Chapter 2

NON-MARKET ASSET PRICES: A COMPARISON OF THREE VALUATION APPROACHES*

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1 INTRODUCTION

With the growing research in the valuation of environmental commodities, recent studies have attempted to compare differing experiments and valuation techniques. Schulze, et al. (1981) compared six valuation experiments. However, the study was limited by relatively distinct locations and environmental attributes. Brookshire, et al. (1982) contrasted results from application of the contingent valuation method and the hedonic method in Los Angeles County. Although the locations were consistent in this study, the definition of the environmental commodity might have varied substantially across locations because of differences in the mix of health and aesthetic effects. Both the Desvousges, et al. (1983) and Seller, et al. (1985) comparative analyses focused on valuation techniques for water quality. These experiments may have been hindered by only partial or incomplete knowledge of the commodity by those revealing their environmental preferences. This paper attempts to take the comparison of valuation techniques one step further by examining an active and well-defined market for an environmental commodity and comparing alternative measurement methods for this commodity.

Three valuation techniques are examined and compared for water quality problems in the Okoboji Lakes region of Iowa. The three techniques are: 1. a site valuation based on comparing property values between two adjacent lakes, 2. a market valuation by asking a sample of realtors and real estate agents in the area to identify causes for the observed price differential between the lakes, and 3. a contingent valuation approach using a

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limited sample of site dwellers to estimate their willingness to pay for improved water quality.

The paper proceeds as follows. Section 2 examines the Okoboji Lakes region experiments in detail. Section 3 introduces the theoretical framework for comparing these valuation techniques. Section 4 discusses the methodology and empirical results. Section 5 contains our tentative conclusions.

2 SITE DESCRIPTION AND BACKGROUND

The site selected for detailed analysis are the two glacial lakes called West Okoboji and East Okoboji in northwest Iowa. The lakes are connected by a shallow canal and are very similar from a visual and locational perspective. Each offers about the same mix of water based recreation activities and there is almost unlimited and costless substitution between them except for site advantages. However, they differ markedly in one group of characteristics, namely, recreation based water quality. East Okoboji is more shallow and has a relatively greater waste input from agricultural and natural runoff. Consequently, during part of the summer recreational months (typically more than 30 days) East Okoboji supports dense blooms of algae resulting in a lime green color and noticeable odor from decaying algae. Alternatively, West Okoboji rarely (less than five days) has a noticeable algae bloom with turbidity and is typically characterized as clean in the summer months.

Historically, real estate development has proceeded with substantial second home development on West Okoboji commencing in the early 1900's and proceeding to current times. The development of East Okoboji has proceeded at a slower pace. The average assessed valuation per residence for West Okoboji in 1983 was $161,716 and average square feet, 2,152 per residence. For East Okoboji, the average assessed valuation was only $61,484 and a typical residence, 1,415 square feet. There is substantial difference in total valuation and value per square foot at the two locations. Given that East Okoboji has been a less desirable location because of water quality, land values have been lower, development occurred at a slower pace, and lower priced housing was erected.

Given the historical development, substitutability between the lakes, and current community awareness, the Okoboji lake region is an active and well-defined market for an environmental commodity. A well-defined market where the respondents are familiar with the commodity is an essential part of any environmental valuation experiment (see Brookshire and Crocker (1981)). However, one conceptual problem with inter-lake comparisons is that individuals with preferences for higher water quality have located at

West Okoboji while those with lesser preferences for water quality or a greater preference for a particular mix of recreation activities have located on the East lake. In consequence, the observed difference in values between the lakes may partially be determined by differences in preference.

3 THEORY AND PROPOSITIONS

This section will introduce a simple theoretical framework necessary for comparing the valuation techniques. A diagrammatical representation will be developed which yields a set of testable propositions. In order to examine preferences, a simple utility maximization model is proposed here.

$$U(c,w) \tag{1}$$

is the individual utility function where c is the composite commodity presumed unrelated to water based recreation and w a measure of water quality. It is assumed $U_c > 0$, $U_w > 0$, U_{cc}, $U_{ww} \leq 0$; and $U_{cw} \geq$ or < 0 where subscripts denote relevant partial derivatives. The utility function (1) is subject to the budget constraint

$$Y - c - R \cdot w \geq 0, \tag{2}$$

where Y denotes disposable personal income, the price of the composite commodity is assumed to be 1, and the individual takes the rent or cost paid for water quality as given, and equal to R.

