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The West is undergoing a period of change where water rights, range rights, and other attributes historically attached to land, are being reevaluated. To date, not all of these relationships have been hammered out or confirmed to exist. One such example of this is Klamath County, Oregon. Here we see the mitigation of reassigned water rights as it pertains to agricultural, Native American, and environmental users and applications. In order to determine these relationships with land values, if they exist, and the magnitude of them, some dollar figures must be assigned. This project applied the Hedonic Price Model to a set of county land sales in an attempt to effectively separate out these individual characteristics.

Land and Water Values in Klamath County, Oregon: Application of Hedonic Price Modeling

By

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James Heffner, Author

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INTRODUCTION

Problem Statement

The West is currently undergoing a period of change, a period where water rights, range rights, and other attributes attached to the land are being reevaluated. Since the late 1800's, the settlement and development of the West has been guided by the doctrine of reclamation. Unlimited resources and uncontrolled growth have been the ideas that transformed the sprawling West from desert to paradise. However, it is only recently that society is finding the boundaries of these so-called limitless resources. Water rights have been fully allocated in most areas, and the land is largely in private holdings or allocated to private individuals through a permit system, yet demand for these resources continues to grow with the increase in population. In addition to the growing demand accompanying growth and development, the West has seen the reinstatement of Indian rights, as well as recognizing previously ignored rights of wildlife and other non-human values. The redistribution and mitigation of these rights requires new measurements in the valuation of each individual attribute.

A key example of this ongoing process to reallocate resources is Klamath County, Oregon. Here, all of the key uses of water come together in competition, and thus many of the key water issues found in the West are present. Klamath County was settled in the late 1800's, with the first appropriations of water rights claimed for irrigation in 1870. The passage of the Reclamation Act in 1902 motivated the creation of irrigation districts. In 1905 the Klamath Project was approved. This is by far the county's largest project, effectively draining a good portion of Upper Klamath Lake and linking the Lost River and Klamath Basins for irrigation purposes. Also, at this time, the Lower Klamath Wildlife Refuge was created, becoming the first of five such refuges in the basin. Range and cattle development also grew quickly. This overall growth eventually pushed the native Indian tribes onto a reservation, where they stayed until disbanded. (Soil Conservation Service, 1970) So, the stage was set: continuous growth and limited resources. Water rights in the basin have been over allocated, causing two major problems in the area: the reclamation of old water rights belonging to the Klamath Indian tribe, and the recognition of new rights protecting the needs of wildlife in the basin.

Reclamation of Old Water Rights

The Klamath Indian tribe, disbanded over forty years ago, was re-instated and now are reclaiming their land and their rights. According to the Klamath Indian Tribe Restoration Act, passed on August 27, 1986:

> "All rights and privileges of the tribe and members of the tribe under any federal treaty, executive order, agreement, or any other federal authority, which may have been diminished or lost...are restored" (Public Law 99-398)

Thus, all water rights lost over the years essentially must be restored to their former status along with their priority dates.

Recognition of New Water Rights

Another complication in the water rights debate in Klamath County is the recent addition of two species of native fish (Lost River Sucker and the Short Nose Sucker) to the Endangered Species list in 1988 and the identification of the Largescale Sucker as a category two species (under consideration for listing as endangered) in the following year. These listings are the result of a long term decline in fish populations that began with the first development of irrigation in the area. Indeed, after the completion of the Klamath Reclamation Project in 1905, over 100,000 acres of wetlands were destroyed or inundated by the dams and reservoirs (U.S. Fish and Wildlife Service, 1993). Even the recent plight of Upper Klamath Lake fisheries has been known since the late 1960's. However, with the recent droughts of the 1980's and a massive fishkill in 1986, the Sucker's status became critical (National Fisheries Research Center, 1990). In order to meet the demands for the listing, the U.S. Fish and Wildlife Service, acting on behalf of the federal government, outlined specific goals which must be met:

Task 331: Investigate additional water storage in the Upper Klamath Lake basin

Task 333: Determine minimum pool and instream flow requirements for stable sucker populations in Upper Klamath Lake Basin

Task 334: Secure adequate water levels and flows for stable sucker populations in Upper Klamath Lake Basin

(U.S. Fish and Wildlife Service, 1993)

This re-distribution of water rights between the Endangered Species, the Klamath Indians, and current users will be extremely difficult because for much of the county, no formalized water rights have actually been recorded on the state level. This is not to say that the current users do not already have usufructory rights. Current appropriators do indeed hold these claims due to historical use. However, the priority dates and amounts associated for many of these rights have yet to be formally determined. As a result, the Oregon Water Resources Department has been attempting to adjudicate the water rights in Klamath County for the last few years.

With the impending mitigation of water rights, range use, and other property characteristics, some way must be found to give these traditionally non-valued resources tangible values.

Throughout the process of reorganization and formal recognition of these rights, there are going to be winners and losers. Some users will retain their rights as held historically, other may lose them, either partially or entirely. In order to accommodate the needs of priority users, some properties and their associated water rights will have to be bought outright, or forfeited. In either case, monetary transactions may be used, particularly on those lands which produce only small or negligible returns for the use of these rights. One such method to estimate implicitly valued attributes is through the Hedonic price model. This process links the value of individual characteristics, like water rights in each district, to real estate prices exhibited in the market. The Hedonic price model can also pick up any trends occurring through time based upon management decisions under the Endangered

Species Act and through natural phenomena like droughts. The resulting values could be used by lawmakers, mitigators, and policy coordinators to aid in a more equitable redistribution of rights currently underway in Klamath County.

Project Overview

This project applies hedonic price analysis to Klamath County property sales in order to reveal the implicit value of water, both by source and by time, as components of the total property value expressed on the market.

The study area is Klamath County in southern Oregon. The primary source of irrigation water is the Klamath Project, which uses the combined watersheds of the Klamath River and the Link River. The soils in the study area are primarily drained marshland and are typically shallow in depth. The climate is drier and more extreme that the rest of Western Oregon, with little rainfall annually (ranging from 10 to 15 inches in the valleys to 30 to 40 inches against the slopes of the Cascade Mountain Range). Irrigated agricultural land in the county is used primarily for alfalfa, wheat, barley, rye, oats, some potatoes, and pasture. (Soil Conservation Service, 1970)

The main objective of this project is to quantify relationships and extract values for non-market rights attached to land in Klamath County, thereby providing policymakers with information that can be used to determine what compensation, if any, should be given for those losing water rights. The specific objectives of interest follow:

1) Produce estimates for the value of water rights by source.

2) Produce estimates for the value of land-attached water rights over time.

3) Produce estimates for soil class values of land.

The hypotheses to be tested are as follows:

1) Values of irrigated land (and therefore water) vary according to irrigation district.

2) Values of irrigated land vary according to government management and policy decisions occurring over time.

3) Values of irrigated land vary according to soil class.

The following chapters describe the theory underlying the Hedonic price model, the description of the data used in the model, the results returned, and conclusions reached.

HEDONIC ANALYSIS APPLIED TO LAND MARKETS

Validity of Hedonics

The value of land is tied directly to two things: the amount of revenue it can generate and the costs incurred while in production. Essentially, this is a return to the most basic rules of a profit maximizer. Producers, acting under perfect competition, will use their land to the extent that the marginal return from the fields will equal the marginal costs of production. This naturally leads to the increased value in land as the productivity increases. Class VII land has poorer profit potential than Class I land as it requires more effort and other costs to produce smaller quantities of a crop than the high yielding soils of Class I. Thus, when a parcel of land is exchanged in the market, this productivity difference will be reflected in land price. The question now is which approach should be used to estimate these values and the differences between them.

There are essentially two distinct approaches to the problem of deriving values for agricultural resources: the value added or income appraisal approach, and the hedonic method. The income approach uses capitalized values of returns generated by common agricultural commodities to estimate land value. This approach presumes that agricultural income is the sole determinant of land values. Given this, along with the assumption of efficient markets, water values obtained with this method should be equivalent to that of hedonics. However, since the 1970's, values generated by these two methods have diverged, and appraisers have relied more on market data and hedonics for valuation. (Torell, et al. 1990) The reason for this disparity may be that the appraisal approach provides for subjective assessments of the characteristic values based upon comparable cases, while the hedonic price model provides an objective estimate of these same land and water components. (Miranoski, 1984). Thus, while the previously discussed method of income appraisal is acknowledged to be valid and acceptable, the use of the hedonic approach to estimate implicit values of water and other qualities associated with land sales is the preferred approach.

