AN ABSTRACT OF THE THESIS OF

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Joe B. Stevens

Many parts of the West are experiencing substantial growth pressures that have increased the demand for water. These new demands come at a time when most of the water in the West has been fully appropriated by traditional uses such as agriculture, mining, and industry. Some attempts are being made to accommodate this new demand by reallocating water rights through market forces. Most western water markets are in their infancy at present, and have had limited trading activity; this has resulted in large variations in prices. Oregon's water market is no exception to this situation; little market information is available. The market is most appropriately characterized as a gray market. This thesis gives color to Oregon's gray water market.

The first step was to assess current market activity. A review of the Oregon Water Resources Department water right transfer records identified 140 potential water right sales during the five year period from 1989 to 1994. A mail survey was used to collect market information on these potential sales. Reported sale prices exhibited a large degree of variation, ranging from $5 per acre-foot to as much as $1388 per acre-foot. The data suggests that there are two types of markets for water rights in Oregon. The first is a commercial market that includes participants such as commercial farmers, industries, and municipalities. The second is an amenity market whose participants have primary occupations unrelated to the use of the water right and who generally use water for small-scale, low-valued agricultural production.

The second step in giving color to Oregon's gray water market was to identify potential price determinants for water rights. An econometric model based on hedonic price theory was constructed to analyze the relationship between potential price determinants and market prices. Results indicated that the duty of the water right, its relative seniority, the parcel size of the sale, and the geographic location of the sale are determinants of water right prices.

GIVING COLOR TO OREGON'S GRAY WATER MARKET: AN ANALYSIS OF PRICE DETERMINANTS FOR WATER RIGHT

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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"Even a century ago, water supplied freely by nature at the source was worth shooting people for."--Mason Gaffney 1992

1.0 INTRODUCTION

Water has been of paramount importance to Oregon's economic development, scenic beauty and preservation of biological diversity. For example, the Columbia river is a corridor of economic trade with the rest of the world. It also serves as a valuable water source for irrigated agriculture, hydroelectric power generation, recreation, and maintaining critical habitat and spawning grounds for many endangered anadromous fish. There is concern that Oregon's water supplies are running out.

Already, in many parts of Oregon, existing water supplies cannot meet growing water needs. Industrial and commercial uses of water are increasing with population growth and economic development. The agricultural industry, the largest and oldest user of water in the state, is having to adjust its practices to accommodate the increasing urbanization of Oregon's population. The agricultural use of water is expanding in some areas and decreasing in others depending on cropping patterns and land use changes. Heightened environmental concern has prompted the enforcement of established instream flow rights. The growing population, expanding economy, changing agricultural sector, and instream flow requirements are increasing the demand on Oregon's water resources.

Oregon's institutional structure for allocating water has been unable to accommodate the state's increasing need for water. Escalating demands for dwindling water supplies has caused conflicts over the allocation of water. Recently, attention has focused on markets as a means of accommodating the state's ever-changing need for water.

Oregon has already taken a free-market approach to resolving its instream flow water allocation problem. In 1987, the Oregon State Legislature created a new type of water right called an instream flow right. The legislation authorized any person [public or private] to purchase, lease, or receive as a gift any water rights for instream use (ORS 537.348). While the legal structure of water marketing exists in Oregon, only a handful of market acquisitions have occurred to maintain and enhance stream flows.

In 1991, the Oregon Water Resources Department (OWRD) convened a task force in response to the large number of bills concerning water marketing issues that were introduced during recent legislative sessions. A water market conference discussing these issues was the result of the efforts of the task force. The major goal of the conference was to provide Oregon water resource managers with information concerning experiences of other states with active water markets. The central focus of the conference was market structure, including supply and demand characteristics, pricing strategies, and policy recommendations.

1.1 OREGON WATER LAW

Oregon's water law, like many other western states, is based on the doctrine of prior appropriation. The doctrine is commonly characterized by its "first in time, first in right" principle. Under the doctrine of prior appropriation, a water right provides the right to the use of water. A water right is acquired through the act of appropriating water. An appropriation involves diverting water from its source and applying it to a beneficial use.[1] The date in which the water was first put to beneficial use determines the priority of a water

[1] ORS 536.300 states that domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife, fish life, pollution abatement, drainage, reclamation, flood control and reservoir uses are all beneficial uses.

right. The priority of a water right determines the superiority of the right over other rights of later priority. During times of water shortages, earlier or senior water right are permitted to use water, and later or junior water rights may be entirely denied use.