Taking the first-order Kuhn-Tucker conditions for this simple model, one obtains

$$\frac{\partial L}{\partial c} = U_c - \lambda \leq 0, \quad c \geq 0, \quad c(\partial L/\partial c) = 0 \tag{3}$$

$$\frac{\partial L}{dw} = U_w - \lambda R \leq 0, \quad w \geq 0, \quad w(\partial L/\partial w) = 0 \tag{4}$$

The optimal interior solution for the maximization problem when the rental gradient is not dependent on water quality is represented by

$$\frac{U_w}{U_c} = R, \tag{5}$$

which is a common result observed in studies on environmental quality and housing values. (See for example, Freeman (1979) and Brookshire, et al. (1982)). It states that in equilibrium, the rational purchaser of property will equate the marginal rate of substitution between water quality and consumption with the "rent gradient" associated with locations differentiated by a unique level of water. The rent gradient reflects the individual's marginal implicit price for water quality in the housing market. (See Rosen (1974) for a complete discussion of rent gradients.) In this case the rent gradient will be linear since the individual's purchase of improved water quality (by purchases of a new site) has no impact on the housing market equilibrium with respect to water quality or other housing characteristics.

Figure 1 illustrates this simple model, and is a simplified modification of the graphical representation in Brookshire, et al. (1982). Let line aa represent the rent gradient where the quantity of the composite commodity c is on the abscissa and the level of water quality w is on the ordinate. Point A is the equilibrium point suggested by equation (5). The individual utility curve U_0 is tangent to the budget constraint or the rent gradient, line aa.

However, if R is a rent gradient for property which depends on water quality (net of effects from other characteristics of housing) and the individual can adjust by changing

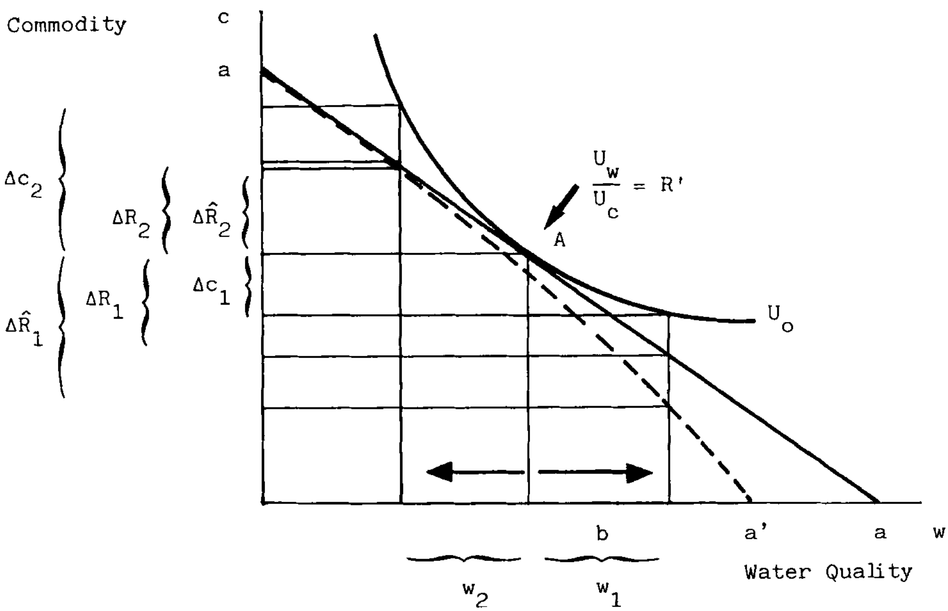

Fig. 1. Rent gradient and compensating surplus.

location, then R w needs to be rewritten as R(w) and (4) changes to

$$\frac{\partial L}{\partial w} = U_w - \lambda R_w \leq 0, \quad w \geq 0, \quad w(\partial L/\partial w) = 0, \tag{6}$$

and equation (5) changes to

$$\frac{U_w}{U_c} = R_w. \tag{7}$$

In equation (7), the purchaser, by his actions in the housing market, influences the "price" of water quality as reflected by the rent gradient. The purchaser could influence the "price" (1) if the individual decides to purchase more water quality by locating or relocating at the cleaner lake, he will shift demand for the water quality upward, thereby raising its price, and (2) given a small or "thin" property market, the buyer may make an offer below the seller's price, thereby pressuring the "price" downward. In a relatively small residential market such as the Lake Okoboji area, single sales may in fact influence housing prices, especially for relatively high priced vacation homes (there are less than 100 high-priced vacation homes on both lakes).

If the purchaser can influence the "price" then the appropriate rent gradient would be concave downward such as line aa' in Figure 1. Given the purchaser may or may not influence the "price" of water quality, and if the market for housing has typical characteristics in terms of supply and demand, the rent gradient (budget constraint) shall be either linear (line aa) or concave downward (line aa').