Theory

Each land transaction in a sample consists of one or more parcels of land. Each parcel is, in turn composed of a bundle of goods, including soil quality, water, a set of improvements, etc. denoted z_1, z_2, z_3, ... ,z_n. These values of z can then be considered a qualitative characteristic of a differentiated market good. Individuals have the freedom to choose a bundle of land attributes that best meets their personal and business needs. Thus, the market for land functions as the market for the attributes reflected in the land. The hedonic method allows for the differentiation of closely related products and the estimation of the implicit price relationship with the price of any bundle of goods representing the sum of the individual values for all attributes (Freeman, 1993).

The Hedonic price model then, provides an ideal methodology to estimate values for attributes not separately traded in the marketplace. In perhaps the earliest work on this approach, Rosen (1974) states that the model is essentially a competitive equilibrium model of several dimensions in which buyers and sellers select their bundles and conduct their transactions. The item of interest is then a vector of values: $z=(z_1, z_2, z_3, \ldots, z_n)$ where each z_i represents the amount of the i^{th} characteristic of each good. Thus, for any price $p(z)$, $p(z)=p(z_1, z_2, z_3, \ldots, z_n)$ is defined at each point on a plane and it is in this space where buyers and sellers conduct business.

Each product has a market price and is associated with a fixed value of z, so that the implicit function $p(z)=p(z_1, z_2, z_3, \ldots, z_n)$ is revealed to show consumers preferences for each component z_i. (Rosen, 1974)

Crouter (1987) pushes the definition further. The hedonic model applies to heterogeneous goods which are composed of different quantities of attributes. These attributes then, cannot effectively be separated and sold individually, but only as a packaged bundle. Therefore, farm land parcels are Rosen goods. Each parcel(s) within each sale is composed of many variables, including land and water characteristics. Given the legal and institutional constraints placed upon water rights, these characteristics cannot be traded separately from the land. (Crouter, 1987). Similarly, the other components of the sale cannot effectively be separated and sold independently. Chicoine's work with urban fringe farmland shows the remaining characteristics to be a function of access, amenity and physical properties, the availability of public services, and other institutional factors. (Chicoine, 1981). All of these factors are effectively inseparable from the bundle as a whole.

Palmquist (1989)

Necessary Conditions for Hedonic Analysis

Rosen (1974) noted that, in order for the hedonic method to work, several conditions must be met. Three conditions relate directly to the basic assumptions of microeconomic theory. The first is that the market must be at equilibrium. Thus, the change in sale price due to the change in the quantity of the component is equivalent to the value of marginal productivity associated with said component. Second, there must be perfect information to both buyers and sellers. The market participants can rationally delineate between different characteristics and make their valuation. Third, there should be zero transaction costs involved. As this is unrealistic when applied outside of the theoretical world, these transactions costs should at least be low enough so that the estimation of the implicit values of the characteristics is not impaired. (King, et al., 1988. Freeman, 1993)

In addition to these standard assumptions, two final conditions must be met. First, there must be a good representation for different combinations of goods. If this is the case, then it should be possible to separate out the implicit prices associated with the environmental attributes. Also, Palmquist (1989) reiterates the importance of selecting a single land market for the analysis. Thus, the rest of the outside influences on the market (political, meteorological, topographical) are equalized and disappear from the analysis: essentially the "all other things being equal" clause. It does not make sense, for example, to compare a farmland sale in the high desert in Oregon with another from the another part of the state with different climatic or social-political characteristics. There are simply too many other factors involved.

Second Stage Hedonics and the Demand Curve

Hedonic methods are used in order to infer the implicit values of non-marketed environmental attributes. This, however, is only the first stage of the hedonic model. The second stage, which is much more difficult, is to extrapolate this information and apply it to the derivation of the demand curve. This involves finding all individual utility curves, information which is not observed in the marketplace, and converting them into the market demand curve for a specific attribute. Several criticisms have developed over this stage of hedonics. The second stage process assumes *a priori* restrictions on the functional form of the price model or first stage. (Brown and Rosen 1982; Epple 1987). It also assumes equal access to the market, and identical demand for goods by potential buyers (Bartik, 1987). One suggestion for completing the second stage is to examine separate markets. Then, individual characteristics can be controlled for, so that identical buyers face different price functions. However, this approach requires enough variation across the markets to elicit the demand curve (Palmquist 1984; Brown and Rosen, 1982). This particular study is not focused on the demand function of the sample area, only in marginal prices, so second stage estimation was not undertaken.

Functional Form

Variable Transformations

While theory may help guide the choice of variable to be included in the model, it does provide much guidance in the search for an appropriate functional form. Functional form as applied to econometrics refers to the mathematical expression used to represent the particular relationships in the model. For example, the Rosen bundle of goods may be a strictly additive relationship, or perhaps a more complicated one with interactions between variables such as a multiplicative relationship. The functional form is a representation of the state of nature. While many prior models begin with the assumption of strictly linear, additive models, more recent empirical work has shown that perhaps the better form is a non-linear function with multiplicative terms. However, even with a beginning functional form, it is wise to check and evaluate other possibilities which may be specific to the region being modeled. Finally, another factor to be taken into consideration when choosing a functional form is the size of the data set being used. A smaller data set will limit the size and complexity of possible functional forms to be examined. A larger data set allows for more degrees of freedom and hence more elaborate models should they become necessary.

Without a theory to suggest the proper functional form, it is best to test for alternative possibilities in order to find the optimum fit. The relationships implied by the chosen functional form will directly affect the estimates given by the model. An inappropriate functional form may likely produce less accurate estimates and fail in approximating the process being examined. Thus, it is recommended that the data be used to specify the functional form imposed (Freeman, 1993; Palmquist, 1991). One widely accepted methodology is to apply a Box-Cox variable transformation on either the dependent or independent variables, or both (Box and Cox, 1964). This transformation essentially focuses on the powers of exponentiation on the variable(s) chosen. There are several different versions of the Box-Cox specification tests.

The Box-Cox transformation of a variable is as follows:

$$X^{(\lambda)} = (X^{\lambda}-1)/\lambda \qquad \forall\ \lambda\neq 0 \qquad \text{Eq(1)}$$

$$X^{(\lambda)} = \ln X \qquad \lambda=0 \qquad \text{Eq(2)}$$

The simplest form of the Box-Cox transformation is the transformation of only the dependent variable:

$$(y^{\lambda}-1)/\lambda = f(x_i) \qquad \text{Eq(3)}$$

Where $f(x_i)$ = Hedonic function

By allowing the model to pick the λ using the method of maximum likelihood, the resulting model will produce the Maximum Likelihood Estimator (MLE). This can then be tested against the desired hypothesis ($\lambda=-1$, $\lambda=0$, $\lambda=1$) using the respective log-Likelihood (lnL) functions of the MLE compared to the lnL of the restricted models. The resulting test statistic generated is:

$$-2(\ln L_{RESTRICTED}-\ln L_{UNRESTRICTED}) \sim \chi^2_1 \qquad \text{Eq(4)}$$

where the Null Hypothesis is rejected iff

$$-2(\ln L_{RESTRICTED}-\ln L_{UNRESTRICTED}) > \chi^2_1 \qquad \text{Eq(5)}$$

An alternative approach to letting the model choose the value of lambda would be to run a grid search from $\lambda=-2$ to $\lambda = 2$ by .1 increments. By choosing the λ which gives the best fit via the maximum likelihood value, the MLE will be identified and the above test run in an attempt to reject any alternative hypotheses.

Among the other possible transformations are the transformation of the dependent and all independent variables. The simpler version transforms the independent variables by the same λ.

$$(y^{\lambda 0}-1)/\lambda_0 = \beta_1((x_1^{\lambda 1}-1)/\lambda_1)+ \beta_2((x_2^{\lambda 1}-1)/\lambda_1)+\ldots \beta_i((x_i^{\lambda 1}-1)/\lambda_1)$$

Eq(6)

-or alternatively-

$$(y^{\lambda 0}-1)/\lambda_0 = \beta_1((x_1^{\lambda 1}-1)/\lambda_1)+ \beta_2((x_2^{\lambda 2}-1)/\lambda_2)+\ldots \beta_i((x_i^{\lambda i}-1)/\lambda_i)$$

Eq(7)

Where $\lambda_1 = \lambda_2 = \quad \lambda_i$

Then by following the same testing procedures as in the simpler transformation, the hypotheses can be checked and tested. Table 1 below indicates the respective functional forms associated with varying values of λ_0 and λ_1.

