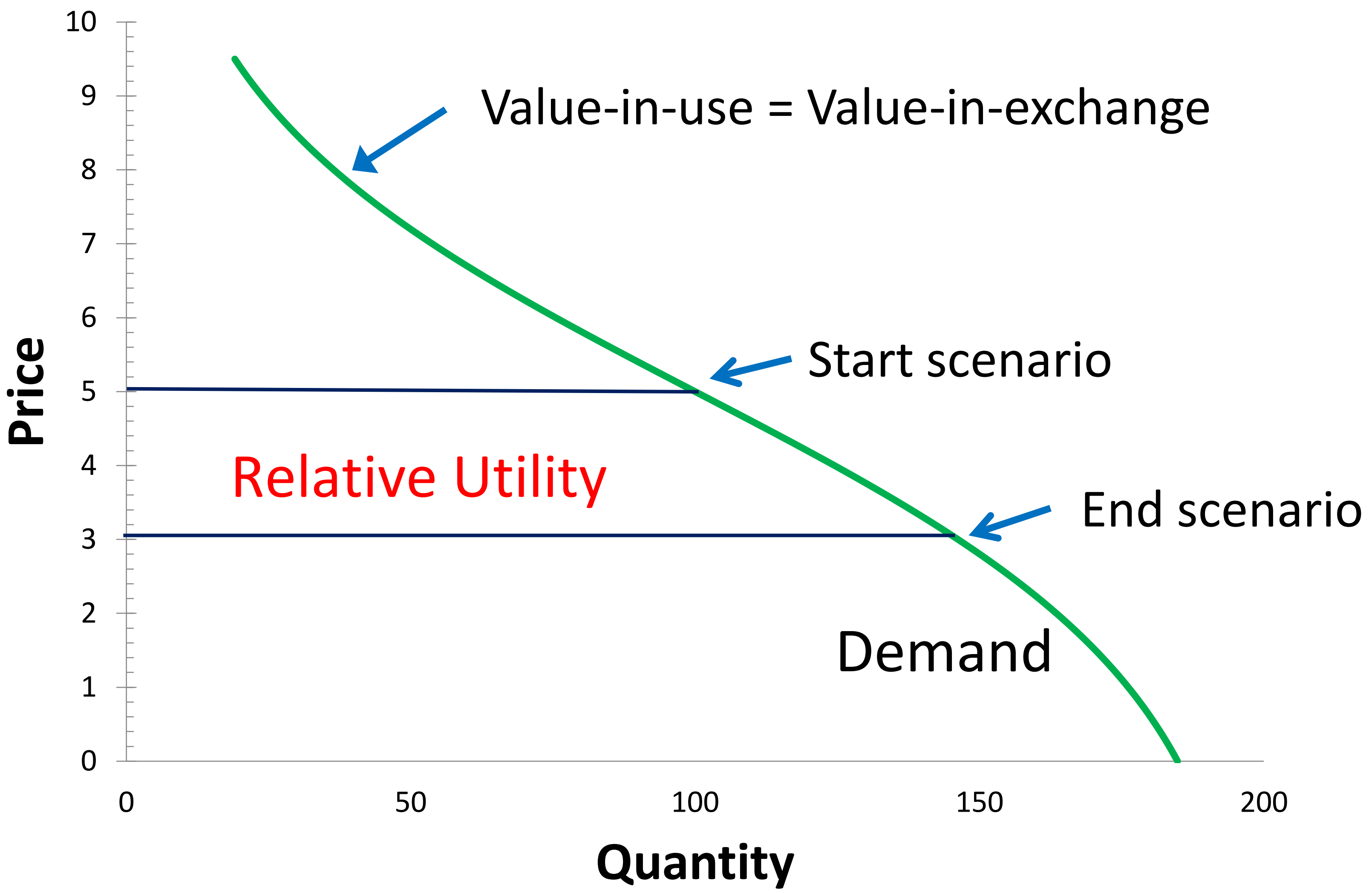
- As Oscar Wilde remarks, economists can measure value-in-exchange, or price. The challenge to welfare economics in product applications is to infer, from observations on choices and prices, the impact on consumer's values-in-use and well-being of changes in economic and environmental circumstance.
- This talk –
  A. A little history of welfare economics for consumer goods and services
  B. Practical solutions to retrospective valuation problems
  C. Behavioral and data issues in applications

A. A Little History of Welfare Economics …

- Adam Smith (1776): value-in-use ≈ value-in-exchange (at the margin)

- Jules Dupuit (1844, 1849): The integral of demand between two prices (≡ values-in-exchange) is a measure of ***relative utility***, a solution to the inverse problem (for multiple goods, the intergrability problem) of recovering utility from demand.

Jules Dupuit (1844)



- In Dupuit's market, buyers were firms, the supplier was a public entity (i.e., Bureau of Bridges). His colleague Louis Bordas (1847) pointed out that Dupuit's analysis also applies to final consumers <u>if</u> ***Marginal Utility of Income*** (MUI) is constant.
- Hermann Gossen (1854): Equal marginal utility per unit of expenditure on each consumer good maximizes utility
- Alfred Marshall (1890): Rediscovered Dupuit's relative utility, renamed ***Marshallian Consumer Surplus*** (MCS). Marshall was aware of the constant MUI requirement, but treated it as a harmless approximation.
- John Hicks (1939): To circumvent the assumption of a constant MUI, defined ***Hicksian Compensating Variation*** (HCV), the <u>net decrease</u> in end scenario income, and ***Hicksian Equivalent Variation*** (HEV), the <u>net increase</u> in start scenario income, that equate utility in the two scenarios.
- Since Hicks, welfare economics has been considered a dusty, finished subject, but practical solution of the inverse problem is still incomplete, 175 years after Dupuit.