Consider now the two rent gradients in terms of a change in water quality. Using the theoretical framework and Figure 1, a set of five testable propositions are developed. First, in Figure 1, Δc_1 measures the income loss (in commodity terms) that would leave the individual at the same utility level as before the change in water quality (Δw_1), the ΔR_1 measures the changes in rent along the rent gradient involved by a change in water quality Δw_1. As demonstrated by Schulze, et al. (1981), among others, $\Delta R_1 > \Delta c_1$ if the typical properties of indifference curves hold and the rent gradient is not somehow extremely distorted. This result also holds if the rent gradient is concave downward (aa'). Therefore, we would anticipate that observed prices paid or inferred from assessor's valuations for higher water quality derived from a hedonic price equation would normally exceed estimates of marginal willingness to pay. Alternatively, amounts of compensation (Δc_2) necessary to maintain individual utility with reduced water quality (Δw_2) would substantially exceed estimates derived from the rental gradient (ΔR_2) or property value differentials. The relationship between the linear rent gradient (line aa) and individual valuations can be described by Proposition 1.

Proposition 1. Given the assumptions of the model, (a) a decrease in water quality implies an individual's minimum willingness to accept compensation exceeds or equals the implicit price as reflected by a linear rent gradient. (b) An increase in water quality implies an individual's maximum willingness to pay is exceeded by or equals the implicit price of the linear rent gradient.

a) $\Delta c_2 \geq \Delta R_2$ and b) $\Delta R_1 \geq \Delta c_1$

Second, note further that in Figure 1 for improvements in water quality (Δw_1), if the purchaser does influence the rent gradient through inducing a higher "price" for water quality, or if the "price" of water quality increases as one moves to a cleaner and clearer site ($\Delta \hat{R}_1$), the resulting observed hedonic rent estimates will overstate willingness to pay by even more than if the gradient were linear (ΔR_1). In symbols, $\Delta \hat{R}_1 > \Delta R_1$. The bias for rent gradients (hedonic prices) to overestimate marginal willingness to pay is thereby even greater when individual purchasers may influence the demand for an environmental attribute, or where the "price" of water quality is not constant. This relationship is described by Proposition 2.

Proposition 2. Given the assumptions of the model, water quality improvements imply the implicit price derived from the concave downward rent gradient exceeds the implicit price derived from the linear rent gradient, $\Delta \hat{R}_1 > \Delta R_1$.

Third, in the case of water quality losses (Δw_2), it can also be noted that if the purchaser does influence the rent gradient ($\Delta \hat{R}_2$), the observed hedonic rent estimates will understate compensation by more than a linear rent gradient (ΔR_2).

Proposition 3. Given the assumptions of the model, water quality decrements imply the implicit price derived from the linear rent gradient exceeds the implicit price derived from the concave downward rent gradient, $\Delta R_2 > \Delta \hat{R}_2$.

Fourth, and finally, due to differences in residential characteristics, a distinct rent gradient can be proposed for each lake. The residents of West Okoboji typically have higher incomes, greater environmental preferences, and a steeper budget line (rent gradient). The residents of East Okoboji typically have a lower income, perhaps less of a preference for water quality, and may confront a less steep budget line (or rent gradient). If we assume that line aa in Figure 1 is the rent gradient for West Okoboji, and given the assumptions stated above, then the rent gradient for East Okoboji would have to lie totally inside line aa and at a less steep angle. Given the distinct rent gradients, for small changes in water quality, we would anticipate that the rental gradient would approximate compensation or marginal willingness to pay for each lake. And through competition, at the margin, we would anticipate that the "price" differential between lakes would approximate differences in utility levels of the residents. If this were not the case, individuals could relocate thereby increasing utility in a relatively lumpy housing market. Therefore, we anticipate that the marginal willingness to pay by residents of West Okoboji Lake will exceed that of the residents of East Okoboji. These relationships are described in the following propositions.

Proposition 4. Given the assumptions of the model, for improvements in water quality the marginal willingness to pay by residents of West Okoboji Lake will exceed the marginal willingness to pay by residents at East Okoboji Lake.

Proposition 5. Given the assumptions of the model, the implicit price implied by the rent gradient of West Okoboji will exceed the implicit price implied by the rent gradient of East Okoboji.

These five propositions are partially tested and reported on in Section 4. Before proceeding one can make some general inferences about the magnitudes derived from the methods outlined in the introduction. The site valuation method can be biased upward or downward depending on the degree of difference between preferences, income, and rent gradients confronting the different residents. The contingent valuation method will be relatively unbiased if problems of sampling, strategic behavior, information bias, and hypothetical bias are not substantive. Finally, the market valuation method will be unbiased unless there are noncompetitive, information, or other natural distortions operating on this market.

4 THE OKOBOJI EXPERIMENT

4.1 Methodology

Basic date were collected during the summer and fall of 1984 in the Okoboji Lakes region. Data was collected for (i) housing assessed valuations, (ii) the contingent valuation experiment, and (iii) realtors and real estate agents response survey (referred to as data (i), (ii), and (iii), respectively). The sample size for the experiment was relatively small, 66 for housing assessed valuation (about 10% of the residences in the Lakes region), 20 for the contingent valuation experiment (3% of households), and 17 realtors and real estate agents (15% of total agents).[1] For data (i) and (ii), only residences actually located on one of the lakes were examined. That is, each residence selected had some amount of actual lake frontage.[2] By only including "residents", we omit consideration of individuals forced to relocate because of higher prices, i.e., a "choke" price. The problem of establishing "choke" price does not arise as it does with travel cost models if our sample adequately reflects all dimensions of the resident population. Therefore, we can avoid the problem of truncation and censoring that lead to biased parameter estimates using ordinary least squares (OLS) (see Smith, et al. (1984)).