The "first in time, first in right" principle of prior appropriations has given an advantage to the first uses of water. Much of the state's water is still controlled by these early uses. For example, agriculture was one of the state's earliest largest uses of water. As a result, the industry still controls over 86 percent of the state's water (USDA 1990). Very little unappropriated water is available to new uses. In some parts of the state certain waters have been closed to new appropriations out of concern for the existing water users and important natural resources. In such cases, new water users can obtain water rights only by acquiring them from an existing use.

1.2 TRANSFERRING WATER RIGHTS

The sale of a water right involves transferring the place of use of the right. When a water right is conveyed separately from land, the water rights transfer provision outlined in ORS § 540.510 to ORS § 540.550 must be followed. Oregon water law allows the owner of a water right to transfer the place of use, point of diversion, and/or purpose of use without loss of priority (OWRD 1994). A water right transfer must be approved by OWRD. The transfer provision is not intended to regulate the sale of water right, but is designed to protect other existing water rights holders from adverse affects that may result from the transfer. The transfer provision originated from early case law which held that water right holders could sell water to others for an entirely separate use as long as there was no adverse affects on other existing water rights (Kraynick et. al. 1983).

To approve the transfer application, OWRD needs to determine that the proposed changes will not injure other water right holders. The right holder must also provide evidence that the right has been used continuously and has not been abandoned. Generally, if no injury is shown, OWRD does not evaluate abandonment in the transfer proceedings unless it is evident that the right has not been used (Achterman 1993). If OWRD finds that the transfer can be made without injury to existing water rights and that the water right has not been abandoned, it must approve the transfer application (ORS 540.530). When the transfer application is approved, a water right is issued in the name of the new right holder. There is evidence that isolated water market transfers are occurring across the state (Brown 1994, Nunn 1994). For example, classified ads in local papers can be found advertising water rights for sale. Water market transfers are not a recent development in Oregon. In 1981, a review of all legal water right transfers occurring in Oregon between the years 1970 and 1980 was conducted. The review identified 28 transfers that involved a change in ownership of a water right (Kraynick et. al. 1983). In the aggregate, these isolated transactions formed a limited market. However, the review did not attempt to collect important market information such as sale price.

The transfer mechanism in Oregon offers the opportunity for the market exchange of rights between new users in need of water rights and existing water right holders. It is expected that the number of water right transfers has increased significantly in recent years because of increasing growth pressures and a substantial reduction in the number of new water rights issued by the state. However, little is known about this market. It is most appropriately characterized as a gray market. This project proposes to give color to Oregon's developing water market.

1.3 THESIS OBJECTIVES

There are two general objectives of this thesis. The first objective is to assess current market activity and market prices in Oregon's developing water market. The lack of available market information requires that primary data be collected in order to conduct the analysis. Following the procedures of Kraynick et. al. (1983), potential market transfers were identified by reviewing OWRD's water right transfer records. Primary market data were collected through a mail survey.

The second objective of this thesis is to identify determinants that can explain price variations within the water market. Significant price variation can be expected in markets with limited exchange. Price variations can be caused by several factors including asymmetric information, high transaction costs, and product heterogeneity. The empirical focus of this study is on measuring the relationship between water right prices and water commodity and transaction characteristics.

1.4 THESIS ORGANIZATION

Chapter Two is a review of recent literature on water valuation methods. Different methods used for estimating water values are described. Also included in the chapter are empirical estimates from recent studies.

Chapter Three outlines the economic theory for a competitive, well-functioning water market. Factors that cause price dispersion within the market are also identified. The extent to which these factors persist in Oregon's water market are discussed.

Chapter Four outlines the econometric model used to identify water right price determinants. The chapter begins by laying out a general framework for a hedonic price model for heterogeneous factors of production. The specific hedonic price model used to analyze price dispersion is also developed.

Chapter Five discusses the questionnaire format, survey methods, and the responses from the mail survey used to collect primary market information.

Chapter Six assesses market activity and presents descriptive results of market information collected through the mail survey. The results include the observed range of prices, location of market transaction, and qualitative characteristics for commercial and amenity market participants.

Chapter Seven presents the econometric analysis of water right price determinants. The primary objective of the analysis is to better understand the relationship between potential price determinants and Oregon water right prices.