Neoclassical Consumer Theory (2 Minute version)

- Maximize utility $U(q_0,q_1)$ of two goods subject to a budget $I = p_0q_0 + p_1q_1$

  Substituting in the budget constraint, $q_1 \equiv (I - p_0q_0)/p_1$

  FOC: $\partial U/\partial q_0 - (p_0/p_1)\partial U/\partial q_1 = 0$ or $(1/p_1)\partial U/\partial q_1 = (1/p_0)\partial U/\partial q_0$ (Gossen)
- Maximands: $q_0 = D_0(I,p_0,p_1)$ and $q_1 = D_1(I,p_0,p_1) \equiv (I - p_0D_0(I,p_0,p_1))/p_1$
- Indirect utility: $V(I,p_0,p_1) \equiv U(D_0(I,p_0,p_1),D_1(I,p_0,p_1)) \equiv \max_{q_0} U(q_0,(I - p_0q_0)/p_1)$
- MUI: $\partial V/\partial I = (1/p_1)\partial U/\partial q_1 + FOC\cdot(\partial D_0/\partial I) \equiv (1/p_1)\partial U/\partial q_1$

  or $p_j = (1/MUI)\cdot\partial U/\partial q_j$ (Smith)
- $\partial V/\partial p_1 = -(D_1(I,p_0,p_1)/p_1)\partial U/\partial q_1 + FOC\cdot(\partial D_0/\partial p_1) \equiv -D_1(I,p_0,p_1)\cdot(\partial V/\partial I)$

  or $D_1(I,p_0,p_1) = -[\partial V/\partial p_1]/[\partial V/\partial I]$ (Roy, 1947)

From Demand to (Relative) Utility

MCS = $\int_{p_{1e}}^{p_{1s}} D_1(I,p_0,p_1)dp_1$ (Dupuit-Marshall relative utility/consumer surplus)

$$\equiv \int_{p_{1s}}^{p_{1e}} \frac{\partial V/\partial p_1}{\partial V/\partial I}\, dp_1 \equiv \frac{1}{(\partial V/\partial I)^{\#}} \int_{p_{1s}}^{p_{1e}} \frac{\partial V}{\partial p_1}\, dp_1 \equiv [V(I,p_0,p_{1e}) - V(I,p_0,p_{1s})]/MUI^{\#}$$

by Roy's identity, where $(\partial V/\partial I)^{\#}$ = $MUI^{\#}$ is some intermediate value

Hicks: $0 = V(I\text{-}HCV,p_0,p_{1e}) - V(I,p_0,p_{1s}) = [V(I,p_0,p_{1e}) - V(I,p_0,p_{1s})] - MUI^{\%}\cdot HCV$

$0 = V(I,p_0,p_{1e}) - V(I\text{+}HEV,p_0,p_{1s}) = [V(I,p_0,p_{1e}) - V(I,p_0,p_{1s})] - MUI^{\&}\cdot HEV$

where $MUI^{\%}$ and $MUI^{\&}$ are intermediate values

A new measure – ***Market Compensating Equivalent*** (MCE):

MCE = $[V(I,p_0,p_{1e}) - V(I,p_0,p_{1s})]/MUI^s$ (MUI^s = value at start scenario)

∴ MCS, HCV, HEV, MCE have the same sign, differ only because of scaling by MUI at different arguments, (nearly) equal when MUI (nearly) constant

Retrospective Welfare Analysis and MCE

- Welfare theory has historically been <u>prospective</u>, asking how to determine the impact of <u>future</u> policies on consumer well-being, but <u>retrospective</u> welfare analysis is common, targeted to fulfilling compensation after-the-fact. While MCS/MCE and HCV/HEV differ only in scale, they are theoretically applicable in mutually exclusive circumstances:
  - HCV/HEV apply when compensation <u>is exactly fulfilled before</u> consumer optimization in each scenario, only possible prospectively
  - MCS/MCE apply when compensation <u>is not fulfilled exactly</u> and/or is calculated in retrospective analysis <u>after</u> consumer optimization in the end scenario. MCE is an generalizable update to MCS that is practical to calculate whenever indirect money-metric utility at baseline prices and attributes can be recovered from choice data.
- <u>Conclusion</u>: For <u>retrospective</u> welfare calculations, or <u>prospective</u> analysis <u>without</u> fulfillment, leaving the consumer in her as-is state, MCE is good theoretically as well as practically, and HCV/HEV is only approximate!

Analysis … Gaps in the Neoclassical Framework

  - Inattention to retrospective issues (e.g., compensation after-the-fact)
  - Assumes individual consumers with known preferences, little consideration of welfare assessment and necessarily inexact compensation when preferences are heterogeneous in the population and only <u>partially observed</u> for individuals.
  - Focus is primarily on overall well-being, not on losses, entitlements, and benefits for designated classes in the population.
  - No room for behavioral deviations from neoclassical assumptions.
- The neoclassical foundations need correction and expansion to support applied welfare analysis of products and services
  - Steps: practical approximation, estimation, market simulation

Applied Welfare Analysis for Products & Services – The Program

Data

Revealed Preference (RP):
as-is market opportunities
and choices

Stated Preference (SP):
hypothetical market choices
hypothetical referenda
psychometric/neurological