TABLE 1: Box/Cox Lambda Values

λ_0	λ_1	FUNCTIONAL FORM
0	0	Log-Log
0	1	Log-Linear
1	1	Linear

A still more general form allows for the unique transformation of each independent variable. (Box and Tidwell, 1962)

$$(y^{\lambda 0}-1)/\lambda_0 = \beta_1((x_1^{\lambda 1}-1)/\lambda_1)+ \beta_2((x_2^{\lambda 2}-1)/\lambda_2)+\ldots \beta_i((x_i^{\lambda i}-1)/\lambda_i) \quad \text{Eq(8)}$$

Where $\lambda_1 \neq \lambda_2 \neq \ldots \neq \lambda_i$

Thus there are many possible transformations available for investigating the most appropriate functional form. However, with the exception of the first example, the dependent variable transformation, the other form initially assume a linear, additive relationship of the independent variables. If this assumption is relaxed, the ability to transform the independent variables quickly becomes difficult if not impossible.

Non-linearity vs. Linearity

Yet another consideration in modeling hedonic relationships is the possibility of a non-linear form. Early work in the field favored the linear model, as the properties were known and useful. With a linear model, the error term is assumed to be normal. This is very convenient for testing. However, applying a strictly linear, additive formula to land sales may be unrealistic. This assumes separability of land and other markets, like water. However, past experience has shown that water and land markets are not usually separable (Crouter). Thus, there is an interaction between the two markets, leading to a more complex relationship like a multiplicative or exponential one. This most likely cannot be solved for a linear equivalent form, thus leaving a non-linear relationship which must be estimated using non-linear estimation techniques.

The use of non-linear relationships does not necessarily eliminate the ideal properties of the normal distribution. The properties of small samples are unknown, but asymptotically, these estimators will approximate the normal distribution, and can be treated as such. As long as the sample size is sufficiently large, the estimates and the approximated variances associated with them can be used for t-tests and F-tests as with any linear function. The main issue here is the interpretation of the coefficients, which after transformation to the non-linear form may become cumbersome and confusing, thus limiting the usefulness of the model to decision makers. So a trade off exists between the interpretive ability and the accuracy of the model. The current trend has been toward non-linear models. (Xu, et al, 1993; Xu, et al 1994)

Truncation vs. Normal Distribution

Another transformation of the model to be considered is to allow for possible truncation bias. Under the previous assumptions of normality, variable coefficients are allowed to assume both positive and negative values. For a rural land market, however, negative land prices do not exist, meaning that negative land prices must have a zero probability. Thus, it is more appropriate to use a model that has a truncated distribution which does not allow for negative values. This truncated distribution is assumed to have all positive values and then is rescaled so that the probability function again equals one. However, using a truncated normal distribution is typically unstable when using non-linear regression. Therefore, an alternative is to use a truncated logistic distribution in estimating land values (Xu, et al, 1993; Xu, et al 1994). The logistic distribution is favored as it is better suited for analysis while retaining similar statistical properties. The major difference between the normal and the logistic distributions is that the logistic has slightly thicker tails (Amemiya, 1985).

The original specification of the model is of the form:

$$Y=f(X,b) \text{ as used above} \qquad \text{Eq(9)}$$

This must be converted so that $E(Y|Y\geq 0)$. The logistic density function for μ when $E(\mu)=0$ and $Var(\mu)=\sigma^2$ is defined as:

$$h(\mu)= \exp^{(-\mu/\tau)} / \tau[1+\exp^{(-\mu/\tau)}]^2 \qquad \text{Eq(10)}$$

Given that $Y=f(x)+\mu$ (suppressing the parameter vector β), the density function for Y is:

$$g(Y)= \exp^{(-Y-f(x))/\tau)} / \tau[1+\exp^{(-(Y-f(x))/\tau)}]^2 \qquad \text{Eq(11)}$$

By definition, the truncated density for Y when $Y\geq 0$ is given as:

$$g(Y|Y\geq 0)= g(Y) / P(Y\geq 0) \qquad \text{Eq(12)}$$

And given that the cumulative distribution function for Y:

$$G(Y)= 1 \;/\; 1+\exp^{(-(Y-f(x))/\tau)} \qquad \text{Eq(13)}$$

it follows that:

$$P(Y\geq 0) \;=\; 1-G(0) \;=\; \exp^{(f(X)/\tau)} \;/\; 1+\exp^{(f(X)/\tau)} \qquad \text{Eq(14)}$$

$$= 1 \;/\; 1+\exp^{(-f(X)/\tau)} \qquad \text{Eq(15)}$$

Derivation of $E(Y|Y\geq 0)$ proceeds from here:

$$E(Y|Y\geq 0)= \int_0^\infty Yg(Y|Y\geq 0)\,dy \qquad \text{Eq(16)}$$

$$= \int_0^\infty Y\{\exp^{(-Y-f(x)/\tau)} \;/\; \tau[1+\exp^{(-(Y-f(x))/\tau)}]^2\}dY \qquad \text{Eq(17)}$$

After some work, this expression can be simplified to the finalized truncated logistic function:

$$E(Y|Y\geq 0)= \tau(1+\exp^{(-f(x,b)/\tau)})*\ln(1+\exp(f(X,b)/\tau)) \qquad \text{Eq(18)}$$

After this transformation, the test for truncation must be applied. The nesting of the original specification within the truncated functional form allows for a one-sided t-test to be performed on τ (Xu, et al, 1994).

Heteroskedasticity

When examining panel, or longitudinal data sets, another likely violation of the classical linear regression model is heteroskedasticity. Panel data incorporate vary large cross sections in the observations, but the number of periods for which the data exists are typically small. Thus, heterogeneity across observations is quite likely, and heteroskedasticity becomes a greater issue for analysis (Greene, 1993).

Several tests exist to detect heteroskedasticity. The Goldfield-Quant (G-Q) test divides the data into two sub-groups and then checks to see if the error terms are significantly different from each other, and thus heteroskedastic. The test statistic is a ratio between the estimated variances of each sub-group and approximates an F-statistic.

The Breusch-Pagan (BP) test is less structured than the G-Q test, but still requires the sources of heteroskedasticity be defined. In this case, the residuals are taken from the original regression and saved. A regression is then run on the residuals using the independent variables and the R^2 from this auxiliary regression is saved. The test statistic then is:

$$BP = RSS_{AUXILLARY}/2\sigma^4 \quad \text{Eq(19)}$$

The null hypothesis (homoskedasticity) is rejected if $BP > \chi^2_S$, where S equals the number of regressors in the auxiliary regression. It is important to remember that the BP test is an asymptotic test. Thus, with small sample sizes it may not be entirely accurate and may lead to rejecting the null hypothesis less often than it should. The BP test also requires prior specification of the auxiliary regressors, although usually the independent variables from the original regression are used. Finally, the last note of interest about the BP test is that it is very sensitive to the assumption of normality in the errors. The final test used was White's asymptotic test. This test is a more general version without much structure or restrictions imposed. It is similar to the BP test as it runs an auxiliary regression on the residuals, but this test also includes all cross products between the independent variables. The White test statistic appears as:

$$W = nR^2_{AUXILLARY} \quad \text{Eq(20)}$$

The null hypothesis (homoskedasticity) is rejected if $W > \chi^2_P$, where P equals the number of regressors in the auxiliary regression. White's test is not as strong as the Breusch-Pagan test as it does not have as much structure.

Constancy Over Time

Another concern with panel data is the lack of depth in the data. The relatively small number of periods make any sort of time trend analysis difficult. Random shocks or other unique events in any one period will have a profound effect on the overall trend picked up by the regression (Greene, 1997).

To test for any possible differences occurring through time, two types of tests can be used, one for examining temporal shocks across the system and another for examining differences between groups. The first type is the testing procedure outlined by Brown, et al (1974). This includes both the Cumulative Sums of the residuals, or CUSUM, test which examines the residuals by each time period for any shocks which cannot be explained beyond a determined confidence interval. It also includes the "moving regression" test. This test effectively runs regressions across each time period in question and checks to see if the estimates produced within the time period are vastly different from the estimates produced across the entire data set. Both of these tests should pick up any shocks occurring in any time period and indicate if a control variable should be added (Brown, et al. 1974).

The other type of test is to check for differences across groups. Essentially, this consists of including a dummy binary variable for the group of interest. When the regression is rerun, a t-test on the dummy is performed. If the hypothesis (dummy variable=0) is rejected, then there is a significant difference between that group and the rest of the data. If the hypothesis cannot be rejected then there is no significant difference between the group in question and the remainder of the data (Greene, 1997).