Chapter Eight concludes the thesis with a summary of the study, a discussion of its policy implications, and suggestions for future research.

CHAPTER TWO:
LITERATURE REVIEW

2.0 INTRODUCTION

Water market information is often difficult to find due to the private nature of market transfers and because these transactions are often not publicly recorded (Michelsen 1994). The lack of adequate price information has prompted the need for techniques to estimate water values. Value estimates are useful in supplementing limited price information to assist potential buyers and sellers in negotiating prices and making well-informed decisions (Colby 1989b).

The following chapter examines the recent literature on estimating water values. The chapter begins by providing a general description of the valuation techniques identified in the literature. Then the empirical estimates of water values from the literature are presented. The estimates provide evidence of the growing disparity of water values across different uses. These large disparities are the driving force behind the emergence of many new water markets.

In rare cases when water market information is available, it is common to see large variations in sale price. Price variation can be caused by a variety of factors including limited market information, differences in water right attributes and specific sale characteristics. Very few studies exist that have been able to use real market prices to examine price variations in water markets. The last part of this chapter reviews these limited water right price-determinant studies.

2.1 A REVIEW OF WATER VALUATION METHODS

There are a variety of methods that are used to appraise the value of water. However, no standardized method has been adopted for valuing water rights (Colby

1989a). The definition of value varies depending on the use in question. As a result, it is possible to generate several alternative dollar estimates of the value of water. Because of this, it becomes crucial to select a method of appraisal most suited to the purpose of the valuation. Several methods for valuing water have been identified in the economic literature. These include the sales comparison method, income capitalization method, land value differential method, development-cost method, contingent valuation method, and the travel cost method.

2.1.1 Sales Comparison Method

The sales comparison method is a feasible method when adequate sales data are available. This method involves comparing the subject water right with similar water rights that have recently been sold or leased (Colby 1989a). Prices generated from comparable properties suggest a range within which the value of the subject property should fall. This approach is particularly useful in assessing current market conditions. A market price conveys specific time and locational information on the buyer and seller's value of the right being transferred.

2.1.2 Income Capitalization Method

The income capitalization method is most commonly used when water is made available by forgoing agricultural production (Gibbons 1986). When agricultural production is forgone, the value of water is determined by the land base (acres), the crop type, the market price of the produced crop, the level and costs of other inputs (labor, management, capital investment), and the contribution of water to production. This method is based upon the capitalized value of a farm unit with and without water. It involves analyzing the stream of net benefits a farm unit will generate over time and converting this net benefit stream into a value estimate. Several techniques have been developed to separate the contribution water has to overall production. Two methods, farm-crop budget analysis and linear programming analysis are described below.

2.1.2.1 Farm-Crop Budget Analysis

Farm-crop budget analysis utilizes enterprise budgets such as those that have been developed by the Oregon State University Extension Service. The method estimates the maximum revenue share of water as an input to crop production. Total crop revenue less all non-water input cost leaves a residual amount equal to the maximum amount a farm unit is willing to pay for water and still cover production costs. The residual, divided by the amount of water used in irrigation, represents the maximum average amount that the farm unit would be willing to pay for an annual unit of water. The farm budget approach can also be used to identify the value of an additional unit of water by estimating the contribution to total revenue less all non-water cost that would be generated by applying one more unit of water.

A variation of this method is the comparison of irrigated to dry land crop production. This method can be used when estimates of crop yields for irrigated and dry land production are available. These estimates can be acquired from most Soil Conservation Service soil surveys. Estimates are not provided if a certain crop under a given watering practice is not used in an area. Site specific information can be obtained when both irrigated and dry land practices occur within a homogenous farming area, and when factors such as soil type and climatic conditions are similar. The residual in net returns from the two farming practices can be attributed to the use of irrigation water. This is a relatively straightforward method and is preferred by the United States Water Resources Council (1983). The Council is an independent federal executive agency that appraises the adequacy of existing and proposed water policies. Appendix A demonstrates the farm-crop budget analysis by calculating water use values for alfalfa production in north-central Oregon.

