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Estimating a Price for Water Rights in the Umpqua Basin, Oregon

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Abstract

This paper builds on previous research by using the hedonic price method to estimate the value of an acre-foot of irrigation water in Douglas County, Oregon. The analysis uses detailed structural, location, and amenity information for 113 arms-length transactions of farmland in Douglas County, Oregon between 2000 and 2001. Results from a hedonic analysis are consistent with other studies. Estimates for the value of leasing water are provided using different discount rates and a range of timeframes.

Introduction

The Umpqua River Basin in Douglas County, Oregon encompasses over 3 million acres (Figure 1). Timber and agriculture are the primary industries in Douglas County with livestock production on pasture and alfalfa being the dominant form of agriculture.

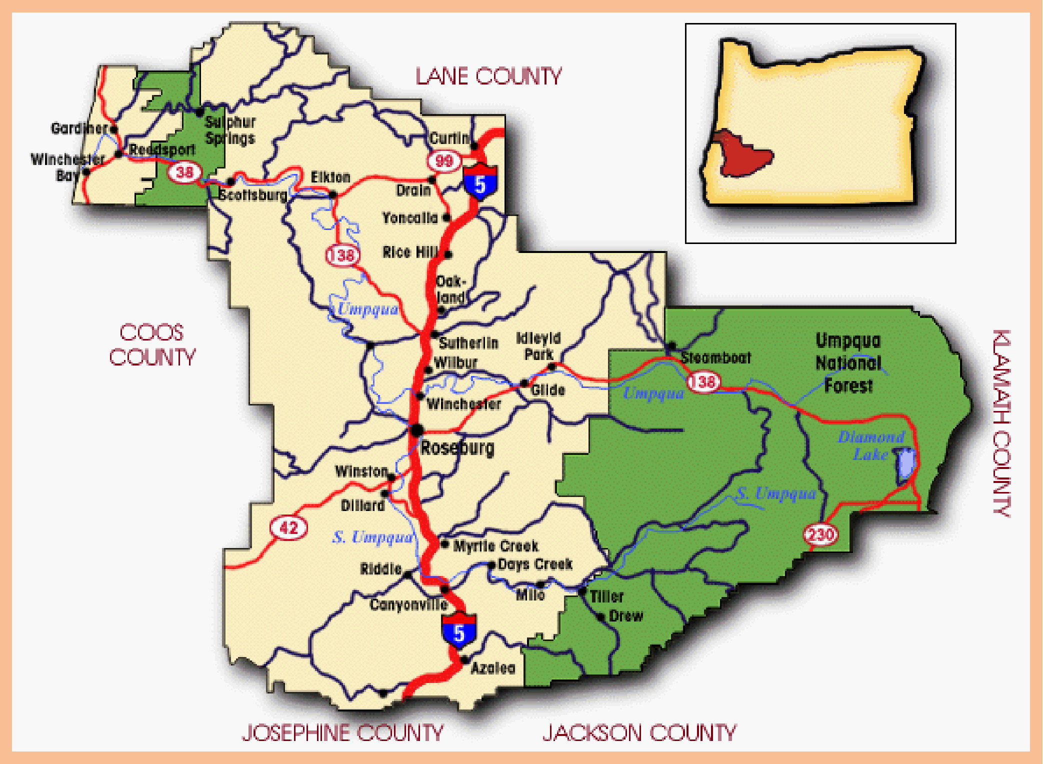

Figure 1: Douglas County, Oregon (Douglas County, Oregon Assessment and Taxation 2002)

Water rights for the North and South Umpqua rivers and their tributaries are heavily subscribed resulting in low instream flows for some streams during the summer months. The right to use water for irrigation is no longer being appropriated for much of the basin including all of the South Umpqua and its tributaries. Many tributaries are included on the Clean Water Act 303 (d) list.

Inadequate stream flows have been cited as a factor in the decline of anadramous and resident fish populations. Spring and fall chinook, coho salmon, chum salmon, summer and winter steelhead, sea-run cutthroat and resident cutthroat and resident rainbow trout are found in the basin (Oregon Water Trust 2004). Coho are listed as threatened and coastal cutthroat are listed as endangered under the Endangered Species Act; Umpqua summer and winter steelhead are candidates for listing (NOAA 2004). Recovery plans emphasize the importance of improving water quantity and enhancing stream flows for aquatic habitat, fisheries and ecological systems.

Higher stream flows can be achieved using water saving technologies and by purchasing or leasing water rights. While the incorporation of water saving technologies may decrease the amount of water taken out of a stream by one user, these technologies do not guarantee that stream flows will improve because landowners with junior water rights may still withdraw water.