4.2 Rent Gradient and Willingness to Pay Results

The three data sources revealed three estimates of the rent gradient associated with different locations differentiated by a unique level of water quality, and two compensating surplus measures of consumer surplus for differences in value per square foot of housing attributable to water quality. Consider each implicit price estimate.

First, one measure of the rent gradient is the realtors' best estimate of price differentials between East and West Okoboji residences. Table 1 illustrates the realtors' prorated response sheet to the observed difference in water quality between East and West Okoboji. The realtors attributed 46 percent of the difference in housing between

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[1] Whether these are adequate samples to represent the area is unclear. Using a single power test suggests that sample size for the contingent valuation method should be 22 (with R^2 = .30, number of variables 5, and significance level .05). For estimating precise benefits of water quality improvements rather than examining methodologies and experimental approaches, probably a larger sample would need to be taken for accuracy in application of the contingent valuation method.

[2] Actual frontage ranges from 33 to 150 linear feet.

TABLE 1

Realtors' Prorated Response Data (Percentage of East and West Okoboji Housing Differences Attributable to Characteristic).

Water Quality	46%
Neighborhood and Social Class	24%
Beach Access	6%
Road Access	2%
Nearness to Town	2%
Visual Beauty	9%
Water Activity	8%
Seclusion	2%
Other	1%
Total	100%

17 respondents
11.76 average years experience

East and West Okoboji to water quality. The next largest percentage was neighborhood and social class accounting for 24 percent. The remaining 30 percent were divided between beach and road access, nearness to town, visual beauty, water activity, and seclusion. By and large, water quality dominates the differential in housing between East and West Okoboji.

The realtors' best estimate of rent gradient was estimated as follows. Data (i) was collected on most recent sales of private residences on both East and West Okoboji Lake. The assessed valuation per square foot on West Okoboji Lake (in 1983) was \$75.15 and for East Okoboji Lake, \$43.48.[3] The average difference in housing square foot assessed valuation between the lakes was therefore, \$31.67. One of the central questions in this paper is to what extent water quality contributed to this observed differential. According to the survey of realtors and real estate agents (Data (iii)) in the Okoboji area, water

[3] Note, we have used assessed valuation rather than reported sales prices in the computation. The reason was that there are likely to be substantial errors in reporting of sales prices for the Okoboji area both because of tax avoidance and the method of reporting. The raw correlation coefficient between assessed valuation and reported sales prices was less than 0.25. Thus, a more accurate measure of "actual" selling price was thought to be assessed valuation.

quality differences between the lakes accounted for about 46 percent of this difference.[4] From the realtors' perspective, the dominant factor affecting housing prices (adjusted for square footage) was the known difference in water quality. The realtors' (averaged) estimate of the losses in valuation due to water quality is 46 percent of $31.67, or $14.57 per square foot for lake front property.

Second, a rent gradient was estimated by comparing imputed lake frontage prices. Hedonic types of equations were estimated for West and East Okoboji Lakes separately, see Table 2. The difference in regression coefficients of feet of lake front equalled $1,009 per square foot. Using the average measure of lake front, housing square feet, and

TABLE 2

Regression Estimates for Property Value Study Experiment: Assessed Valuation.

		Independent Variables						
Dependent Variable	Constant	House Square Feet	Total Rooms	Age of House	Feet of Lake Frontage	Number Other Bldgs	F Stat	R^2
Assessed Valuation 1983-West Okoboji	44,845 (2.02)*	14.30 (1.80)	3,178 (0.99)	-853 (-3.83)	1,373 (5.18)	10,327 (0.88)	23.20	.78
Assessed Valuation 1983-East Okoboji	1,734 (.12)	17.60 (2.79)	4,623 (2.09)	-457 (-1.97)	364 (2.00)	1,389 (0.23)	12.46	.75

* Numbers in parentheses are "t" statistics
Number of observations was 39 for West Okoboji and 27 for East Okoboji.
Degrees of freedom was 33 for West Okoboji and 21 for East Okoboji.

4 The raw correlation matrix indicates that realtors in the Okoboji area perceive some significant effects on housing prices other than water quality, especially social class, miles to town, and scenic beauty. They tended to increase the share of value allocated to these substantially when decreasing the share to water quality. Thus, there appears to be some substitution between very broad attributes associated with a site in that some realtors place a greater emphasis on characteristics other than water quality in establishing site value and they are negatively related. Interestingly, the longer the realtor was in real estate, the more value that was placed on water quality.

realtor's average proportions allocated to water quality, this implies a valuation loss of $12.83 per square foot of dwelling.