Supply side structure/conduct

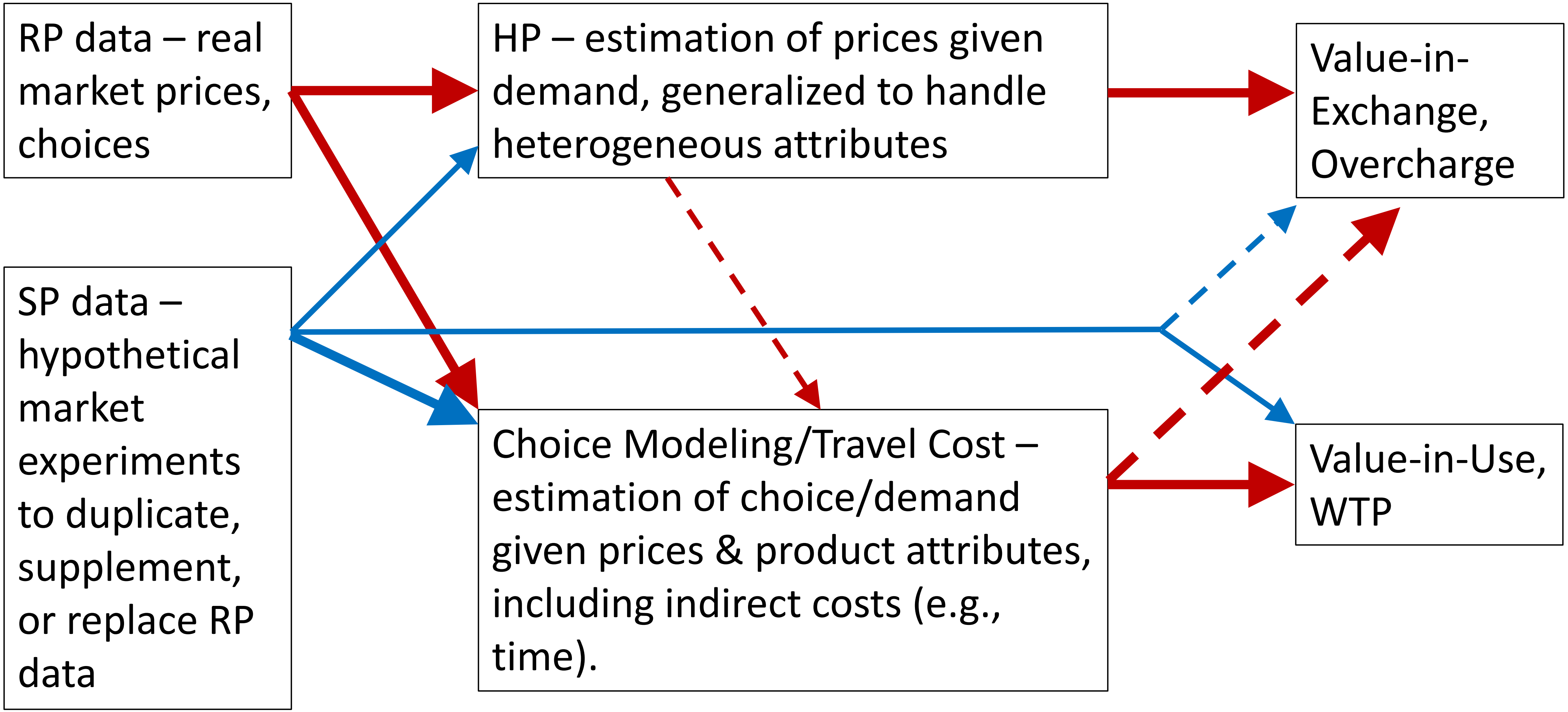
Analysis & Valuation

Models:
Hedonic price (HP)
Choice/demand (e.g., travel cost model)
Supply side (e.g., Nash market game)

Market equilibrium

Valuations:
Overcharge
Consumer utility & WTP

Paths and Objectives



B. Practical Models for Product Choice

- Indirect utility u = $V(I - p_j, z_j, r, \rho)$ of income *I*, price p_j and vector of attributes z_j for product *j* from a finite universe of possible products, a vector of prices *r* of goods in continuous supply, tastes ρ. Money-metric if for good 0 and baseline $\bar{p}_0, \bar{z}_0, \bar{r}$, the indirect utility is scaled so that $V(I, \bar{z}_0, \bar{r}, \rho) \equiv I$.
- In a population with tastes ρ drawn from a field of Lipschitz-smooth neoclassical preferences, indirect utility in money-metric form exists, and is approximated uniformly by $v_j(\beta_\rho, \sigma_\rho) = I - p_j + X\left(I - p_j, z_j, r\right)\beta_\rho + \sigma_\rho \varepsilon_j$, a linear-in-parameters specification where *X* is a vector of predetermined functions (e.g., polynomials), the ε_j are i.i.d. EV1 shocks, and $(\beta_\rho, \sigma_\rho)$ characterize the tastes ρ.
  - Specializes to $v_j(\beta_\rho, \sigma_\rho) = I - p_j + X(I - p_j, e^{z_j \gamma}, r)\beta_\rho + \sigma_\rho \varepsilon_j$ if attributes are embedded in products and quality perception is homogeneous, corresponding to a regression log $p_j = z_j \gamma + \xi$ in which the residual ξ is log quality-adjusted price.

Implementing the approximation --

- Suppose you have observations on a sample of n = 1,…,N consumers, each a neoclassical utility maximizer with indirect utility $V(I - p_j, z_j, r, \rho_n)$, who face m = 1,…,M finite menus of products C_m and make choices indicated by δ_{jmn} (i.e., 1 if chosen, 0 otherwise) that maximize this utility. With RP data, M = 1. With SP data, M can range from 1 to about 30.
- Given any tolerance level $\alpha > 0$, the approximating *X* can be chosen so that consumer ρ has independent "flat" MNL choice probabilities

$$L_{j|C_m}(\beta_\rho,\sigma_\rho) = \exp(v_{jm}(\beta_\rho,\sigma_\rho)/\sigma_\rho)/\sum_{k\in C_m}\exp(v_{km}(\beta_\rho,\sigma_\rho)/\sigma_\rho)$$

such that $|\delta_{jmn} - L_{j|C_m}(\beta_{\rho_n}, \sigma_{\rho_n})| < \alpha$ with prob. at least $1 - \alpha$, uniformly in ρ.

- In this ***Random Utility Model*** (RUM) approximation, σ_ρ can be homogeneous or heterogeneous, but must be contained in an interval $0 < \sigma^- \le \sigma_\rho \le \sigma^+$ with σ^+ sufficiently small. Achieving this approximation requires an econometric specification search and application of a stopping rule.

Estimation strategies:

- Taste parameters (β_ρ,σ_ρ) appear in this MNL model as “fixed-effects” for each consumer ρ. It is however impractical to estimate this model in this form, as even in SP data with multiple menus there are insufficient data to reliably estimate individual tastes. Two solutions:

1) Interpret the (β_ρ,σ_ρ) as “random effects” that in the population of consumers are distributed with a density $f(\beta,\sigma|s,\theta)$, conditioned on observed background characteristics *s* and depending on deep parameters θ. The result is a **mixed MNL** model. Estimate θ using maximum (simulated) likelihood.

2) Interpret the (β_ρ,σ_ρ) in a **Hierarchical Bayes** framework as random parameters with a prior $f(\beta_{\rho_1},\sigma_{\varrho_1}|s_1,\theta)\cdot\cdots\cdot f(\beta_{\rho_N},\sigma_{\varrho_N}|s_N,\theta)\cdot g(\theta)$, where g is a (diffuse) density on deep parameters θ. Multiply this prior by the likelihood to form the posterior (up to a scale factor) for all these parameters, and take the posterior mean of θ as an estimate of the deep parameters.