2.1.2.2 Linear Programming Analysis

From the information provided for the income capitalization approach, a more sophisticated linear programming analysis (LP) can be developed. The LP objective is to maximize net returns for a farm subject to a series of constraints which may be economic as well as physical. Constraints commonly used in programming analysis include acreage limitations, water requirements for each crop, input costs, rotational requirements, available technology, efficiency of water conveyance systems, crop prices, and available water limitations. The LP solution estimates the marginal values for all resources including water. Changing the water availability constraint allows alternative LP solutions to be generated. This process yields a set of implicit prices for a range of water supplies, from which a farm level water demand schedule can be constructed. When water supply is low, the program solution allocates water to its highest-valued use. As supply increases, other less valuable and/or more water intensive crops enter the solution. The demand schedule can be used to estimate the farm's unit offering price for water.

2.1.3 Land-Value Differential Method

One approach commonly used to value water rights is to examine the values of agricultural land or other income-producing property with and without water rights (Colby 1989a). This assumes that a comparison of market data on the price of dry land with market prices for irrigated land can be used to establish a price differential that represents the increased productivity attributable to the water right (Ross 1984).

2.1.4 Development-Cost Method

The development-cost approach is an estimate of the current cost of reproducing or replacing real estate improvements (Colby 1989a). This approach should be used when the market price in a local potential or actual water market is dominated by investment alternatives that increase water supply (Gibbons 1986). In the analysis of water rights, it requires estimation of the least-cost alternative for providing an amount of water similar to that of subject property's water right. This method should only be used when evidence suggests that users have actually been paying or are willing to pay costs at the levels estimated to develop additional water supplies, i.e. that the provision of water by alternative means is considered a feasible option (Colby 1989a). Without overwhelming evidence, there is no reason to assume that water users would be willing to pay development costs. This method is not related to market demand, and is thus not a measure of willingness to pay. It should be a method of last resort for valuing water rights.

2.1.5 Hedonic Price Method

The hedonic price method uses regression analysis to separate out factors affecting the value of a market good (Williams 1991). The hedonic price method estimates the implicit prices of product characteristics that differentiate similar products. For example, property values vary with respect to different production, amenity, and locational characteristics. The hedonic price method can be used to sort out the extent to which each of these characteristics contributes to the overall value of the property. The hedonic price model has also been applied to water right prices. This approach will be explained in greater detail in Chapter Four.

2.1.6 Travel Cost Method

The travel cost method (TCM) is most commonly used to estimate the recreational value of water (Brookshire and Smith 1987, Gibbons 1986). TCM estimates the recreational value of water by using travel expenditures as a proxy for market prices (Williams 1991). A value for a particular resource can be inferred by recording people's direct and indirect travel expenditures. This method appears to be the superior approach when costs differ significantly across users, when single-sites trips occur, and when nonuse values are insignificant (Gibbons 1986).

2.1.7 Contingent Valuation Method

The contingent valuation method (CVM) involves creating a hypothetical market to value proposed changes to an environmental good such as stream flow levels or water rights (Williams 1991). CVM relies on survey methodology to elicit values from a respondent and is used to estimate both user and non-user values (Brookshire and Smith 1987, Colby 1989a, Williams 1991). This is a direct approach which simply asks people whether they are willing to pay a particular price for a change in an environmental attribute such as stream flow levels. The attempt of CVM is to elicit valuations or bids that are close to those consumers would reveal given actual market conditions (Pearce and Turner 1990). From these bids, inferences can be made about the value of the environmental good.

2.2 WATER VALUE ESTIMATES IN ALTERNATIVE USES

Water is used for a multitude of different uses. The type of use in question will determine the estimation technique used to value the water. Different types of water uses and valuation methods can generate different dollar estimates. The following section reports water value estimates by their associated uses. The reported values are drawn from two major reviews of water values (Colby 1989b, Gibbons 1986). All values reported in the following section are stated on an annual per acre-foot basis and are expressed in 1994 dollars by using the Gross National Product index. Annual values are not directly comparable to the sale price of water rights. The present value of the perpetual flow of annual values can be calculated to compare with sale price.[2]

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[2] The present value of the water for some specified period of time can be calculated by using the following discounting formula:

$$PV[v_t] = \sum_{t=0}^{T} \frac{v_t}{(1+r)^t}$$

where $PV[v_t]$ is the present value of the a stream of annual benefits v_t, r is the discount rate, and T is the specified period of time.