MODEL SPECIFICATION AND DATA CHARACTERISTICS

The first step in formulating a hedonic model is to identify the dependent variable and all relevant independent variables to be included in the analysis. Each observation in the study represents the sale of a parcel or parcels of farmland and all accompanying physical assets.

Variable Identification: Dependent Variable (Sale Price)

The total sale price for each parcel at market represents the total value of all components which make up the parcel, whether explicitly or implicitly valued. This includes productivity of soils, water rights, and improvements to the property (buildings, fences, roads, etc). For this data set, assets that were not fixed, meaning physically moveable objects like farm equipment, were not included in the sale price.

The total price received by the seller is the dependent variable in this study. Both total sale price and sale price per acre were considered as possible dependent variables. Total price was chosen partly because of the complexity of the initial functional form used, and partly because of discrepancies in the county assessor data. The sale price per acre model was investigated in order to be completely thorough in the investigation, but the models produced singular matrices in SAS and would not yield usable results. In this sample the observations ranged from $3000 to $1,150,000. The mean sale price was $158,754. The median was $122,500. The interquartile range was from $55,500 to $200,000.

Variable Identification: Hedonic Variable (Land Class)

Soil productivity, based here on soil classifications by the USDA, Natural Resources Conservation Service (NRCS), is an important attribute of land sales. The NRCS has classified, identified, and mapped the soils in most counties of the United States. The system used by the NRCS identifies 7 soil types, known simply as Classes I through VII. Class I represents level, well drained soils capable of producing maximum yields under an ideal climate and no limits on inputs. At the other extreme are Class VII soils, which have steep slopes and/or are extremely rocky, making them of little value for pasture or timber production. These classifications are modified somewhat in Klamath County based upon the presence of irrigation water. Also, the assessors office places all lands not in production under Class 7, in addition to those described by the NRCS. Class I through IV usually represent irrigated land, either by natural or mechanical conveyance. Soils of

Class I - IV that are not irrigated are valued as Class V or lower soils. The remaining classes are not so ambiguous. Class V through VII represent land without water, in decreasing productivity. For a more complete description of the NRCS Classification of soils, see Table 2.

All corresponding soil data have been cross-listed by the Assessor's Office with current property lines. Because real estate and natural boundaries seldom occur simultaneously, each property is comprised of pieces of one or more soil classes, rather than being of one uniform soil strata.

The form of the variable here is continuous based on the appropriate land class (Crouter, 1987; Xu, et al., 1993). Other studies have chosen to use an artificial, average land class, but this eliminates some of the explanatory power of the variable (Faux and Perry, forthcoming). For interpretation, the coefficient represents the per acre value of any given land class, holding all other variables constant.

TABLE 2: SCS Soil Classification

CLASS	DESCRIPTION
I	Soils have few limitations that restrict their use.
II	Soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.
III	Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
IV	Soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
V	Soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.
VI	Soils have severe limitations that make them unsuitable for cultivation and that limit their use largely to pasture, range, woodland, or wildlife habitat.
VII	Soils have very severe limitations that make them unsuitable for cultivation and that restrict their use to pasture, range, woodland, or wildlife habitat.*

*Again, all lands not in production are included in this category by the Klamath County Assessors office.

(Soil Conservation Service. 1982)

The totals and percentage of all soil classifications in the sample set are as follows:

TABLE 3: Land Class Acreage by Irrigation District

Land Classification

IRRIGATION DISTRICT	I	II	III	IV	V	VI	VII	PERCENT OF TOTAL
Klamath	950	759	397	136	13	73	141	22%
Malin	790	224	262	66	0	67	461	17%
Langell	838	188	38	6	0	17	52	10%
Pine Grove	95	181	1441	746	77	149	408	27%
Horse	65	154	691	218	294	7	291	16%
Van Brimmer Ditch	0	79	124	61	6	0	27	3%
Other Water	122	184	167	137	0	29	0	5%
Total Acreage by Class	2859	1769	2940	1285	390	353	1379	10975
Percent of Total	26%	16%	27%	12%	3%	3%	13%	100%

Variable Identification: Scalar Variables

The scalar variables are those which affect the values of all land classes uniformly. For example, distance of sale and water source will be assumed to affect Class I land in the same manner as it would Class IV land. These variables then are to be multiplied by the sum of all hedonic variable to produce the sale price. Other studies using this model formulation are Xu, et al, and Torell, et al.

This form effectively simplifies interpretation as the resulting coefficients can be interpreted as percentage shifts in the hedonic variable.

Irrigation Water

Quantity and availability of water is an important component of total sale price. Irrigation greatly improves the productivity of most lands, when water is a limiting input to production. This is particularly true in an area such as Klamath County, where annual rainfall is 10 to 15 inches annually, and most water comes from large storage projects. There are several irrigation sources that provide water in the area, six of which are represented in the data here. In addition to these, there are seven sales where water is obtained through other water sources, whether it be through another district not well represented in the data, or from individual water rights.

Again, holding all other factors constant, land which has senior water rights providing access to large quantities of water has a higher probability of producing more crops, although there is a point at which the law of diminishing returns comes into effect. Also, land which has access to a reliable source of water is not as vulnerable to droughts and thus can generate a more constant revenue stream. In the Klamath Basin, reliability of water source is directly tied to the seniority of the water rights in each irrigation district. Districts or water companies with earlier priority dates, and thus seniority, should have higher valued land than those with junior rights. It should be noted here, however, that the nature of the Klamath Project may nullify any such relationships between water sources. Most of the irrigation districts came into being at or around the time of the project thus the differences between entire districts or water companies may not be observed. Disparities between junior and senior rights holders will have a much more direct impact on individual users. Table 4 lists the water sources involved in the study and some of their attributes.

TABLE 4: KLAMATH IRRIGATION SOURCES DESCRIPTIVE STATISTICS

IRRIGATION SOURCE	DATE OF INCEPTION	NUMBER OF FARMS	IRRIGATED ACREAGE	EARLIEST WATER RIGHT CLAIM
Klamath	1954	3000	39874.52	Pre-1900
Malin	1922	N/A	3422.61	Unconfirmed
Langell Valley	1918	78	16300	1905
Horsefly	1911	122	10102.3	1905
Pine Grove	1972	12	3227	Unconfirmed
Van Brimmer Ditch Co.	1903	46	4589.3	Pre-1900

The location of properties within water districts was taken from Bureau of Reclamation maps showing the major districts lying within the boundaries of the Klamath Reclamation Project, where the majority of the data were located. The breakdown of sales by water district is shown in Table 5.

TABLE 5: Sales by Irrigation Source

IRRIGATION SOURCE	NUMBER OF SALES
Klamath	39
Malin	20
Langell Valley	16
Pine Grove	12
Horsefly	16
Van Brimmer Ditch Co.	6
Other Water Source	5

Given the nature of the adjudication dilemma in the Klamath Basin, obtaining quantitative amounts for each sale and each water right is not feasible. Thus, the model uses binary variables to represent each water district, with the "other" category omitted from the model for estimation purposes. If all water variables equal zero, then the remaining land class values represent those which receive their water from other water sources.

Time of Sale

Time of sale in each water source is used to reflect changes in market supply and demand conditions over time. It may reflect the cyclical nature of the market, or other changes due to other factors which appear at random over

time. Time of sale also includes changes occurring in the land market due to changes in government policy and the reallocation of rights in the basin.
From a modeling perspective, this was accomplished by a monthly index from 1 to 84 representing all sales from January, 1990 (Time=1) to December 1997 (Time=84). Table 6 shows the breakdown of sales by year.

TABLE 6: Total Farm Sales in Data Set, by Year of Sale

YEAR	NUMBER OF SALES
1990	16
1991	17
1992	17
1993	15
1994	20
1995	22
1996	17

Time of Sale Within Each Water Source

Another possibility to the assumption of a uniform time trend across all water sources is the interaction between the irrigation source and the time of sale. Each district has its own priority dates and other differing institutional factors. Thus, some districts or water companies may be more directly impacted than others by the listing of the suckers. A source with later priority dates and less productive land may have a rash of sales occurring after the government policies and management operations, such as the listing of endangered species, have changed. A water source with more senior rights, on the other hand will not likely have such a jump in sales. This was examined in the model by a monthly index from 1 to 84 representing all sales from January, 1990 (Time=1) to December 1997 (Time=84) for each individual water source, creating seven new variables.