More on the Mixed MNL Model

- With the utility-maximizing choice from a single menu C_m of an individual with tastes ρ approximated by the "flat" MNL probability $L_{j|C_m}(\beta_\rho,\sigma_\rho)$, and a density $f(\beta,\sigma|s,\theta)$ of taste parameters in the target population conditioned on consumer characteristics s, the population choice probability given s has the mixed MNL (MMNL) form

$$P_{j|C_m}(s,\theta) = E_{\beta,\sigma|s,\theta} L_{j|C_m}(\beta,\sigma) \equiv \int L_{j|C_m}(\beta,\sigma) f(\beta,\sigma|s,\theta)\, d\beta\, d\sigma$$

- When choices indicated by δ_{jm} from menus m = 1,…,M are observed for a single individual with characteristics s, the probability of this event is

$$E_{\beta,\sigma|s,\theta} \prod_{m=1}^{M} \prod_{j\in C_m} L_{j|C_m}(\beta,\sigma)^{\delta_{jm}}$$

$$\equiv \int \prod_{m=1}^{M} \prod_{j\in C_m} L_{j|C_m}(\beta,\sigma)^{\delta_{jm}} f(\beta,\sigma|s,\theta)\, d\beta\, d\sigma$$

Maximum (Simulated) Likelihood of MMNL

- The log likelihood of observing the sampled choices is

$$\sum_{n=1}^{N} \log \boldsymbol{E}_{\beta,\sigma|s_n,\theta} \prod_{m=1}^{M} \prod_{j\in C_m} L_{j|C_m}(\beta,\sigma)^{\delta_{\mathrm{jmn}}}.$$

- Numerical or simulation methods that draw evaluation points (β_i,σ_i) and weights w_i are required in general to approximate the expectation inside the log as a function of θ. Programs are available in STATA, R.
- Cautions:
  - In high dimensions, a very large number of well-chosen evaluation points are needed for accurate approximation in which simulation noise can be neglected
  - Simulation method must avoid chatter; i.e., (β_i,σ_i) must vary equicontinuously with θ
  - Can be numerically unstable if the support of the density *f* wrt σ is not bounded above
  - Log likelihood is not generally concave in θ, and simulation can add wrinkles, so care is needed to avoid local false maxima
  - It is consistent, less efficient, more robust, to not enforce common (β,σ) across menus for a subject, and treat responses on different menus as independent. However, if this is done, standard errors of estimates need to be calculated using a sandwich formula with grouping by subject.

Hierarchical Bayes (HB) estimation

- Use a ***Monte Carlo Markov Chain*** sampler to draw points from the posterior density

$$A \cdot \prod_{n=1}^{N} \prod_{m=1}^{M} \prod_{j \in C_m} L_{j|C_m}(\beta_n, \sigma_n)^{\delta_{jmn}} f(\beta_n, \sigma_n | s, \theta) g(\theta) ,$$

where A is scale factor (calculation unnecessary) such that the density integrates to one. Estimate θ by forming the mean of its sampled values.

- Cautions:
  - Very large numbers of draws, burn-in, serial correlation control, tuning, are needed for adequate coverage of support of posterior
  - Estimation programs in R: STAN package, ***NUTS sampler***, ***Allenby-Train sampler***
- Both MSL and HB are consistent and asymptotically efficient when the support of *g* contains the true θ and simulation noise is driven to zero.

Illustration: Table Grapes (Artificial SP/Choice-Based-Conjoint study)

- Attributes: Price (\$1 to \$4 per 500g), Sweetness [*tart* (17 brix, coded 0) or *sweet* (24 brix, coded 1)], Crispness [*soft* (pH 7, coded 0) or *crisp* (pH 5, coded 1)], Size [*small* (40 count, coded 0) or *large* (20 count, coded 1), Organic [*No* (coded 0) or *Yes* (coded 1)]
- 1000 subjects, 8 menus, no-purchase (j=0) and three bunches (J=3) per menu
- RUM linear in attributes plus Sweetness*Crispness interaction plus Sweetness*(Gender=female) interaction plus indicator for "grape-preference" that is turned on for all except the no-purchase alternative.

$$u_{jm} = I - p_{jm} + x_{jm}\beta + \sigma\varepsilon_{jm} \equiv I + v_{jm}(\beta) + \sigma\varepsilon_{jm}$$

$$\varepsilon_{jm} \sim \text{i.i.d. EV1, } \beta \text{ and } \log\sigma \text{ multivariate normal}$$

Table 1. A Table Grape CBC Menu

Menu 1	Bunch #1	Bunch #2	Bunch #3	No Purchase
Price	$2.50	$2.75	$3.00	$0.00
Sweetness	Tart (0)	Sweet (1)	Sweet (1)	
Crispness	Crisp (1)	Soft (0)	Crisp (1)	
Size	Small (0)	Large (1)	Small (0)	
Organic?	No (0)	No (0)	Yes (1)	
Your Choice	⊔	⊔	⊔	⊔

Table 2. Extract of Data from the Table Grape CBC

Subject	Menu	Alternative	Price	Sweetness	Crispness	Size	Organic?	Sweet*Crisp	S*Gender	Bunch intercept	Gender	Choice
1	1	1	2.98	0	0	0	1	0	0	1	0	0
1	1	2	1.51	0	1	0	1	0	0	1	0	0
1	1	3	1.42	1	0	0	0	0	0	1	0	1
1	1	4	0	0	0	0	0	0	0	0	0	0
1	2	1	1.12	1	0	0	1	0	0	1	0	1
1	2	2	1.63	1	1	1	1	1	0	1	0	0
1	2	3	2.77	1	0	0	0	0	0	1	0	0
1	2	4	0	0	0	0	0	0	0	0	0	0

Model, Estimators, Comparative Performance

- The β parameters and log σ are components of a multivariate normal vector, with no restriction on β correlations, zero correlations between β and log σ imposed in data generation and estimation
- Running times
  - MSL 3-4 hours
  - AT sampler 12 minutes (200K draws, first 100K discarded as burn in)
  - NUTS overnight (11K draws, first 5.5K discarded as burn-in)