2.2.1 Agricultural Uses

The two most common approaches used to estimate the value of water in agriculture are the farm-crop budget analysis and linear programming analysis. Crop prices are the most influential determinant for the value of water in agriculture (Gibbons 1986). These two methods are well-suited to reflect the influence crop prices have on the value of water used for agricultural production.

Lacewell et. al. (1974) estimated water values for the Texas high plains using crop budgets. They used estimates of yields and prices for five crops and three input costs which included management, land rent, and the pumping costs of acquiring water. Thus the residual figure imputed for water represented the returns to water beyond water application costs. The residuals estimated the value of the water at the source. To convert the source value of the water to on-site values required that the cost of water application be added to the source value. The estimates of the on-site value of water ranged from \$37 per acre-foot for wheat production to \$130 per acre-foot for cotton production and even as much as \$151 per acre-foot for soybean production.

Willitt et. al. (1975) estimated agricultural water values for four counties in Arizona. They derived average water values for different crops by budgeting the residual of net returns over total non-water costs. The total non-water costs included both fixed and variable costs. The value of water for each crop varied greatly across the four counties. The estimated values for all crops and all counties ranged from -\$9 per acre-foot (indicating a reduction in overall revenues resulting from use) to \$92 per acre-foot. Crops of particular interest such as alfalfa hay ranged from \$15 to \$34 per acre-foot.

A more recent study using the farm-budget approach was conducted by Duffield and Neher (1991) for Montana's Fish, Wildlife, and Parks Department. The study reported water value estimates for six crops in eight Montana counties. They estimated on-site values by reflecting a range of efficiency levels for different irrigation systems. These estimations were to be used by the Fish, Wildlife, and Parks Department to negotiate lease prices for water needed for fish habitat protection. To account for different lease periods, they calculated both short-run and long-run annual water values. The short-run on-site values for different irrigation efficiency levels for alfalfa hay ranged from $ 5.90 per acre-foot under flood irrigation to $ 60.50 per acre-foot for center pivot or sidewheel irrigation systems.

Kelso et. al. (1973) developed 150 linear programming models for representative farm situations of various crops at the county level in Arizona. These models were used to forecast cropping changes and farm unit responses to increasing costs of irrigation water. The study traced out irrigators' demand curves for two Arizona water conservancy districts. Estimated water values ranged from $25 to $41 per acre-foot for alfalfa hay, to $30 to $32 per acre-foot for wheat , and as much as $68 to $87 per acre-foot for sugar beets.

Young (1984) used a linear programming model to estimate water values for corn, alfalfa and irrigated pasture in the Platte Basin of Colorado. Water values for corn were estimated at $39 per acre-foot, while both alfalfa and irrigated pasture had water values of less than $39 per acre-foot. Young noted that the value of water for growing specialty crops was considerable higher than all others in the basin. However, water use for specialty crops account for less than 10 percent of the basin's water use. Young concluded that the use value of 90 percent of the basin's irrigation water was below $30 per acre-foot.

2.2.2 Municipal Uses

Municipal water is used by a variety of consumers, ranging from commercial and industrial establishments to residential homes. Most studies that have estimated value of municipal water have focused on consumer responses to price changes or price elasticities rather than water values. These studies are based on a variety of data, and have produced a wealth of price elasticity estimates. Price elasticity of demand is defined as the percentage change in quantity of a commodity demanded given a one percent change in price. The lower the coefficient, in absolute value, the less responsive demand is to price. The coefficient provides a convenient way of summarizing the price responsiveness of demand.

Price elasticity for municipal demand tends to be relatively low when compared to other uses such as irrigation (Colby 1989b). That is, municipal demand is less sensitive to price than irrigation demand. Municipal water price elasticity can vary depending on the use in question. For example, domestic in-house demand tends to have a lower elasticity (less price responsive) than does the demand for landscape watering (Young and Gray 1973). Howe and Linaweaver (1967) derived different price elasticites for the eastern and western United States that indicated in-house water use is consistently price-inelastic (-0.23), while landscape watering is more elastic and differs considerably between the east (-1.6) and the west (-0.70). The arid climate of the west is a reasonable explanation as to why landscape water is less price sensitive than in the east. Table 2-1 provides a comparison of price elasticities calculated for municipal water demand throughout the United States.