For purely descriptive purposes, the Table 7 breaks down the sales in each district by year:

TABLE 7: Sales by Year

IRRIGATION SOURCE	1990	1991	1992	1993	1994	1995	1996
Klamath	4	8	8	7	5	3	4
Malin	5	2	2	3	2	5	1
Langell Valley	1	3	2	1	0	6	3
Pine Grove	2	2	3	2	5	4	4
Horsefly	3	2	0	1	5	2	3
Van Brimmer Ditch Co.	1	0	1	1	1	1	1
Other Water	0	0	1	1	1	1	1

Distance of Property to Transportation Hub

The distance farm land is from the nearest transportation center represents another component of the parcels sale price. The closer a site is to the transportation hub, the less cost is incurred in shipping the product to market. In addition, the closer distance reduces the cost of buying supplies, soliciting services, and in general acquiring the conveniences of living. Thus, all other factors being equal, the closer parcel will have greater value.

Distance to the nearest transportation hub (Klamath Falls, OR) was measured by the shortest overland route via highway maps. This was favored over "straight-line" measurements due to the nature of the area. The true distance to travel to Klamath Falls is of course, dictated by the geography, and thus the practical distance to the hub is often double or triple the "straight-line" distance. Distance ranged from 5 to 50.25 miles from Klamath Falls. The mean distance was 25.46 miles and the median was 26 miles. The distance variable was treated as a continuous variable.

Total Agricultural Acreage over 10 Acres

Total agricultural acreage is another scalar variable. It has been theorized that larger bundles of goods sell less on a per unit basis than small ones. This occurs because the ratio between total price and fixed transaction costs incurred in the sale. For a small parcel, the proportion of the sale which is devoted to the transaction costs is large, and thus the per unit sale price is high. In a large sale however, once the transaction costs have been tallied, selling more units of land in the same transaction adds little to transaction costs. Thus, the fixed costs as spread over a larger acreage and the per acre sale is relatively lower than that of a smaller bundle. Also, smaller parcels are more accessible price-wise by those working in non-farm occupations who wish a rural lifestyle. In the data, these values ranged from 10 up to 1023.93 acres. The mean acreage was 98.79 acres. The median was 64.35.

Under 10 Acres

A continuous variable was included for all sales under 10 acres as these sales may be more susceptible to urban pressures, as well as the possibility that these parcels were purchased for their lifestyle value, rather than as an important source of income for the owner. These small parcels of land are typically different than larger parcels of strictly agricultural land. The definition of strictly agricultural land as used here indicates all land which is used for agriculture as an important source of income. In contrast, owners of small parcels of land typically have major non-farm income. In this model, these lands were assumed to be parcels which were less than 10 acres in size. These properties were usually found near towns, or were small ranchettes where agriculture is at best a break even proposition. In those lands located near towns, additional value accrues because of speculation for development. These lands are in the path of the cities growth and are then likely to be developed at a substantial gain. In the latter case, a similar scenario ensues. The parcels essentially become estates, and the added value occurs from the option of living in the rural countryside while working in town. In either case, transitional land should sell at a greater price than strictly agricultural land. Seventeen of all sales accounted for were for parcels less than 10 acres in size.

Residential Permits

Oregon's land use laws regulate and control the availability of residential permits on Exclusive Farm Use (EFU) zoned land. These rules are set up to preserve the "gentleman farmer", or private operation, and discourage the further subdivision of farm land for development for other uses. Effectively, this makes it difficult, if not impossible to create new residences on those properties zoned for Exclusive Farm Use. Thus, the value of a permit by itself should have value.

Residential lots, being essentially improvements, also increase the value of a property. Not only do the physical value of the buildings add to the sale price, but also the presence of a residential permit usually is tied to the owner/operator scenario. In this case, the primary benefactor of the farm has the option to also reside there and thus retain many conveniences left out to those who must commute to the farm. There were 38 sales which contained residential permits.

Improvements

The improvements on a property include any fixed capital investments. Thus, fences and barns add value to the land by decreasing or eliminating the start up costs of the buyer. The parcel can be bought ready to be put to productive use. However, typically the improvements do not exactly match the needs of the buyer, and are likely to be valued less than their replacement cost.

The county

market value was not explicitly given in the sales data. The assessed value of improvements is based on their replacement cost. The value of added improvements ranged from $0 to $290,760. The mean was $39,919. The median was $14,510.

The capital investments, or improvements variable was modeled as strictly additive and not influenced by the scalars. This formulation was selected because none of the scalars, including water source and time, were anticipated to impact the value of improvements. The variable is continuous and is the dollar value of the improvements made. The estimated coefficient then represents the percentage discount observed in the market. For example, a coefficient of .91 means that the market discounts the improvements to $0.91 for every $1.00 of assessed value.

Data Omitted

When preparing the raw data for use in regression analysis, some observations were dropped because of structural differences in the market, or through lack of information. These were not eliminated as outliers. Dropping outliers from a model is not generally a good idea, since these observations typically contain important pieces of information pertinent to the model (Kennedy, 1996). However, if the observations violate major assumptions about the market, then it is justifiable to eliminate them from the study.

Trusts/Incorporation Sales

Two sales were dropped because they were trust sales, meaning they were lands put into a trust and sold for $100. This does not represent an "arms length" market transaction. Under the same argument, two more observations were dropped because they were sales by an individual to themselves in the guise of a corporation or vice versa.

Family Sales

The nature of the relationship between the buyer and the seller has been acknowledged to affect the price of the land passing hands. It is assumed that close interpersonal relationships lead to lower prices. However, the extent of the influence is not entirely known. One study by Perry has found that the only significant buyer/seller scenario which greatly discounts the market price is the parent/prodigy transaction. Given the smallness of the initial sample size, and the questionable accuracy of the information provided, three sales between parents and their child were dropped, rather than creating another variable to control for this relationship.

Government Sales

One observation was dropped because it represented a sale by the federal government to a private party. Since government sales typically do not observe the same assumptions as a market between two private individuals, this sale was excluded from the analysis.

Data Summary and Distribution of Characteristics

The final data set contained 124 observations. Table 8 illustrates the characteristics of each variable in the sample set.

Summary of Variables

Table 9 describes all variables included in the original model specification. Equations 21 through 23 provide the functional form initially used in the estimation process.

TABLE 8: Data Summary

VARIABLE	MEAN	MEDIAN	INTER-QUARTILE RANGE	STD. DEV.	MIN	MAX
SALE PRICE ($)	158755	125000	55000-200000	168543	3000	1150000
LC1 (ACRES)	23.05	0	0 - 26.69	45.97	0	275.02
LC2 (ACRES)	14.26	0	0 - 11.09	30.75	0	155.74
LC3 (ACRES)	23.71	0	0 - 25.15	51.53	0	387.70
LC4 (ACRES)	10.36	0	0 - 7.96	27.59	0	203.96
LC5 (ACRES)	3.14	0	0 - 0.00	23.33	0	544.70
LC6 (ACRES)	2.84	0	0 - 0.00	11.85	0	107.64
LC7 (ACRES)	11.12	0	0 - 0.39	35.85	0	269.92
DISTANCE (MILES)	25.46	26	17.3 - 29.25	10.28	5	50.25
ACREAGE (ACRES)	98.79	64.35	24 - 112	142.07	0	1024
UNDER 10 (ACRES)	.42	0	0 - 0	1.39	0	7.64
IMPROVE ($)	39918	14510	0 - 61765	3.15 E9	0	290760

Original Functional Form

Hedonic = (A1*LC1+A2*LC2+A3*LC3+A4*LC4+A5+LC5
+A6*LC6+A7*LC7) Eq(21)

Scalar = (W1*KLAM+W2*MALIN+W3*LANG+W4*PG
+W5*HORSE+W6*VBD+D*DATE+D1*DATEK
+D2*DATEM+D3*DATEL+D4*DATEP+D5*DATEH
+D6*DATEV+D7*DATEO+O1*DIST+O2*ACREAGE
+O3*UNDER15+H*HOMESITE) Eq(22)

SALEPRIC= $(\text{Hedonic}*\exp^{\text{Scalar}})$+C1*IMPROVE Eq(23)

TABLE 9: Variables in Original Model: Dependent and Hedonic

VARIABLE	VARIABLE NAME	VARIABLE TYPE	VARIABLE UNITS	COEFFICIENT UNITS
Dependent	SALEPRIC	Continuous	Dollars	None
Hedonic	LC1	Continuous	Acres	Dollars/Acre
Hedonic	LC2	Continuous	Acres	Dollars/Acre
Hedonic	LC3	Continuous	Acres	Dollars/Acre
Hedonic	LC4	Continuous	Acres	Dollars/Acre
Hedonic	LC5	Continuous	Acres	Dollars/Acre
Hedonic	LC6	Continuous	Acres	Dollars/Acre
Hedonic	LC7	Continuous	Acres	Dollars/Acre

