CASE STUDY:

Choe, K., Whittington, D., & Lauria, D. T. (1996). The economic benefits of surface water quality improvements in developing countries: a case study of Davao, Philippines. *Land Economics*, 519-537.

EE465/EE463 Project Evaluation

Semester 2/2014

Background

- Objective: to estimate the economic value that residents place on improving water quality in rivers and sea near their community, in particular for recreational use
- Apply two nonmarket valuation techniques
  - Stated-preference: CVM
  - Revealed-preference: travel-cost method
- Davao: second largest urban area in Philippines
  - In 1990, the population was estimated to be 850,000.
  - Most densely populated portion: on coast

Water quality in Davao

- Since mid-1980s, most households have installed flush or pour-flush toilets, voluntarily
  - But: toilets empty into holding tanks, which seep into ground or overflow into street drains and ditches
  - < 1% of households are connected to sewer lines
- Consequence: Davao River and Davao Bay have become highly polluted
  - What had been most popular beach, Times Beach, has gotten little use since 1992 public health warnings

Three Stages of Surface Water Quality

Stage 1: safe, hygienic conditions in their houses

- Removal of wastewater from the household's living space

Stage 2: clean, sanitary neighborhoods

- Neighborhood collection of household wastewater

Stage 3: improved quality of surface waters

- Construct sewer lines and build wastewater treatment plants

Research Design

- Two-stage stratified random sampling (1,200 hhs)
- Interviewed based
- Three groups of samples:
  1. HHs that owned their homes and had a water-sealed toilet for their exclusive use (n = 364)
  2. HHs that were renting their dwellings (n=87)
  3. All other HHs (n = 326)

Water improvement scenarios (1)

- Scenario 1: Water Quality Improvement Plan
  - Improvement from Stage 2 to Stage 3
  - Assume there is a city-wide plan to clean up rivers and sea and make Times Beach safe for swimming and other recreation
  - If adopted, each household will be required to pay a monthly fee
  - Five different monthly fees (25, 50, 100, 150, 200 pesos) were randomly assigned to different hhs
    - Two-step bidding game with open-ended final bid
  - Sample: half of Group 1 hhs + All hhs in groups 2&3

Water improvement scenarios

- Scenario 2: Sewer Plus Treatment Plan
  - Improvement from Stage 1 to Stage 3
  - Assume there is a city-wide plan to construct sewer lines and treatment plants, which will not only clean up rivers and sea and make Times Beach safe for swimming and other recreation, but will also enhance public health
  - If adopted, each household will be required to pay a monthly fee (same starting bids in scenario 1)
  - Sample: other half of Group 1 hhs

Approaches to estimate WTP

1. Open-ended question - point estimate of household's WTP
   - WTP = $WTP^{open\text{-}ended}$
   - Mean WTP = 29 pesos per month
2. "Yes/No" questions based on the answers from the referendum and the first follow-up questions)
   - classify household's WTP into three categories (Interval data)

     Category 1: $WTP < L$

     Category 2: $L \leq WTP < H$

     Category 3: $H \leq WTP$
   - Use 4 different distributions (see table 1)
3. "Yes/no" questions based on the first referendum only (see table 2)
   - Analyze using more sophisticated econometric methods (ie. OLS, probit, hazard models)

Results for the 2nd Approach

TABLE 1
ESTIMATED SCALE, MEDIAN, AND MEAN HOUSEHOLD WILLINGNESS TO PAY FOR "WATER QUALITY IMPROVEMENT PLAN" FROM FOUR DISTRIBUTIONS (WITHOUT COVARIATES; SCENARIO 1)

Distribution	Scale	Median (pesos per month)	95% Confidence Interval (pesos per month)	Mean (pesos per month)	95% Confidence Interval (pesos per month)	Log-likelihood
Exponential	1.00	27.7	25.5–30.0	40.0	37.3–42.7	−436
Weibull	1.28	20.8	17.4–24.2	38.5	38.5–38.5	−427
Log-normal	1.12	21.9	19.1–24.6	40.9	36.5–45.3	−428
Log-logistic	0.63	22.4	19.8–25.0	48.9	—	−431

Results for the 3nd Approach

TABLE 2
PERCENTAGE OF RESPONDENTS WHO GAVE POSITIVE ANSWERS TO REFERENDUM QUESTIONS (DAVAO)

Referendum Prices (pesos per month)	Sewer and Wastewater Treatment (Scenario 2)	Water Quality Improvements and Beach Clean-up (Scenario 1)			
	Households with Water-Sealed Toilets for Their Exclusive Use (%)[a]	Households with Water-Sealed Toilets for Their Exclusive Use (%)	Households Renting Their Dwelling Unit (%)	Other Households (e.g., squatters) (%)	Total (%)
25	63	53	53	41	46
50	32	42	50	21	31
100	16	10	11	16	13
150	25	15	0	4	7
200	14	9	0	0	3

Excerpt from Table 4:

MULTIVARIATE MODELS OF THE DETERMINANTS OF HOUSEHOLDS' WILLINGNESS TO PAY FOR WATER QUALITY IMPROVEMENT AND TIMES BEACH CLEANUP BASED ON RESPONSES TO CONTINGENT VALUATION QUESTIONS (DAVAO)