Third, a rent gradient was estimated through a pooled estimate based on assessed valuation of differences in housing characteristics, see Table 3. For assessed valuation as a measure of price, the pooled regressions had significant coefficients for square feet of housing, age of house, feet of lake frontage, and most importantly, whether the property was located on East or West Okoboji. An $84,189 difference was observed net of basic housing characteristics. This amounts to a $39.12 per square foot difference, which is higher than the $31.67 actual average difference in the sample, but close enough to appear to be reasonable. The pooled regression equation does contain socio-economic variables reflecting neighborhood effects, visual beauty of the site, etc. in the East/West dummy variable. In order to account for these factors, the gross difference in terms of the pooled regression is adjusted yielding a net difference of $29.52. Applying the 46 percent estimate by realtors to the net difference from the pooled regression yielded a square foot valuation of water quality of $13.58, which is very close to realtors' own best estimate ($14.57). It is only slightly higher than the reported value ($12.83) from the differences in lake frontage values. However, all three of the rent gradient estimates are dependent on the realtor's average allocation of value to water quality attributes.

TABLE 3

Pooled Regression Estimates, East and West Okoboji.

		Independent Variables							
Dependent Variable	Constant	East or West West=1 East=0	House Square Feet	Total Rooms	Age of House	Feet of Lake Frontage	Number Other Bldgs	F Stat	R^2
Assessed Valuation (1983)	-20,657 (-1.09)*	84,189 (10.09)	15.93 (2.76)	3,836 (1.83)	-850 (-5.21)	1,037 (5.79)	1,600 (0.22)	66.42	.87

* Numbers in parentheses are "t" statistics.
Number of observations was 66. Degrees of freedom: 59.

The final two measurements of the analysis are based on a limited application of the contingent valuation method (see Durden and Shogren (1988)). A questionnaire utilizing the water quality "ladder" was employed.[5] Both willingness to pay and willingness to be compensated measures of consumer surplus were elicited from a stratified random sample of residents at both lakes. The willingness to pay measure is equivalent to the compensating surplus measure of consumer surplus, since we are asking how much income the individual will give up (increased property tax) to obtain a specified water quality improvement (see Freeman (1979) and Just, et al. (1982)). Alternatively, they were asked how much they would need in *minimum* compensation (i.e., reduced property taxes) to be as well off as before given a symmetrical water quality decrease. This is also a compensating surplus since utility is unchanged in either case. Neither measure is likely to coincide with equivalent surplus, the "best welfare measure of benefits" (see McKenzie and

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[5] The water quality "ladder" was developed by W. Vaughan for Resources For The Future, Inc. (see Vaughan (1981)). The "ladder" is a form of anchoring surveys and is used extensively in water quality benefit analysis. A partial experiment was developed to test whether the water quality "ladder" is a valid approach without serious inherent economic bias. The possible bias arises since accurate value responses from subjective indexes implies that these indices contain distinct and separable activities. This separability allows say, for exact measures of value for an improvement in water quality from "boatable" to "fishable". However, if the indices are not separable, but perceived as complements or substitutes, the response may not accurately measure benefits of water quality improvements. Complementarity or substitutability may bias the willingness to pay response in a downward or upward direction, respectively.

A modified ladder was developed that attempts to incorporate the possibility of complementarity and substitutability into the willingness to pay response. Several attempts were made to experiment with the modified ladder and also to test whether the various water based recreation activities identified on the ladder tend to be complementary, substitutes, or neutral.

Most individuals responded to identifying whether various water based recreation activities were neutral, substitutes, or complements to them personally. Fishing and boating were highly complemental, while potable water and boating were strongly neutral. It appears the pairs of swimming/fishing, drinking/swimming, and swimming/boating were either complements, substitutes, or neutral depending on the individual. These results are suggestive that as one moves up the water quality ladder, there is at first complementarity (between fishing/boating), then substitution (between swimming/fishing), and finally, either complementarity or neutrality (between drinking/swimming or swimming/boating). Bids across activity pairs tended to indicate greater neutrality across activities than the questions on identification of how individuals compare pairs of activities. However, the preliminary results are suggestive that the assumption of neutrality in applications of the water quality ladder needs to be either verified through repeated trials or that modifications must occur prior to its use for adequate benefits estimates to be forthcoming. (For more specific results, see d'Arge (1985)).

Pierce (1982)). However, for commodities (such as the water quality at the two lakes) that enter regularly, if indirectly, in a market we can presume they would be reasonable close (see Willig (1976)).