TABLE 9: Continued

VARIABLE	VARIABLE NAME	VARIABLE TYPE	VARIABLE UNITS	COEFFICIENT UNITS
Scalar	KLAM	Binary	None	Percent
Scalar	MALIN	Binary	None	Percent
Scalar	LANG	Binary	None	Percent
Scalar	PG	Binary	None	Percent
Scalar	HORSE	Binary	None	Percent
Scalar	VBD	Binary	None	Percent
Scalar	DATE	Continuous	Months	Percent/Month
Scalar	DATEK	Continuous	Months	Percent/Month
Scalar	DATEM	Continuous	Months	Percent/Month
Scalar	DATEL	Continuous	Months	Percent/Month
Scalar	DATEP	Continuous	Months	Percent/Month
Scalar	DATEH	Continuous	Months	Percent/Month
Scalar	DATEV	Continuous	Months	Percent/Month
Scalar	DATEO	Continuous	Months	Percent/Month
Scalar	DIST	Continuous	Miles	Percent/Mile
Scalar	ACREAGE	Continuous	Acres	Percent/Acre
Scalar	UNDER15	Continuous	Acres	Percent/Acre
Scalar	HOMESITE	Binary	None	Percent
Capital Investments	IMPROVE	Continuous	Dollars	Percent/Dollar

MODEL ESTIMATES AND ANALYSIS

The tests performed were checked in all possible permutations in order to avoid any pre-test bias created by their order of examination.

Truncation

The tests on truncation were not completed. The model, when transformed into the truncated logistic distribution, would not solve in SAS/ETS. The model was checked at each and every level of the specification tests, and in all cases the non-linear model would not converge.

Heteroskedasticity

After performing the three tests outlined earlier, the model appears to be heteroskedastic. The relevant test statistics are listed in Table 10, along with the critical value associated with each.

Since the model proved to be heteroskedastic, weighted non-linear least squares (WNLS) was run on the model to produce results with a homoskedastic error term. The source of the heteroskedasticity was found by selecting the variable which had the most significant estimate on the residuals. Of course, as the model testing progressed, and the order of the tests changed, more than one variable were involved. However, the one variable which was a constant and significant source of heteroskedasticity throughout all tests was the capital investments variable.

TABLE 10: Test Results for Heteroskedasticity

Test	Test Statistic	Critical Value	Result
G-Q	5.88	1.15	Reject H_o: @.05%
B-P	72.36	35.17	Reject H_o: @.05%
White	55.35	35.17	Reject H_o: @.05%

Correlation Among Land Class Variables

During the testing, it became quite apparent that there existed correlation between the land class variables, indicating a high degree of interaction which could not be accurately modeled here. This is not entirely unexpected given the nature of real estate data. Since parcels are comprised of different types of land, it is conceivable that some sales will contain similar mixes of land classes, particularly those on the margin. For example, sales with class III land are likely to also contain class IV land. In addition to this, the presence of an unstable land market will also make it difficult, if not impossible, to accurately differentiate between land class values. As a result, using the model with separate variables for each land class resulted in negative values for some lands during the testing sequence, and exaggerated values for others. Some of the correlation was eliminated by combining the land class variables for III and IV lands, but this forced the other variables to assume more of the burden of explanation. The model and results appear below.

Expanded Land Class Model

Hedonic = (A1*LC1+A2*LC2+A34*LC34+A5*LC5+A6*LC6+ A7*LC7+H*HOMESITE) Eq(24)

Scalar = (DK*DK92+DM*DM92+DL*DL92+DH*DH92 +DP*DP92+DV*DV92+T1*ACREAGE +T2*UNDER10+O2*DIST) Eq(25)

SALEPRIC= $(Hedonic*exp^{Scalar})+(C1*IMPROVE)$ Eq(26)

The land class variables are represented by LC1, LC2, LC34, LC5, LC6, and LC7. DK92, DM92, etc. represent monthly indexes from 1992 onward for Klamath Irrigation District, Malin Irrigation District, etc.

TABLE 11: Expanded Land Class Results

VARIABLE	VARIABLE NAME	COEFFICIENT	T-RATIO	P-VALUE
Hedonic	LC1	1198.26	4.07	.0001
Hedonic	LC2	1299.94	3.72	.0003
Hedonic	LC34	692.58	3.25	.0015
Hedonic	LC5	358.11	.91	.3667
Hedonic	LC6	580.81	.94	.3504
Hedonic	LC7	899.46	2.17	.0322
Hedonic	HOMESITE	19869.58	1.65	.1011
Scalar	DIST	.0035	.44	.6619
Scalar	ACREAGE ABOVE10	.0004	2.02	.0454
Scalar	UNDER10	.3014	3.09	.0026
Scalar	KLAMATH 1992-96	.0006	.17	.8677
Scalar	MALIN 1992-96	-.0036	-.90	.3680
Scalar	LANGELL VALLEY 1992-96	.0011	.29	.7731
Scalar	HORSEFLY 1992-96	-.0013	-.35	.7301

TABLE 11: CONTINUED

Scalar	PINE GROVE 1992-96	.0069	1.91	.0584
Scalar	VAN BRIMMER 1992-96	.0168	2.77	.0066
Scalar	OTHER SOURCE 1992.96	-.0107	-1.31	.1921
Capital Investments	IMPROVE	.6565	4.36	.0001

The R^2 value was .78.

In light of this a weighted average land class variable was used to represent land quality. Actually, a soil index based upon the inverse of the weighted average was used. Thus a parcel with an average land class of II would have a corresponding soil index of (8-2)=6. Similarly, class VI would convert to an index value of (8-6)=2. The use of a weighted average weakens the explanatory power of the model as it eliminates the ability of the model to select the individual land class values and assumes a linear relationship between land classes. Every land class value produced will be some multiplier of the poorest soil index value. This multiplier then dictates a constant and equally proportionate increase between land classes.

Functional Form

An attempt was made to estimate a Box-Cox form of the initial model, but the Box-Cox transformation on the dependent variable proved to be unstable. When running both the free-roaming lambda method and the grid search, the algorithm selected a squared dependent variable. However, when this assumption was imposed on the model, the resulting estimates and associated R^2 statistics provided for a poorer fit than the original. In light of this instability, the Box-Cox transformation was eliminated from the analysis and two other frequent choices for functional form were examined: a square root dependent variable and a log-linear form. After examining the resulting R^2 statistics, both of these proved to be less favorable choices for functional form, and the linear form was kept.

TABLE 12: Functional Form

FUNCTIONAL FORM	R^2
Linear	.76
Square root dependent	.14
Log-linear	Not Solvable
Linear, Weighted Least Squares	.76

Water Source

In the first, full model specification, water sources (irrigation districts and ditch companies) were assumed to have different impacts on the price of land within each district. Each district has a different priority date and thus different seniority to water use. Those districts with older priority dates were expected to be of higher value than those with later dates as the supply of water would be more stable.

Tests were conducted to see if the irrigation districts in the study had different contributions to land value than other districts and other water sources. T-tests were performed on each individual water source to search for values significantly different than zero. F-tests were performed across the districts to determine if: all irrigation districts and the ditch company were equal and non-zero; and all water sources (including those outside of the districts and ditch company) were equal and non-zero. The following table summarizes the tests performed and the results. As shown, there appeared to be no significant difference between water sources. Therefore, these variables were dropped out of the analysis.

TABLE 13: Tests on Water Source

HYPOTHESIS H_o:	TEST STATISTIC	CRITICAL VALUE	RESULT
W1=0	.68	1.96	Do not Reject H_o: @.05%
W2=0	.65	1.96	Do not Reject H_o: @.05%
W3=0	.68	1.96	Do not Reject H_o: @.05%
W4=0	.65	1.96	Do not Reject H_o: @.05%
W5=0	.57	1.96	Do not Reject H_o: @.05%
W6=0	.48	1.96	Do not Reject H_o: @.05%
W1=W2=W3=W4=W5=W6	1.04	2.21	Do not Reject H_o: @.05%
W1=W2=W3=W4=W5=W6=0	1.30	2.10	Do not Reject H_o: @.05%

Time & Time of Sale Within Each Water Source

Using the processes outlined in the previous section, moving regression testing on the date variable were conducted in conjunction with tests between groups on the interaction variable between date and water source. The moving regressions were run on the full set of data with one year of data eliminated. The estimates were then checked to see how much they varied from each other. The results are shown in Tables 14 and 15.