The purchase or lease of a senior water right can provide greater certainty about stream flows since instream use is equivalent to other water rights under the doctrine of prior appropriation. In times of low flows, however, certain beneficial uses receive preferential treatment. Human consumption, livestock consumption, and irrigation of non-commercial gardens that do not exceed one-half acre are given preferential consideration in the Umpqua River Basin over other beneficial uses.

Water rights can be purchased or leased in Oregon. A total of 114 leases and 5 purchases occurred between January 1995 and December 1999 (Loomis et al. 2003). The average price paid per acre-foot was $243 (1999 dollars). Groups that purchase and lease water rights in Oregon include the Bonneville Power Administration, Oregon Water Trust, Deschutes Resource Conservancy, and the National Fish and Wildlife Foundation.

This paper uses the hedonic pricing method to estimate the minimum payment a seller would be willing to accept for a water right. The analysis takes into account characteristics of a property such as its size, soil productivity, assessed value of residential and non-residential buildings, assessed timber value, and whether a property has a water right. The second section of this paper describes relevant literature. This is followed by an overview of the hedonic price method, a description of the data used in the analysis, results, and conclusions.

Literature

The value of water has been estimated using several techniques including the hedonic price method, farm crop budget analysis, and linear programming.

Crouter (1987) explores the possibility of separate markets for land and water in Weld Country, Colorado. Crouter hypothesizes that if the value for land and water rights can be estimated separately using the hedonic price method, and if water rights can be repackaged linearly, then a separate water market for land and water exists. Although

Weld County has no legal restrictions preventing the formation of a separate market for land and water, Crouter was unable to establish their existence.

Faux and Perry (1999) use the hedonic price method to estimate the value of a water right for an acre-foot of water in Malheur County, Oregon. The authors' value irrigation water by taking the difference between irrigated land classes and a non-irrigated land class. The value of water per acre-foot is estimated to be $147 for the least fertile land and $729 dollars for the most fertile land.

Farm crop budget analyses use agricultural production budgets to estimate the value of water. The maximum amount a farmer would be willing to pay for water is estimated by taking the difference between total crop revenue and non-water input costs. This technique has been applied to wheat, grain sorghum, corn, cotton, soybeans, and rice (Gibbons 1986).

Turner and Perry (1997) use the linear programming technique to estimate the price of irrigation water in the Deschutes Basin, Oregon. The authors' estimate that water needed to restore habitat in the Deschutes River could be purchased from the Central Oregon Irrigation District for less than $70 an acre-foot.

Hedonic Price Method

The hedonic price method uses the price of a marketed good, such as a property, to value a characteristic of the good that is not formally traded on a market (Freeman 1993). This technique has been used to estimate the value of open space proximity, air and water pollution, and scenic views.

The hedonic function for land is:

$$P = P(Q_{S,} Q_{A,} Q_{NR,} Q_{WR})$$

where Q_S is the vector representing soil quality, Q_A represents total acreage, Q_{NR} is non-residential improvements, and Q_{WR} is the water right. Soil quality and total acreage are assumed to be exogenous while non-residential improvements and water rights are endogenous.

The functional form for the hedonic price model is uncertain (Freeman 1993). A semi-log form is estimated since simpler functional forms are found to produce better results when information is missing (Cropper et al. 1988).

The statistical model is represented by:

$$\ln \text{price} = \beta_1 Q_S + \beta_2 Q_A + \beta_3 Q_{NR} + \beta_4 Q_{WR} + u_i$$

where lnprice is the log of the sale price per acre and u_j is the error term. The constant is dropped to avoid collinearity with the land class variables.

Data Set

Variables that reflect a property's characteristics, and the productivity of the land on which the structure is located, were selected from the Douglas County, Oregon Assessor's "Farm Sales Report" (2000, 2001). Information on the physical location of the property was obtained through the Douglas County, Oregon Assessor's web site (2002). The data set, after cleaning for missing values and checking for arms-length transactions, includes 195 of 210 sales.[1] Of the 195 sales, 113 were in the property classes designated for farmland.

The dependent variable is the log of sale price per acre. Explanatory variables and their hypothesized relationship to the dependent variable are listed in Table 1.