Comparative performance of the estimators for the Table Grape CBC

Parameter	True Values		HB-AT		HB-NUTS		MSL	
Means	Population	Sample	Mean	Std Dev	Mean	Std Dev	Estimate	Std Error
β_S	1.0	1.005	0.9682	(0.0445)	0.9784	(0.0407)	0.9694	(0.0457)
β_C	0.3	0.299	0.3495	(0.0358)	0.3610	(0.0342)	0.3554	(0.0391)
β_L	0.2	0.197	0.1781	(0.0251)	0.1898	(0.0258)	0.1760	(0.0238)
β_O	0.1	0.109	0.0910	(0.0238)	0.0964	(0.0224)	0.09988	(0.0248)
β_{SC}	0.0	0.001	-0.0450	(0.0485)	-0.0515	(0.0464)	-0.0579	(0.0490)
β_{SG}	0.1	0.093	0.1369	(0.0540)	0.1446	(0.0469)	0.1523	(0.0536)
δ_n	2.0	2.012	2.0049	(0.0498)	2.0159	(0.0583)	1.9893	(0.512)
$\log(\sigma_n)$	-0.5	-0.481	-0.5277	(0.0253)	-0.5038	(0.0228)	-0.5687	(0.281)

Parameter	True Values		HB-AT		HB-NUTS		MSL	
Std Devs	Population	Sample	Mean	Std Dev	Mean	Std Dev	Estimate	Std Error
β_S	0.3	0.303	0.3086	(0.0633)	0.3299	(0.0610)	0.3044	(0.0889)
β_C	0.1	0.099	0.2149	(0.0354)	0.1299	(0.0539)	0.2661	(0.1085)
β_L	0.1	0.101	0.1621	(0.0370)	0.1325	(0.0497)	0.1496	(0.0517)
β_O	0.2	0.210	0.2157	(0.0378)	0.1863	(0.0489)	0.2440	(0.0467)
β_{SC}	0.05	0.051	0.2227	(0.0516)	0.0974	(0.0738)	0.2564	(0.1511)
β_{SG}	0.2	0.202	0.2518	(0.0758)	0.2960	(0.1325)	0.3955	(0.1084)
δ_n	1.0	0.988	0.7924	(0.0764)	0.9288	(0.0548)	0.8917	(0.0606)
$\log(\sigma_n)$	0.3	0.296	0.4220	(0.0257)	0.2757	(0.0415)	0.3406	(0.0415)

Market Simulation Strategies

- For policy analysis, generate a simulated population with a distribution of s that matches the real target population. If the estimation sample is a (weighted) random sample from the target population, its subjects and their observed s_n can be used as a base, with replications to incorporate weighting and achieve a large simulated population.
- For each simulated consumer:
  - Calculate the as-is v_j' and choice probabilities $P_{j|C',s}'$ from the fitted mixed MNL model. Calibrate model parameters so that the $P_{j|C',s}'$ are consistent with market-level or external data and match as-is market equilibrium. Draw a simulated as-is choice from these probabilities.

More on Calibration to As-Is Market Equilibrium

- When the model is estimated using RP data from the as-is environment, then simulated demand estimates from this model given as-is products should reproduce the as-is market equilibrium, and will do so if the model includes alternative-specific constants and the estimation sample is the simulated target population.
  - If further correction is necessary to exactly match as-is market shares, this can be done by introducing or modifying alternative-specific constants.
- When the estimation sample or data differ from the as-is environment (e.g., when SP data is collected), substantial calibration may be required
  - When possible, model estimation using stacked SP and RP data, or impose as-is constraints in estimation, to find most likely consistent model
  - Calibration by adjusting mean alternative-specific effects to match as-is market outcomes is practical, but second-best. Resolve non-unique calibration methods by comparing MSLs of calibrated models.

Market Simulation continued

- Calculate the but-for v_j'' and choice probabilities $P''_{j|C'',s}$, adjusting prices to attain market equilibrium given supply conditions. Draw a simulated but-for choice from these probabilities.
  - A model of the supply side of the product market is required. Examples are Nash equilibrium pricing by oligopolistic sellers of differentiated products, or government provision through regulation and restoration of public goods such as groundwater free of industrial pollutants.
- Calculate as-is and but-for indirect utilities, and as-is MUI, then calculate the MCE, for each simulated consumer. Process the empirical distribution of MCE for designated consumer classes to determine compensation rules and/or draw policy conclusions.

Some Shortcuts

- When income enters indirect utility linearly (i.e., no income effect on discrete choice, so MUI $\equiv$ 1),

$$MCE(s) = I'' - I' + E_{\beta,\sigma|s}\, \sigma \left\{ \log \sum_{k \in C''} \exp(\mathrm{v}_k''/\sigma) \,/\, \log \sum_{j \in C'} \exp(\mathrm{v}_j'/\sigma) \right\}.$$

- When the <u>only</u> difference between the as-is and but-for scenarios is that a set of alternatives B $\subseteq$ C'' is unavailable in C',

$$MCE(s) = -E_{\beta,\sigma|s}\, \sigma \cdot \log\,(1 - P''_{B|C'',s})$$

- When the share of B in the but-for market is small,

$$MCE(s) \approx E_{\beta,\sigma|s} \sigma \cdot P''_{B|C'',s}\;,$$

the σ-weighted share of people with characteristics *s* who choose from B when this set of alternatives is available

The "Benefit of the Bargain"