Average bids by location and pooled across residents were converted to housing value equivalents by using the average residence size on each lake and a 5 percent real rate of discount.[6] The adjusted bids by location are shown in Table 4. The bids were requested in dollars per $1,000 assessed valuation. The bids and compensation referenced the same units as the hedonic regression equations. The mean bids pooled across both East and West Okoboji residents was $6.29 per $1,000 assessed valuation. Average square feet for houses on both lakes equalled 1,851, and the average assessed valuation on both lakes

TABLE 4

Average Imputed Bids or Compensation by Location, Present Value per Square Foot of Housing*.

Location of Residence	WTPA[1]	WTPB[2]	WTPC[3]
West Okoboji Lake	6.26	3.03	4.69
East Okoboji Lake	6.01	4.31	7.02

* Presumes a 5 percent real rate of interest (net of inflation) and the appropriate square feet of housing is 2,152 for West Okoboji and 1,425 for East Okoboji, and the average assessed valuation (1983) for West Okoboji is $161,716, and for East Okoboji, $61,484.

1 Willingness to pay in increased property taxes for improved water quality. (From B to A on ladder.)

2 Amount of compensation in reduced property taxes for a decrease in water quality. (From B to C on ladder.)

3 Amount of compensation in reduced property taxes for a decrease in water quality. (From B to D on ladder.)

NOTE: Because of differences in weights (average assessed valuation, average square feet, sample size) between East and West Okoboji, these estimates are different from those derived over the pooled sample and reported in Table 5.

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6 Executive order #12291 requires the use of a 10 percent discount rate, but offers the option of using other rates if they can be justified. We justify the use of a 5 percent real rate of discount based on the recommended 10 percent discount adjusted for 5 percent inflation.

equalled $120,700. The average bid per square foot in present value terms for both lakes can be found in Table 5 and is calculated as follows:

$$\frac{(\text{Bid}/\$1{,}000) \cdot (\text{Average assessed valuation in } \$1000)}{(r) \cdot (\text{Average number of square feet})} = \frac{(6.29)(120.7)}{(0.05)(1851)} = \$8.20 \qquad (8)$$

The average bid per square foot is $8.20.[7] The willingness to pay measure (compensating surplus) is estimated to be about 56 percent of the realtors' best estimate ($14.57) and approximately 60 percent of the traditional "hedonic" price derived from a pooled OLS regression ($13.58). This is consistent with other researchers' findings and the discussion earlier that the rental gradient should exceed marginal willingness to pay (see Feenburg and Mills (1980)).

The average compensation bid per square foot was determined in the same fashion as equation (8). The average compensation per square foot, in present value terms, for both lakes equalled $4.34. Note that the magnitude of compensation is not consistent with Proposition 1 established earlier. Estimated compensation is less than both the estimated rent gradient and willingness to pay, the exact reverse of Proposition 1. However, it is unlikely that this compensation estimate represents an accurate one. This is due to a 60 percent refusal rate by respondents to be compensated. Whether this was due to questionnaire design or inherent problems in eliciting responses for compensation is unclear.[8] The true estimate is probably at least several times the $4.34 calculated here. We base this statement on the experimental finding of willingness to accept versus willingness to pay disparities (see for example Knetsch and Sinden (1984)). This result also confirms Cummings, et al.'s (1986) argument to use willingness to pay measures, not willingness to accept, when eliciting valuations in contingent markets.

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[7] This figure presumes the life of the house to be indefinitely large but the contribution to value beyond 100 years is marginal at a 5 percent discount rate.

[8] Most of the non-respondents were from the West Lake, while individuals from the East Lake were more prone to provide an estimate. The majority of non-respondents indicated a very large compensation initially or indicated that reduction in water quality was "totally unacceptable", or "ungodlike", or something harmful enough to call in the "National Guard".

Table 5 summarizes the results from the comparative analysis. It can be seen that marginal willingness to pay is less than the rental gradient, as is predicted by Proposition 1, but not substantially so. For the Los Angeles experiment, marginal willingness to pay was only 34 percent of the rent gradient estimate for the sample (see Brookshire, et al. (1982)). Also, the three estimates of the rental gradient are reasonably close together with the realtors' estimate being the highest. This might be anticipated "ex ante", since realtors would have a strategic incentive to overvalue characteristics of the commodity they are selling. Second, ex ante, we should anticipate these estimates to be relatively close, given that the "commodity" is well defined to residents and has been for at least 30 years. In consequence, residents in the Lake Okoboji area have had a very long history of experience with a distinct and identifiable water quality difference which has not varied substantially over many years.

TABLE 5

Comparison of Valuation Benefits.

Estimate Derived From	Difference In Value per square foot of Housing	Percent of Observed Average Housing Value	Percent of Realtor's Estimate
	(1983 $ per sq foot)	(Percent)	(Percent)
Realtors' Best Estimate	14.57	23	-
Imputed Value from Regression on Lake Frontage*	12.83	20	88
Pooled Regression Estimate Coupled with Realtors' Valuation	13.58	21	93
Imputed Willingness to Pay (Average across Lakes)	8.20	13	56
Imputed Willingness to Accept Compensation (Average across Lakes)	4.34	7	30

* Adjusted for realtors' proportion attributed to water quality.