Table 1: Explanatory Variables

Variable Name	Description	Expected Relationship to the Dependent Variable
RESIDENCE	Assessed value of residential buildings divided by total acreage	Positive
IMPROVE	Assessed value of non-residential improvements divided by total acreage	Positive
TIMBER	Assessed value of timber divided by total acreage	Positive
ACRES	Total acreage	Positive
ACRES2	Total acreage squared	Negative
WATER	Dummy variable =1 if land has a water right	Positive
LAND1	Acres of land class k2 divided by total acreage	Positive
LAND2	Acres of land class k3 divided by total acreage	Positive
LAND3	Acres of land class b2 divided by total acreage	Positive
LAND4	Acres of land class b3 divided by total acreage	Positive
LAND5	Acres of land class b5 divided by total acreage	Positive
LAND6	Acres of land class h5 divided by total acreage	Positive
LAND7	Acres of land class h7 divided by total acreage	Positive
LAND8	Acres of land class ff divided by total acreage	Positive
PROP_A	Dummy variable = 1 if property has no water or designated forestland	Uncertain
PROP_B	Dummy variable = 1 if water is on the property	Uncertain
PROP_C	Dummy variable = 1 if the property has some designated forestland	*Excluded*
ACRES*WATER	Interactive variable: total acreage and irrigation	Negative

A hedonic price model typically includes detailed information about the structural attributes of residential and non-residential buildings and the age, type, and quantity of trees. This information, however, is not maintained by the Douglas County, Oregon Assessor's Office, so the assessed value of residential buildings, non-residential buildings, and timber are used in the model.

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[1] All observations that sold for less than $5,000 or $300 per acre were dropped under the assumption that they were not arms-length transactions. Three observations were dropped because they were the only observations in their land class.

The percentage of land in each land class was calculated for each property. Land classes, which capture soil productivity, are preferred to a condensed soil variable such as a soil quality index (Faux and Perry 1999). The model also includes three dummy variables representing thirty-one property classes. These property classes help identify properties with special zoning restrictions or taxes. Many classes had only one or two observations so similar classes were grouped together.

The presence of a water right is included as a dummy variable. A review of water rights records determined that the nineteen irrigated properties in this study are allotted 2.5 acre-feet a year. We assume that the entire allocation is used but recognize that overuse will bias the value per acre-foot upward.

There are two reasons why seniority is not included in the model. First, relative seniority is hard to identify. For example, a water right from 1950 may be the senior right on one tributary, while a water right from 1940 may be a junior right on a different tributary. Second, the sample contains only nineteen irrigated properties. This limits our ability to create dummy variables to represent properties located on specific tributaries.

Finally, an interactive variable was generated to capture the interaction between total acreage and irrigation. Summary statistics are provided Table 2.

Table 2: Summary Statistics

	Observations	Mean Sale Price per Acre ($)	Standard Deviation	Minimum Sale Price Per Acre	Maximum Sale Price Per Acre
Full Data Set	113	6,773	7,784	414	37,238
Irrigated Observations	19	6,918	8,193	414	37,238

Results

Several models were developed to explain the sale price per acre of properties in the study area. The final model was selected based on goodness of fit. Results are reported in Table 3.

The assessed property value variables, assessed timber value per acre, assessed improvement value per acre and assessed residential value per acre were all positive and statistically significant. The coefficients on these variables are interpreted as the percent increase in the mean sale price from a one-dollar increase in assessed price. For example, a $1,000 increase in assessed value of non-residential improvements is estimated to increase a property's sale price per-acre by 10.9% or $730. Non-residential buildings are overvalued since the estimated increase in sale price per-acre is less than the increase in assessed value. Residential buildings are also overvalued.

The coefficient on the timber variable indicates that timber is undervalued. The result is not surprising since taxes on woodlots in this data set are based on an appraised value of the timber on the lot. Assessors consider this tax a "special use" tax and therefore undervalue the timber (Landgren and Elwood 1997).

Total acreage is significantly negative and total acreage squared is significantly positive. These results are counter to initial expectations, but can be explained by assuming that the land on which a residence is located is the most expensive piece of land. Given this assumption, as total acreage increases the average sale price per acre decreases, but at a diminishing rate.

The coefficients on the property class dummies (PROP_A and PROP_B) are positive and significant. Properties in PROP_A and PROP_B are estimated to sell for 80.27% and 32.22% more, respectively, than properties in the excluded category (PROP_C). The result from an F-test allows us to reject the hypothesis that these coefficients are equal (F (2, 96) = 8.25).

The PROP_A property class includes farmland with no water or designated forestland. Properties in this class are subject to fewer restrictions and tax considerations than the other categories. Properties that intersect water are included in the PROP_B category. The presence of water on a property may reduce the amount of land available for farming. Additionally, these farms are subject to regulations that may increase the cost of farming because of their location in the Umpqua Basin Agricultural Water Quality Management Area.