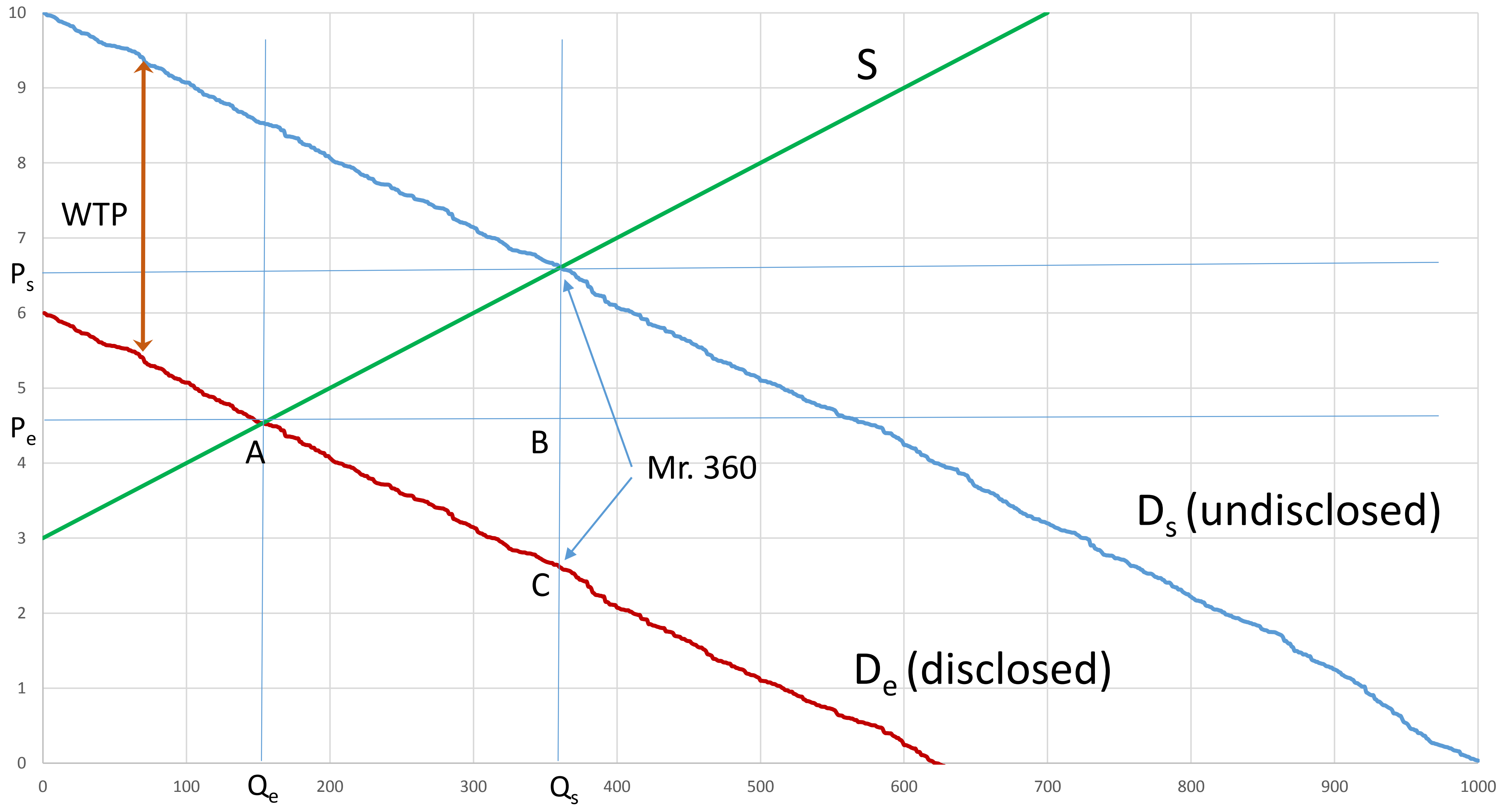
- In retrospective analysis, a legal standard is that consumers are entitled to "The benefit of the bargain"; i.e., to the product as represented or warranted, with the remedies provided by the warrant. Measurement of economic harm should be based on buyers' entitlement under this bargain.
- "Caveat Emptor" applies to warranties that do not guarantee the value-in-use anticipated by the buyer; e.g., "refund" warranties limit recovery to the purchase price of a returned product, "repair or replace" warranties limit recovery to accepting the product with the flaw corrected.
- Sellers are liable for breaches of warranty, such as failure to disclose product flaws. However, liability for the overall economic losses of disappointed consumers may be allocated across "Seller misconduct", "Force majeure", "Third parties" (e.g., stigma), "Buyer misuse or failure to mitigate", etc.

Simulation: the “Bargain” and marginal consumers

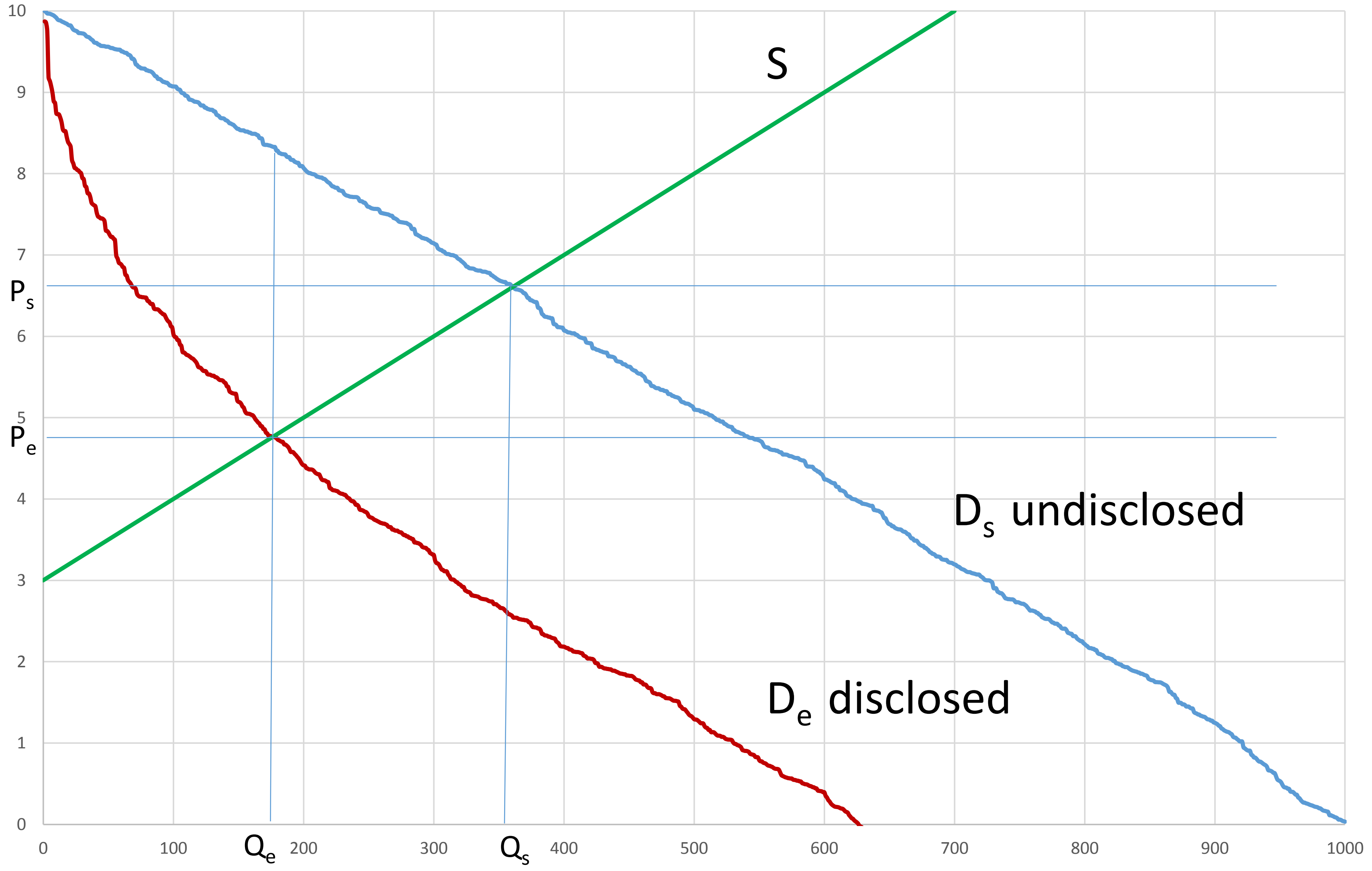
- The Dupuit-Marshall-Hicks welfare calculus for a single “representative” consumer with fully observed preferences is misleading when there are multiple consumers with heterogeneous preferences; a “representative consumer” approximation is satisfactory only under stringent, often implausible, circumstances
- For products purchased in discrete units (e.g., houses), reinterpret Dupuit-Marshall demand as the locus of values-in-use, ranked from high to low
- Aggregate MCE for a group of consumers by adding it up over the group members, assuming that the value of a dollar to each group member is the same (e.g., the Lerner rule).