	Probit	Hazard; Weibull	OLS
Dependent Variable	*VOTE*	*LOW/UP*	*FINALBID*
Independent Variable			
INTERCEPT	−1.017	2.314	−13.554*
	(−2.823)	(44.631)	(−1.770)
INITIAL PRICE	−0.012*	−0.002+	0.021
	(−8.598)	(1.689)	(0.911)
FEMALE	0.065	0.018	0.220
	(0.470)	(0.020)	(0.072)
INCOME	0.067*	0.055*	2.304*
	(3.382)	(7.477)	(4.980)
EDUCATION	0.064*	0.073*	1.757*
	(2.952)	(13.705)	(3.792)
FLOOD	0.218+	0.296*	8.963*
	(1.479)	(4.674)	(2.757)
USE	0.280+	0.253+	6.000+
	(1.658)	(2.676)	(1.683)
NEWS	0.001	0.047	1.451
	(0.017)	(0.345)	(0.706)
SCALE	—	1.211	
log(*L*)	−222.49	−393.12	
X^2	135.78	—	—
N	563	563	563
% of Correct Predictions, Total	82.9	—	—
% of Correct Predictions, Yes Only	30		
(pseudo) *R*-squared value	0.234		0.14

* indicates null hypothesis of $b = 0$ is rejected at 1 percent of one-tailed significance level.
# indicates null hypothesis of $b = 0$ is rejected at 5 percent of one-tailed significance level.
+ indicates null hypothesis of $b = 0$ is rejected at 10 percent of one-tailed significance level.

Excerpt from Table 5:

MULTIVARIATE MODELS TESTING THE SIGNIFICANCE OF THE SCOPE OF CV SCENARIOS USING SUBSAMPLE OF OWNERS WITH WATER-SEALED TOILETS FOR THEIR EXCLUSIVE USE (DAVAO)

	Probit	Hazard; Weibull	OLS
Dependent Variable	*VOTE*	*LOW/UP*	*FINALBID*
Independent Variable			
INTERCEPT	−1.174*	2.279*	−25.062#
	(−2.800)	(45.392)	(−2.104)
INITIAL PRICE	−0.009*	0.002#	0.134*
	(−6.562)	(5.025)	(3.569)
FEMALE	−0.193	−0.039	−5.730
	(−1.194)	(0.096)	(−1.175)
INCOME	0.068*	0.061*	2.564*
	(3.347)	(13.210)	(4.406)
EDUCATION	0.045	0.030	1.414+
	(1.604)	(2.085)	(1.760)
FLOOD	−0.308	−0.050	5.653
	(−1.517)	(0.115)	(0.951)
USE	0.141	0.284+	11.572#
	(0.739)	(3.723)	(1.962)
NEWS	0.066	0.032	−3.526
	(0.564)	(0.146)	(−0.971)
SCENARIO2	0.112	0.232+	14.059*
	(0.703)	(3.602)	(2.952)
SCALE	—	0.946	—
(pseudo) *R*-square	0.19	—	0.19
F-value	—	—	6.172
log (L)	−169.48	−298.83	—
X^2	80.28	—	—
N	348	348	348

* indicates null hypothesis of $\bar{b} = 0$ is rejected at 1 percent of one-tailed significance level.
# indicates null hypothesis of $b = 0$ is rejected at 5 percent of one-tailed significance level.
+ indicates null hypothesis of $b = 0$ is rejected at 10 percent of one-tailed significance level.

Estimation of Hicksian Welfare benefits from scenario 1:

$$\text{Prob(yes)} = a - b^{*}INITIAL\ PRICE + c^{*}INCOME + d^{*}EDUCATION + e^{*}FLOOD + f^{*}USE + \varepsilon. \quad [1]$$

$$E[WTP] = (a + c^{*}INCOME + d^{*}EDUCATION + e^{*}FLOOD + f^{*}USE)/b. \quad [2]$$

TABLE 7

ESTIMATED MEAN WILLINGNESS TO PAY FOR WATER QUALITY IMPROVEMENT FROM CONTINGENT VALUATION AND TRAVEL COST METHODS FOR USERS AND NONUSERS (PESOS PER MONTH)

	WTP from the Users of Times Beach	WTP from the Nonusers of Times Beach	WTP from Both Users and Nonusers of Times Beach
1. Final bids taken as continuous variable			
Mean	37 pesos	26 pesos	29 pesos
Std. Dev.	41	35	37
Median	25	15	20
N	174	389	563
t-stat. (*Ho*: $\mu = 0$)	11.90	14.65	18.59
2. Estimates from Probit models			
(a) All respondents			
Mean	30 pesos	1 peso	10 pesos
Std. Dev.	36	31	35
Median	21	−8	2
N	174	389	563
t-stat. (*Ho*: $\mu = 0$)	10.99	0.64*	6.78
(b) Respondents who voted for Water Quality Improvement Plan (Scenario 1)			
Mean	40 pesos	20 pesos	27 pesos
Std. Dev.	40	39	40
Median	28	7	18
N	43	76	119
t-stat. (*Ho*: $\mu = 0$)	6.56	4.47	7.36
3. Estimates from Hazard model: Weibull distribution			
Mean	51 pesos	35 pesos	40 pesos
Std. Dev.	30	16	23
Median	26	9	21
N	174	389	563
t-stat. (*Ho*: $\mu = 0$)	22.42	43.14	41.26
4. Estimates from travel cost model			
Tobit model ($n = 447$)	51 pesos	(not applicable)	(not applicable)
OLS model ($n = 447$)	36 pesos	(not applicable)	(not applicable)

Testing the accuracy of WTP bids: Davao

1. Cooperativeness of respondents
   - Only 3% of households refused to be interviewed
2. Plausibility of bids, cf. current income and expenditures
   - Median bids = ~$1/month
   - Mean water bill = ~$5/month; mean income = ~$180/month
3. Explanatory power of model of determinants of WTP bids
4. Consistency of model results with economic theory
5. Neutrality of survey design
   - Does starting value of iterative bidding affect final bids?
6. Split-sample “scope” test
   - Do households that own houses with water-sealed toilets bid more in Scenario 2 than in Scenario 1?

Same approaches are used in other contingent valuation studies