Again, considering Table 4, several tentative observations can be made.[9] First, the average marginal willingness to pay for improved water quality by West Okoboji residents exceeds that for East Okoboji residents. This would be expected since West Okoboji residents have paid more via the rent gradient for higher water quality. The difference between the two is very small, on the order of 4 percent. It can be argued that this result should also be observed. If residents of the cleaner lake were willing to pay much less at the margin for cleaner water than those of the less clean lake, we would expect some degree of relocation between lakes which, according to realtors, has not occurred. This result was not confirmed by an OLS regression applied to the limited contingent valuation experiment, see Table 6. Given the East-West Dummy variable in the first equation, the sign of the EOW coefficient indicated that East Okoboji residents' willingness to pay is higher than West Okoboji residents'. However, given the low t-statistic, EOW is not a statistically significant predictor of willingness to pay. Judgement should be weighted accordingly.

Finally, observed willingness to be compensated is substantially higher for East Okoboji residents than for those on the West Lake which is consistent with the concept of diminishing marginal utility. However, the magnitude of compensation is less than marginal willingness to pay for both lakes which makes no sense from the standpoint of diminishing marginal utility, and is probably indicative that the compensation measures are biased downward as was expected given the lack of replies of the respondents discussed earlier.

4.3 Interpretation of Results

Five propositions were proposed in the earlier part of this paper. Proposition 1 indicated that marginal willingness to pay should be observed to be less than the rental gradient and this was the case, for all measurements of the rental gradient. However, the second part of the proposition proposed that the marginal compensation measure should exceed the rental gradient. This was not observed. However, because of resistance by residents at both lakes to accept compensation, it cannot be concluded that any adequate test of this part of the proposition was indeed accomplished.

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[9] Because of the small number of observations, these average estimates must be viewed only as illustrations of the magnitudes of marginal compensation and willingness to pay but not as definite and precise measures.

TABLE 6

Ordinary Least Squares Regression Estimates For Experimental Survey.

Dependent Variable	Constant	EOW**	SATW	SATE	NACT	INCOME	F STAT	R^2
WTPA	-4.40 (-.45)*	-3.96 (-1.30)	2.71 (1.68)	0.57 (0.33)	0.62 (0.30)	.0005 (0.34)	1.09	.41
WTPB	-5.12 (-.93)	-3.21 (-2.33)	1.01 (1.46)	0.57 (0.65)	1.48 (1.39)	.0003 (0.32)	1.87	.44
WTPC	-9.61 (-1.06)	-5.12 (-2.24)	1.88 (1.64)	0.97 (0.65)	2.68 (1.52)	-.00006 (-.04)	1.96	.45

* Numbers in parentheses are "t" statistics.
** East = 0, West = 1.
Number of observations was 20 and included all observations including zero bids and no response recorded as zero. Degrees of freedom is 14 for all regressions.

Definition of Variables

WTP A	Amount the individual would be willing to pay (in higher property taxes) per year for a designated improvement in water quality.
WTP B	Amount the individual would accept in compensation (in lower property taxes) per year for a designated small reduction in water quality.
WTP C	Amount the individual would accept in compensation (lower property taxes) per year for a designated large reduction in water quality.
EOW	East or West Okoboji Lake; 0 = East, 1 = West.
SAT W	Perceived level of water quality, West Okoboji.
SAT E	Perceived level of water quality, East Okoboji.
NACT	Number of water based activities the individual participate in.
INCOME	Household annual income before taxes.

The second proposition was that if individual sales influenced real estate prices, that the actual rental gradient would be steeper than one based on hedonic estimate. If we take the realtors' best estimate as the most likely to be close to the actual rental gradient and compare it with the hedonic estimate, we observe then in fact the proposition is accepted. That is, the hedonic measure of water quality is less than the realtors' best estimate. Whether this observation will continue if a true marginal estimate from realtors was obtained cannot be ascertained given the evidence obtained. Thus, Proposition 2 is accepted, but with substantial caution. Proposition 3 was the mirror image of Proposition 2 for water quality reductions. Since such reductions have not occurred historically, we are unable to make inferences from the results as to its probable outcome.

Proposition 4, that marginal willingness to pay of West Okoboji residents would exceed that of East Okoboji, was observed, both in higher taxes and imputed willingness to pay on housing per square foot basis (rent gradient). Thus, this proposition appears to be substantially confirmed. The reverse of this proposition with respect to magnitude of willingness to be compensated is not supported by the findings of this experiment, but again, may be due to the unreliability of responses to compensation questions.

The fifth proposition on rent gradients being substantially different between the two lakes was observed utilizing three distinct methods of estimation. The first was by solicitation of estimates from realtors. The second was through imputation of differences in the value of lake frontage between lakes, and the third imputed from the results derived from a pooled regression across both lakes. All of these measures were reasonably close together which would be expected, ex ante, where water quality had become an accepted and valued commodity.