MCE when a product has an undisclosed flaw, discrete choice, N = 1000

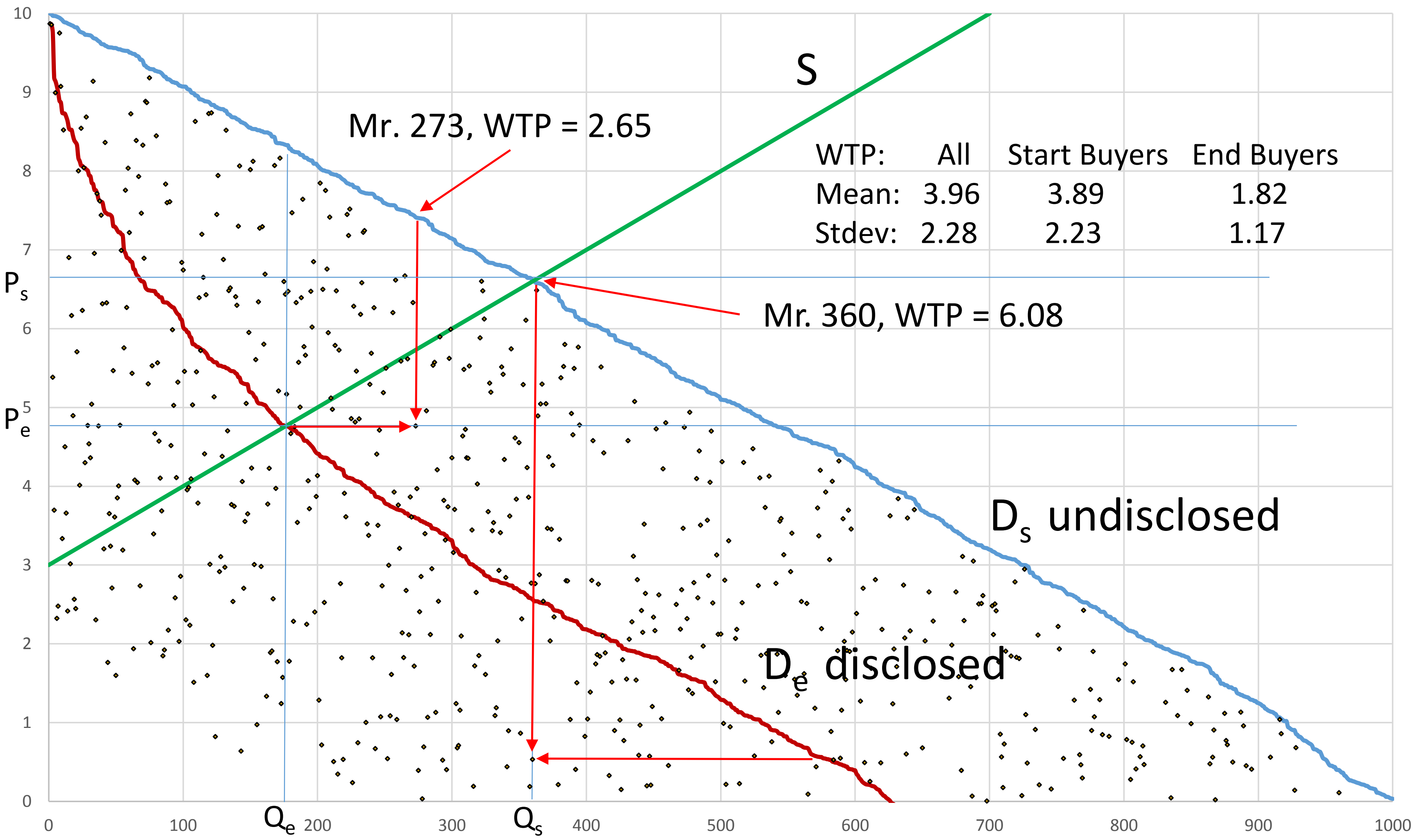
(Heterogeneous value-in-use, uniform WTP ≡ 4)



Heterogeneous value-in-use and WTP, N = 1000



Heterogeneous value-in-use and WTP, N = 1000



Conclusions on Practical Application

- Microsimulation of a population with mixed logit choice probabilities, fitted to RP and/or SP data and calibrated to as-is market conditions, can be used in combination with a model of product supply to calculate but-for market equilibrium, overcharges, and MCE for observed classes of consumers
- The distributions of MCE can be used to design compensation rules, or to evaluate programs for remediation or restoration
- Data collection, model specification, fitting, and simulation are technically nontrivial, and require care in implementation and interpretation of results.