We were not able to determine if the properties in our study are zoned for exclusive farm use or if portions of the property can be developed. Faux and Perry (2001) find that the ability to add a residential building to a plot of land zoned for farming increases the sale price of the land by around $6,000.

The soil class variables are all statistically significant and of similar magnitude. Individual F-tests reveal some differences when one land class is compared directly to another. The null hypothesis that all land classes are equal is rejected.

The dummy variable for irrigation is positive and statistically significant. This coefficient is interpreted as the mean effect of irrigation water on a property's sale price. The presence of a water right is estimated to increase the sale price per-acre of property by almost 30%.

The interactive variable for acres and irrigation is negative and significant indicating that irrigation becomes less valuable on a per-acre basis as acreage increases. There are two explanations for this coefficient. First, the dummy variable representing water rights indicates that the property has a water right, but it does not mean that water is available for the entire property. Because land without a water right is less valuable then land with a water right, additional non-irrigated land decreases the expected sale price per-acre. Another explanation is that water rights holders with smaller allocations use the right more efficiently, that is, the marginal product of a water right decreases as more rights are obtained.

Table 3: Regression Results

Variable Name	Coefficient	P-value
RESIDENCE	0.00008	.000
IMPROVE	0.00010	.000
TIMBER	0.00016	.000
ACRES	-0.006	.000
ACRES2	7.10 e -6	.000
WATER	0.2599	.035
LAND1	8.485	.000
LAND2	8.177	.000
LAND3	8.139	.000
LAND4	7.871	.000
LAND5	8.155	.000
LAND6	7.750	.000
LAND7	7.876	.000
LAND8	7.876	.000
PROP_A	0.58928	.000
PROP_B	0.27929	.000
ACRES*WATER	-0.00182	.012

R-squared = .89; N=113

Estimating a Price for Irrigation Water

The estimated willingness to accept for an acre-foot of water is based on two coefficients: the irrigation dummy variable and the size and irrigation interactive variable.

A property with a water right is estimated to sell for almost 30% ($2,053) more than a property without a water right. Because irrigated properties in our study are allotted 2.5 acre-feet a year, the price per acre-foot of irrigation water is estimated to be $821. The average size of irrigated properties in the data set is 105 acres. The price of an acre of water right for the average size property in the data set is $-1,322. Dividing by 2.5 results in a reduction in the price of an acre-foot of irrigation water of $529. Combining these effects gives a value of $292 for one acre-foot of water.

Many organizations are interested in short-term leases that will help in emergency situations. Thus 1, 3, and 5-year leases are common. Discount rates ranging from 2-10% were used to calculate the willingness-to-accept for a 1-year lease.

Table 4: One-year lease

Discount Rate	Price Per Acre-Foot
2%	$5.84
5%	$14.60
6%	$17.52
7%	$20.44
10%	$29.20

Estimates of the value of lease rates for multiple year contracts are presented in Table 5.

Table 5: Multiple time frames and discount rates (price per acre-foot)

Discount rate	3 years	5 years	10 years	20 years
2%	$16.84	$27.52	$52.46	$95.49
5%	$39.76	$63.20	$112.74	$181.95
6%	$46.83	$73.79	$128.95	$200.95
7%	$53.63	$83.80	$143.57	$216.54
10%	$72.62	$110.70	$179.43	$248.61

Conclusions and Policy Implications

This paper uses the hedonic technique to estimate the value of an acre-foot of irrigation water in Douglas County, Oregon. The estimated willingness to accept for the purchase of an acre-foot of water is $292 which is very close to the reported average price per acre foot of $243 (1999 dollars) for purchases in Oregon (Loomis et al. 2003). The willingness to accept for leasing is estimated using multiple discount rates and time frames. The Office of Management and Budget (OMB 2004) suggests using a real discount rate of 7% which gives a range of lease values per acre-foot of approximately $20 for a one-year lease to approximately $217 for a twenty-year lease.

Few water rights transactions have taken place in the Umpqua Basin, Oregon. The most recent lease, which was negotiated by the Oregon Water Trust, occurred in the summer of 2003. Oregon Water Trust paid eighty-five dollars per-acre foot of water for a 5-year lease for one of the oldest water rights on the South Umpqua (Parrot 2004). This negotiated amount is consistent with the results of this study assuming a 7% discount rate.

Acknowledgements

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