TABLE 14: Moving Regressions Results (Biannual Division)

Term Omitted	Coefficient	Deviation From Full Data Coefficient
1990 - Jan to Jun	-.0076	-.0112
1990 - Jul to Dec	-.0038	-.0074
1991 - Jan to Jun	-.0035	-.0071
1991 - Jul to Dec	-.0033	-.0069
1992 - Jan to Jun	-.0012	-.0048
1992 - Jul to Dec	-.0013	-.0049
1993 - Jan to Jun	Singular	N/A
1993 - Jul to Dec	-.0002	-.0038
1994 - Jan to Jun	Singular	N/A
1994 - Jul to Dec	-.0022	-.0058
1995 - Jan to Jun	-.0023	-.0059
1995 - Jul to Dec	-.0008	-.0044
1995 - Jan to Jun	.0007	.0027
1996 - Jul to Dec	-.0018	-.0054

TABLE 15: Moving Regressions Results (Annual Division)

Year Omitted	Coefficient	Deviation From Full Data Coefficient
1990	-.0076	.0112
1991	-.0038	-.0074
1992	-.0035	-.0071
1993	Singular	N/A
1994	Singular	N/A
1995	.0012	.0024
1996	-.0038	.0074

These results show that the date variable produced smooth and continuous estimates for the time span in question without any relevant shocks or other reactions in sale price due to any particular year or biennium.

In addition to this, F-tests were run to see if the date and water source interaction variables were all equal, and whether they all equaled the original date variable across the entire data set. To time periods and possible effects in question, the irrigation districts were contacted and questioned as to when, if any, observed changes in property values were occurring. These conversations led to testing the date by district variables from the years 1992 and 1994 onward. This allows for the lag time needed to set up and enforce the regulations needed to meet the Endangered Species Act (1992) and also examines any effects occurring from the drought of 1993 and 1994 (1994). After running the tests, the variables from 1992 onward were included in the final model as some of the districts began showing significant results. However, it will be noted that some of these estimates are the result of a very limited number of observations, and thus interpretation of said results should merit caution.

Final Functional Form

Hedonic = (AV*AVGLC*TAC+H*HOMESITE) Eq(27)

Scalar = (DK*DK92+DM*DM92+DL*DL92+DH*DH92 +DP*DP92+DV*DV92+T1*ACREAGE +T2*UNDER10+O2*DIST) Eq(28)

SALEPRIC= $(Hedonic*exp^{Scalar})+(C1*IMPROVE)$ Eq(29)

The average land class variable is represented by AVGLC and total agricultural acreage by TAC. DK92, DM92, etc. represent monthly indexes from 1992 onward for Klamath Irrigation District, Malin Irrigation District, etc. as previously described.

It is acknowledged that this model too is plagued by correlation problems, particularly between the variable (AVGLC*TAC) and ACREAGE. However, when attempting to solve this problem by examining the per acre model, it resulted in a model with a poor R^2 of .04 and also did not return any significant variables, including soil quality. The model and results follow.

Per Acre Functional Form

Hedonic = (AV*AVGLC+H*HOMESITE/TAC) Eq(30)

Scalar = (DK*DK92+DM*DM92+DL*DL92+DH*DH92 +DP*DP92+DV*DV92 +T1*ACREAGE +T2*UNDER10+O2*DIST) Eq(31)

SALEPRIC/TAC = $(Hedonic*exp^{Scalar})$+(C1*IMPROVE/TAC) Eq(32)

TABLE 16: Per Acre Model Results

VARIABLE	VARIABLE NAME	COEFFICIENT	T-RATIO	P-VALUE
Hedonic	AVGLC	6616.81	.74	.4594
Hedonic	HOMESITE /TAC	3876.54	.21	.8316
Scalar	DIST	.0217	.56	.5740
Scalar	ACREAGE ABOVE10	-.0112	-.38	.7014
Scalar	UNDER10	-.0659	-.20	.8445
Scalar	KLAMATH 1992-96	-.0142	-.55	.5804
Scalar	MALIN 1992-96	-.0175	-.52	.6052
Scalar	LANGELL VALLEY 1992-96	-.0128	-.49	.6277
Scalar	HORSEFLY 1992-96	-.0143	-.44	.6604
Scalar	PINE GROVE 1992-96	-.0097	-.29	.7730
Scalar	VAN BRIMMER 1992-96	-.0113	-.18	.8554
Scalar	OTHER SOURCE 1992.96	-.0135	-.24	.8077
Capital Investments	IMPROVE /TAC	.1653	.14	.8905

TABLE 17: Final Specification of the Model

VARIABLE	VARIABLE NAME	COEFFICIENT	T-RATIO	P-VALUE
Hedonic	AVGLC *TAC	129.79	4.09	.0001
Hedonic	HOMESITE	19327.63	1.67	.0971
Scalar	DIST	.0080	1.00	.3184
Scalar	ACREAGE ABOVE10	.0009	4.81	.0001
Scalar	UNDER10	.2779	2.43	.0167
Scalar	KLAMATH 1992-96	.0029	.87	.3841
Scalar	MALIN 1992-96	.0026	.73	.4692
Scalar	LANGELL VALLEY 1992-96	.0027	.80	.4247
Scalar	HORSEFLY 1992-96	-.0053	2.13	.0350
Scalar	PINE GROVE 1992-96	.0077	2.93	.0042
Scalar	VAN BRIMMER 1992-96	.1763	3.25	.0015
Scalar	OTHER SOURCE 1992.96	-.0081	.94	.3481
Capital Investments	IMPROVE	.7231	4.70	.0001

The R^2 value was .76.

RESULTS

Estimated Value of Farm Land

The market value of land was estimated in this study through the application of hedonic analysis on the variables previously described. Specific sales and parcels, as well as representative prices for each land class can be estimated relatively easily from the model results. The coefficient on the average land class variable represent the value of Class VII land without the presence of residential permits or improvements. Corresponding parcels of Class VI, V, IV, III, II, and I, are thus represented by scalar multiples of the average land class coefficient.

Soil Quality

Soil quality had a large effect on the value of farmland, as discussed earlier. Table 18 shows the implicit price estimated for all land classes in Klamath County.

TABLE 18: ESTIMATED LAND VALUES: HEDONIC ANALYSIS

CLASS I	CLASS II	CLASS III	CLASS IV	CLASS V	CLASS VI	CLASS VII
$910	$780	$650	$520	$390	$260	$130

One point should be noted here. The estimates provided by the average land class variable eliminated some of the explanatory power of the model as it imposed an equal and gradual increase in value from class VII to class I land. However, in previous versions of the model, the expansion of the variables by land class provided two very unorthodox results: an increase in value of class III land above that of class I land, and the negative value for class IV land. They are highly related. It is of course, preposterous that land have a negative value. There was some correlation between class 3 and 4 land, but the combination of the two into one variable forces the model to place a higher weight on the most prevalent variable remaining after the first three land classes, namely that of class 7. Thus, after trying many different forms, the less descriptive, but more stable average land class variable was chosen.

Water Source

The source of water to a particular property did not appear to be a major factor in the value of land. The statistical tests in the previous chapter did not show any significant differences in land values across the six irrigation districts here and other water sources (all other factors being equal). This appears counter-intuitive to the uniqueness of water sources and priority dates of water rights. An explanation relates to the nature of the area modeled. Most of the water in the area comes from the same water storage project (Klamath Project, 1905), as well as supplemental reservoirs created later. Thus, most of the irrigation districts have similar water right claim priority dates from essentially one water source. Also, since the storage project supplies most of the water to all users, there would not likely be any differences in water quality among the irrigation districts.

Time Trends

Extensive analysis of the time and time-water source interaction variables initially failed to illuminated any significant effects on the value of land. There would appear to be no county-wide changes in the land value of a sale in 1990 compared to one in 1996. However, when investigating trends among individual districts based on *a priori* information gathered from the districts themselves, some significant disparities were noticed. Horsefly Irrigation District showed a monthly decrease in value, while Pine Grove Irrigation District and Van Brimmer Ditch Co. both showed slight positive increases per month after 1992. However, given the small number of observations in each district, interpretation of these results may merit caution.

One explanation for the lack of time trends as a whole and by many districts is simply that the impacts of the Endangered Species Act and the resulting management decisions have not shown up yet in the market. Discussions with the individual districts operators reveal three possible causes.

The first is that there has not been a high turn over of farm land in the area. People are not so willing to sell their land simply because the times may get hard. There may be some other amenity value attached to owning land that goes beyond the mere physical assets. Whatever the reason, this may not give enough sales to observe any trends in water management. Also, any effects on the value of land may not show up until a later date.