A limited number of studies have reported annual values for municipal water use. Young and Gray (1972) estimated that urban residents place an annual value of $220 per acre-foot for landscape irrigation and a considerably higher value of $3395 per acre-foot for indoor uses. Gibbons (1986) suggests that seasonal variability caused by changes in water availability can influence municipal water values. By using water consumption data from Tucson, marginal values were estimated for a 10 percent reduction in water supply. The reported value estimates corresponding to the reduction in water supply were $139 per acre-foot in winter and $47 per acre-foot in the summer.

Table 2-1
Price Elasticities of Municipal Water Demand

Study and Date	Location	Elasticity Estimate
Gottlieb (1963)	Kansas	-0.66 to -1.24
Gardner-Schick (1964)	Utah	-0.77
Ware-North (1967)	Georgia	-0.61 to -0.67
Howe and Linaweaver (1967)	U.S.A	Total: -0.40 Winter: -0.23 Summer: East -1.57 West -0.70
Turnosvsky (1969)	Massachusetts	-0.05 to -0.40
Wong (1972)	Illinois	-0.26 to -0.82
Young (1973)	Tucson, Arizona	1946-1965: -0.62 1965-1971: -0.41
Danielson (1977)	Raleigh, NC	Total: -0.27 Winter: -0.305 Summer: -1.38
Gibbs (1978)	Miami, Florida	-0.51 to -0.62
Foster and Beattie (1979)	U.S.A.	New England: -0.43 Midwest: -0.30 South: -0.38 Plains: -0.58 Southwest: -0.36 Pacific Northwest: -0.69
Billings and Agthe (1980)	Tucson, Arizona	-0.39 to -0.63

Source: Gibbons, Diana C., The Economic Value of Water, Resources For the Future, Washington D.C., 1986, p. 10-11.

One final consideration when valuing water for municipal use is that the price paid by the urban consumers for delivered water does not necessarily indicate how much the city is willing to pay for an additional right to untreated surface water. Raw water and treated water delivered to residences are two completely different commodities, therefore the values of each are not directly comparable (Young 1986). Martin and Thomas (1987) estimated that willingness to pay for raw water accounts for only 12 percent of willingness to pay for delivered water. It is the municipality's demand for raw water that should be compared to water values in irrigation and other uses (Colby 1989a). Market prices for water rights generally apply to raw water and are not comparable to the value of treated water delivered to consumers. If these two values are to be compared, the cost of treatment, storage, and distribution must first be deducted from the value of delivered water.

2.2.3 Recreational and Amenity Uses

Adequate instream flows are vital for habitat protection of Oregon's valuable fish and wildlife population. Water-based recreation that is dependent on stream flows is another growing part of Oregon's profitable tourism industry. There is little direct market evidence on willingness-to-pay and thus the value that instream flows contribute to water-based recreational opportunities or for fish and wildlife preservation. A variety of nonmarket valuation approaches such as travel cost, CVM, and hedonic price analysis have been applied to estimate the value of water for these purposes. Several studies have recently applied these valuation approaches to estimate the value of water for recreation and for fish and wildlife habitat.

2.2.3.1 Recreation

Blue ribbon trout fisheries and world class white-water rafting draw many visitors to the West each year. Stream flow levels directly influence the recreation benefits of these activities. For example, stream flows can influence the distribution and behavior of insects (a fish food source) and the condition and abundance of fish habitat. These factors effect the fish stock and have an associated impact on angler catch rates (Johnson and Adams, 1988). Higher fish stocks result in higher catch rates which improves the quality of the fishing experience (Johnson and Adams, 1988).

Several studies have attempted to estimate the recreation value of instream flows. Duffield et. al. (1992) estimated the recreation benefits of instream flows for Montana's

Big Hole and Bitterroot rivers. During times of very low flow, the marginal recreation value ranged from $8 per acre-foot on the Bitterroot river to $23 per acre-foot on the Big Hole river. The marginal recreation value for both rivers went to zero during periods of high flow levels. It is interesting to note that these estimates approximate observed purchase prices of water for instream flow. Montana Department of Fish, Wildlife, and Parks leases 10,000 acre-feet annually at an administratively set price of $2 per acre foot, to augment instream flows. This transaction was not a purchase of an existing diversionary water right but the purchase of water stored in the Painted Rocks reservoir. Montana law still restricts the transfer of an existing water right to an instream flow right. Appendix B provides a summary of market acquisitions of water for instream flow that have occurred throughout the West.