5 CONCLUSIONS

This study developed a comparative analysis of various measures of the benefits from water quality improvements. The experiments are applied in a field context developed for the Lake Okoboji region of Iowa. These glacial lakes offer a relatively unique set of characteristics for experimentation since they are connected and have about the same amenities except water quality. Five measures of water quality value are developed and tested including: realtors' best estimate, comparison of imputed lake frontage prices, a pooled regression estimate based on assessed valuation, willingness to pay, and willingness to be compensated; the last two derived utilizing the contingent valuation method on a very limited sample. As might be expected, the values derived from the different approaches were similar in magnitude, except for the compensation measure. Problems with obtaining valid estimates of compensation were encountered. However, the other values might be expected to be similar since an active "implicit" market for water quality through residence site selection has been operating for over 30 years. Five propositions were also tested to find out whether the empirical observations conformed to theoretical expectation. In most cases, the propositions were confirmed, with substantial qualifications.

In conclusion, there are four final points to address. First, the valuation experiment in Okoboji examined only user values. So called nonuser values were not explicitly examined. Example of nonuser values include option value - the risk premium paid above expected consumer surplus to secure future provision of a desirable environmental state (see Bishop (1982)), existence value - the value individuals place on knowing that some good exists in the environment (Krutilla (1967)), and bequest value - the desire of current generations to ensure future generations have access to environmental goods. To obtain a complete ex ante measure of benefits both user and nonuser values should be considered. Our goal was not to obtain a complete ex ante valuation of water quality, rather it was to compare the direct method of the contingent valuation method with the indirect method of rent gradients. The direct method can construct hypothetical markets, thereby capturing nonuser values. Indirect methods, however, do not capture nonuser values since the method is based on current consumption. Therefore, the comparison is based on only user values.

Second, the results obtained in the Okoboji experiment arise due to a highly active and an unusually well-defined market for water quality. Residents have over 30 years experience in dealing with an environmental commodity with a readily accessible substitute. Given historical development and community awareness, the Okoboji region offers a unique opportunity to examine non-market valuation techniques. Having said that, generalizing these site-specific results to other situations of water quality are tentative at best. What needs to be developed is a generalized model that incorporates this and other water quality studies. Such a model would account for more information on significant relationships between environmental attributes and implicit or explicit prices that could then be transferred to other sites, local or regional.

Third, consider the application of the non-market valuation techniques to other goods. When choosing between non-market valuation techniques, one must recall that all methods make three basic underlying assumptions (d'Arge (1985)). First, all methods assume the underlying axioms of welfare economics are valid or closely approximated. Second, all methods presume that the willingness to pay bid is not unique, but can be generalized over time, space, and environmental characteristics. Third, all methods assume to be scientifically valid with no potentially damaging biases. How well a method satisfies these assumptions should dictate their acceptance by a cost-benefit practitioner and policy makers.

The first assumption is relatively better satisfied by the contingent valuation method for one primary reason. All methods estimate consumer surplus; the indirect methods such as rent gradient estimate a Marshallian measure while the direct methods estimate Hicksian equivalent and compensating measures. Recently, economists have preferred the Hicksian equivalent surplus measure since it is a money equivalent of a utility change induced by provision; the closest quantitative measure of changes in utility. If this is the case, then the direct method of contingent valuation would seem to have the advantage. In defense of rent gradient measures, the Marshallian surplus measure will closely approximate the equivalent and compensation measures if the income effect is small (Willig (1976)). Willig's argument fails, however, if the provision of improved water quality induces large implicit price changes, thereby inducing potentially large differences in welfare measures.

The second assumption is relatively better satisfied by direct methods due to its greater flexibility. The contingent valuation method can structure the hypothetical market such that time and space are the exact dimensions of the problem at hand. The rent gradient, however, is restricted to the time and spatial dimensions of the current sale. Extrapolating beyond those current dimensions is difficult, often leading to oversimplification. The direct method can estimate the nonuser values that capture the individual's willingness to pay for guaranteed future access by themselves or others.

Although all methods have bias problems, the third assumption is arguably better satisfied by indirect methods. The biggest asset of rent gradients is its use of actual market data, while the biggest detraction to contingent valuation is its hypothetical data. Since every environmental good is unique, the valuation technique selected depends on how one ranks the relative importance of these three underlying assumptions.

Finally, although tentative, results obtained and presented in Table 5 suggest that from 13 to 23 percent of the residence value (per square foot) is accounted for by water quality improvements. This would yield a sizable benefit if it could be translated to the information obtained for justifying policy decisions. As stated earlier, rather than being a complete ex ante measure of benefits, the importance of the Okoboji experiment to policy makers is the examination of the robustness of techniques to value a non-market commodity such as water quality.

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