The second possible explanation is that there may be uneducated buyers in the marketplace. Buyers from out of the area may not be wise to the present situation in Klamath County and thus, lacking perfect information, buy land at inflated values. In this case, the actual influence of water management decisions will again not be reflected in the market until the land passes hands once again.

A third explanation for the lack of a general response of land prices to the mitigation of the Endangered Species Act is the small number of years in which water shortages have actually occurred. There have only been two, 1992 and 1994 water years. Also, many land owners have been able to compensate for these shortages "drought relief" wells which have been drilled to replace the lost surface water with ground water.

Values of Components

Residential Lots

The analysis applied to Klamath County showed that the presence of a residential permit was a significant factor in land valuation. The estimated value of a residential permit in Klamath County was $19,327, thus perhaps reflecting the difficulty in obtaining new permits according to Oregon's land use laws pertaining to parcels in Exclusive Farm Use zone.

Improvement Value

The coefficient on improvements was estimated to be .72. This means that physical improvements to property in Klamath County clear the market at 72% of the assessed dollar value. This result is consistent with the hypothesis that the imperfect match between the buyer's needs and the improvements present at time of sale.

Distance to Transportation Hub

The hedonic analysis failed to show that distance to Klamath Falls significantly affected land price. This seems contradictory to earlier expectations. However, most land sales in the sample appears to be found 19 to 26 miles from Klamath Falls near smaller local communities like Horsefly, Malin, and Bonanza. The lack of urban growth pressures, combined with more convenient local supply centers, may explain this phenomenon.

Agricultural Acreage: 10 Acres and Greater

The total acreage for sales of 10 acres and greater produced a significant, though negligible effect on sale price. Yet, the estimate, though significantly different from zero, still fails to really impact the value of land. Effectively, it increases the value of land by .09%/acre above 10 acres in size.

Under 10 Acres

Sales under 10 acres in size have a significant effect on land values. The sale price of a parcel of land in this category increased by approximately 28% per acre. This would appear to confirm the hypothesis that smaller land parcels sell at a greater price than those of 10 acres or larger. Size ceases to be a factor influencing land price at this point, as indicated above, though it is statistically significant.

Value of Water

Finally, we come to the primary objective of this study, namely the valuation of water. Given the nature of the area and its soils, non-irrigated land of class I, II, III, IV, and some V essentially assume the productivity levels of classes VI and VII. With this in mind, one method to determine the value of water is to merely subtract the differences in value between land classes with water and those without.

The value of water per acre can be converted to a per acre/ft per year figure by dividing it by the average delivery sent to each land owner. After discussing the matter with the irrigation districts, deliveries can range from 2 to 5 acre/ft, but an acceptable average figure would be 3 acre/ft.

To get a value per acre/ft the acre/ft/yr value can be discounted to provide the desired estimate. For the calculations here, a discount rate of 5% was used over a

"happy medium" chosen as most studies of governmental projects rely on discount rates between 3% and 8%.

TABLE 19: Irrigation Water Value (Using Land Class VI)

	Land Class I	Land Class II	Land Class III	Land Class IV	Land Class V
Value of Irrigated Land per Acre	$910	$780	$650	$520	$390
Value of Land Class VI per Acre	$260	$260	$260	$260	$260
Value of Water per Acre	$650	$520	$390	$260	$130
Average Annual Water Delivery	3	3	3	3	3
Value of Water per Acre/ft (Delivered Perennially)	$217	$173	$130	$87	$43
Value of Water per Acre/ft (Delivered one time)	$17.79	$14.23	$10.00	$7.11	$3.55

TABLE 20: Irrigation Water Value (Using Land Class VII)

	Land Class I	Land Class II	Land Class III	Land Class IV	Land Class V
Value of Irrigated Land per Acre	$910	$780	$650	$520	$390
Value of Land Class VII per Acre	$130	$130	$130	$130	$130
Value of Water per Acre	$780	$650	$520	$390	$260
Average Annual Water Delivery	3	3	3	3	3
Value of Water per Acre/ft (Delivered Perennially)	$260	$217	$173	$130	$87
Value of Water per Acre/ft (Delivered one time)	$21.34	$17.79	$14.23	$10	$7.11

The marginal value of water per acre ranged from $17.79/acre to $3.55/acre according to soil productivity. On a per acre/ft with perennial delivery, the value of water ranged from $216.66/acre/ft to $43.33/acre/ft.

Differences Between Land and Water Values

The estimates of land values per acre derived from the model can be compared directly with both the assessor's estimates of EFU property and actual per acre value paid at market. Table 22 details this comparison.

TABLE 21: Comparison of Land Values

	Land Class I	Land Class II	Land Class III	Land Class IIV	Land Class V	Land Class VI	Land Class VII
Hedonic Analysis*	910	780	650	520	390	260	130
Special Assessed Value							
Value Paid at Market: Full Range	$710 to $2601	$680 to $2599	$110 to $1046	$74 to $950	$220 to $500	$125 to $450	$10 to $366
Value Paid at Market: Inter-Quartile	$1600 to $1600	$1400 to $1400	$950 to $950	$363 to $500	$220 to $220	$450 to $450	$41 to $349

Strategies for Reconciliation of Non-traditional Water Rights

Impacts of the enforcement and mitigation of the Endangered Species Act upon irrigators in Klamath County appear to occur indiscriminately throughout the county. According to the analysis here, no single irrigation district, or group of districts is impacted any more so than the others. Most likely, each district will have irrigators which will be impacted, but there is not discernable trend progressing above individuals. Owner/operators with class 4 and 5 land are most likely to lose water to meet old and new water rights.

SUMMARY

Conclusions in Hedonic Analysis of Agricultural Land Sales

Hedonic analysis of farm sales is a relatively easy and reliable method to illuminate implicit values of irrigation water. Much of the data for such analysis can be obtained through the local county assessors office, including acreage, soil classes, and improvements. This data can easily be cross referenced to other information sources to provide the basis for hedonic analysis. Once collected, simple and more complex regressions can be estimated. Interpretation of coefficients is usually straight-forward.

Water rights can be valued as the difference between irrigated land values and non-irrigated land values. As might be expected, water values on more productive land classes are larger relative to those with poorer soil quality. In other words, soil productivity greatly influences the value of water.

The application of non-linear functional forms to hedonics increases the possibility for problems with executing regression analysis. Some of the assumptions initially used may cause instability in further transformations of the model, as well as simply solving the model itself in it's present form. This problem may be lessened by the use of a larger data set.

Conclusions Specific to Klamath County

The land market is likely still very unstable. The effects of the Endangered Species Act in Klamath County are yet to be determined. The expectations are still that property values will decrease, but upon whom the impacts fall is still uncertain. The adjudication process is still underway and formal rights have not yet been finalized. There will be losers.

Other explanations for the lack of a general response of land prices to the mitigation of the Endangered Species Act are possible ignorance of potential buyers and the addition of "drought relief" wells which have been drilled by current residences to offset the effects of surface water shortages with ground water.

No significant difference was found between water sources. Again, this could be linked to an unstable land market, the lack of effect of the ESA on land values, and the fact that for all practical purposes, the area draws on a single water source. Thus, it would appear that the source of water supply has little or no effect on the price of land in the area. Perhaps a later model examined after all land factors stabilize in the area may show more information or change these results.

According to this model, the price of irrigated land in Klamath County ranges from $520 to $910. However, due to factors not available during the modeling process and the data limitations incurred, the forced usage of the average land class variable severely handicaps the model and underestimates the true value of land in Klamath County.

Distance of a parcel of land from Klamath Falls appeared to be insignificant and of no real influence on land values.

After 1992, land value in Horsefly Irrigation District dropped. Although, this was the occurrence of a drought at which land values were expected to drop, I would remain cautious about any conclusions derived from said estimate given the complexity of the model and the rather small data size. For similar reasons, I would be very cautious about the monthly increase in property values indicated by this model for Van Brimmer Ditch Company and Pine Grove Irrigation District after 1992.

The value of a residential permit in Klamath County is estimated at $19,327.

Improvements were sold on the market at 72% of the assessed value in Klamath County.

Smaller parcels do indeed significantly increase the value of a parcel. In this case, the increase was by about 28%.

Finally, the estimates produced for Klamath County by this hedonic exercise should be examined with a cautious eye. Potential instabilities in the land market itself, the relatively small sample size, and the complexity/ sensitivity of the model all pose considerable problems for robust estimation in this particular county.

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