C. Behavioral Issues in Applications

- **Unrealistic personal probabilities** – many product acquisitions involve choice under uncertainty, and require personal probability judgements. In practice, these probabilities may be internally inconsistent or inconsistent with objective probabilities.
  - Does not necessarily bias forecasts, but confounds recovery of utility and the welfare calculus, with a distinction between decision-utility and experienced-utility
- **Hypersensitivity to framing and context** – consumers are manipulated by the proximate information they receive when making choices
  - Occurs in both RP and SP data, more conspicuous and potentially harmful in SP where it is very difficult to design experiments where framing and context are unimportant
- **Inconsistent accounting for costs** – immediate direct costs weigh more heavily than indirect or delayed costs, payment vehicle influences choice
- **Hedonic treadmill** – endowment or reference point effect in which changes from any established position are viewed with suspicion, WTP ≠ WTA

Data Issues in Applications

- RP data is the “gold standard” for goods that are marketed directly or indirectly
  - Encodes actual consumer behavior, neoclassical or not, and provides a basis for forecasting whenever distributions of choice rules are stable
  - May lack the range and independent variation in covariates needed for accurate forecasting in new environments
- SP experiments such as ***Choice-Based-Conjoint*** (CBC) Analysis, in which subjects indicate product choices from hypothetical menus, have about the same forecasting accuracy as RP data <u>for familiar market products and services</u>
  - Reliability falls rapidly for unfamiliar products or attributes, where information manipulation and cognitive anomalies have substantial influence on stated choices
  - For market goods, calibration is usually needed, achieved by including as-is menus in the experiment and/or by stacking RP and SP data. For nonmarket goods, there is no market benchmark to use for validation; primary checks are internal consistency, external plausibility.
- RP and SP are not mutually exclusive alternatives. Both provide information on preferences. Weighted for accuracy, they can be used to extend and validate each other.

Problems with using SP data to value non-use goods

- A change in attributes of a non-use good induces no measurable change in the economic behavior of consumers. Then WTP for this change cannot be recovered using conventional economic analysis that infers consumer welfare from changes in market behavior.
  - Example: U.S. consumers are harmed by (climate, pollution) damage to a coral reef in a marine sanctuary northwest of Hawaii that is permanently closed to tourism.
- SP can elicit hypothetical market or referendum choices for non-use goods, but has a history of erratic estimates of WTP, particularly the ***Contingent Valuation*** (CV) method popular with resource economists. Much of the problem seems to lie with the nature of nonmarket goods – consumers are often unfamiliar with the products, and the effect and effectiveness of proposed attribute corrections, and unused to thinking about these products in dollar terms (e.g., I may care about saving baby seals, but have difficulty in translating this into a dollar price per head)

SP Problems (continued)

- Kahneman, McFadden, et al. (1998): **Anchoring**, the phenomenon that stated responses are pulled toward numerical cues in a question, is quite similar for questions about unknown facts (height of tallest tree) and WTP for nonuse services (saving offshore seabirds from oil spills). Intrepretation: Subjects seem to go through similar cognitive processes in guessing facts and unexplored tastes, and are manipulated by the proximate information they receive; see also Barrows et al. and Parsons and Myers in McFadden and Train (2017) *Contingent Valuation of Environmental Goods*.
- An internal test for consistency of CV in nonmarket good evaluation is ***adding-up*** (Is the WTP for a whole equal to the sum of the incremental WTP's for its pieces?). Desvousges, Matthews, and Train (2017) show that adding up fails when all the data is used from a "best practice" SP study done for NOAA
- Another internal test is for ***extension neglect*** (Is WTP sensitive to the scale of the non-use service provided or the payment?). McFadden (1994) finds extension neglect in wilderness preservation; Meyers, Parsons, and Train (2017) find that subjects treat a one-time payment and an annual recurring payment as similar, neglecting the large difference in present value.

A “Smell” Test

- Bishop et al. (2011) finds in a study for NOAA that restoring one hectare of coral reef in the Hawaiian marine sanctuary has a WTP of $7.3 billion. Edwards and Gomez (2007) find the cost of this restoration is $13.2 million, a benefit-cost ratio of 553.
- Bishop (2016) finds consumer WTP to avoid the Deepwater Horizon oil spill is about $17 billion. Then, BP could have compensated consumers for all Deepwater Horizon injury by restoring less than 3 hectares of coral reef at a cost of less than $40 million. This is ***Implausible.***
- The settlement of *NRDA Trustees v. BP* (2015), the Deepwater Horizon oil spill litigation, requires BP to pay $8.1 billion for restoration, implying a ***more plausible*** benefit-cost ratio of about 2, or less if the $17 billion is an overestimate of lost value of environmental services.

Are Reliable SP-Based Valuations for Unfamiliar/Nonuse Goods Possible?

- Remedies are possible (although not necessarily easy) if behavioral deviations are noise (i.e., inattention, misperceptions, overemphasis on accessible information and on recent or striking events) that overlay stable deep preferences.
- Give subjects extensive background on products and their attributes, practice and feedback on stated choices that allow them to construct their preferences if necessary, training to recognize and avoid cognitive anomalies. Incorporate the design elements that are known to be necessary for forecasting demand for familiar consumer products
- Mix target products with both use and nonuse products, including nonuse products where social decisions have been made that should reflect social preferences, calibrate against RP market and referendum/legislative data, embed checks and reconciliations to control adding-up and extension neglect.
- Use qualified experimenters, adopt procedures such as “final offer” refereeing of designs and “blind” administration of studies to reduce experimenter effects
- Elicit perceptions and stated protocols as well as choices. Use clickstream and response time data to measure attention and diligence. When sufficiently developed, use neurological measures (e.g., brain activity)

Conclusion

- Applied welfare economics for consumer and environmental products and services is not a finished subject. Among the major issues:
  - Distinguish value-in-exchange and value-in-use, and associated overcharge and WTP measures of economic loss
  - Retrospective compensation analysis for past economic losses
  - Introduce the MCE measure for well-being when consumers are not fully compensated before optimizing in the but-for scenario
  - Develop compensation rules when preferences are only partially observed
  - Integrate RP and SP data inputs to sharpen recovery of preferences and compensation calculations, adopt experimental designs to reduce experimenter effects, process and weigh SP observations to reflect their accuracy