Daubert and Young (1981) conducted another study with similar results. They examined the benefits that stream flows contributed to recreation on Colorado's Cache la Poudre River. This study distinguished between float fishing and shoreline recreation. The marginal value of an acre-foot of water during low flow periods was estimated to be $27 for float fishing and $19 for shoreline recreation. Again, during high flow periods the marginal value of an additional acre-foot of water dropped to zero. The drop in the marginal value of stream flows suggests that recreationists value the maintenance of minimum flows rather than additional increments of flow to already adequate levels (Daubert and Young, 1981). Studies of this kind indicate that there is a tangible increase in recreation value from the availability of increased instream flows during critical times.

Walsh, Auckerman, and Milton (1980) estimated that leaving an additional increment of water in high mountain Colorado reservoirs for an additional two weeks in late summer was valued at $63 per acre-foot in additional recreation benefits during peak recreation periods. A later study conducted on a river in northern Utah by Amirfathi, et. al. (1984) found that the value to recreation of an additional flows was zero until flows dropped to 50 percent of peak levels. The marginal value of water was estimated at $107 when flow levels were 20 to 25 percent of peak levels. Ward (1987) estimated the recreation benefits of angling and white-water boating in the Rio Chama river using the travel cost method. The results indicated that late summer flows had a value of $20 to $35 per acre-foot. Consistent with the other studies, Ward determined that marginal values decrease drastically when stream flows approach peak levels.

Several studies have attempted to estimate the value of water for fishing for both recreational and commercial uses. In a study for the Bumping Lake project in the Yakima River system, the fishing value of water as a result of increased steam flows was estimated to be $26 per acre-foot (Shira 1976). This study did not recognize value changes resulting from different flow levels. A report from the Association of California Water Agencies estimated that water for salmon spawning was valued at $55 per acre-foot (Bollman 1979). There was no distinction of natural or wild salmon or any consideration given to threatened species which may have spawned in this water.

2.2.3.2 Water Quality

Greater stream flows may enhance the pollution assimilation capacity of streams which may improve water quality. This generates economic benefits in the form of lower treatment costs for discharges borne by downstream users. The increased stream flows are able to dilute the non-point source pollution created by agriculture. The agricultural industry may consider enhanced stream flows as an aid to meeting water quality standards required by the Clean Water Act. Further, improved water quality could augment poor crop yields associated with low water quality (Greenley et. al. 1982). No studies have been identified that estimate these potential economic benefits. However, Greenley et. al. (1982) indicate that there are opportunities to create substantial recreational benefits by improving the surface water quality of Colorado's South Platte River.

2.2.3.3 Fish and Wildlife

Instream flow values for fish and wildlife incorporate many different use and nonuse values. User values such as recreational and commercial fishing and hunting are all dependent on instream flows to provide habitat for fish and wildlife. Nonuse values include option, existence and bequest values (Brookshire and Smith 1987, Randall 1981). Studies of nonuse values, for example those associated with threatened and endangered species have indicated that these can be quite high (Colby, McGinnis, and Rait, 1991). Researchers have documented nonuse values that range from $40 to $80 per year per nonuser household for stream systems in Wyoming, Colorado, and Alaska (Greenley et. al. 1982, Madariago and McConnell 1987). The general problem associated with nonuse values is that no market exists to capture these values. While nonuse values are difficult to measure they are usually significant. This indicates that measurable use values of water should be used as minimum estimates of the actual value created by instream flows because they do not account for nonuse values.

2.2.4 Implications Of Water Values

The review of literature on water values in alternative uses demonstrates that a variety of valuation methods are being used. The valuation method used is determined by the current use of the water. A comparison of value estimates by each study shows that large disparities exist across different uses as well as within each type of use. As the disparity of use values increases so does the opportunity for gains from trade. Users that yield modest financial returns to water will find it economically beneficial to sell water to those with higher-valued uses.

However, active, well-defined water markets have been slow to develop because of poorly defined property rights, high transactions costs, lack of good information, and institutional restrictions (Michelsen 1994, Brajer et. al. 1989, Young 1986). Some isolated water transactions have occurred when disparities in value are sufficient enough to overcome these prohibitive factors (Young 1986). When transactions have occurred, there have been wide variations in the price of water rights (Person and Michelsen 1994, Colby et. al. 1993, Water Strategist 1990). Data on water transfers and water market prices can be difficult to obtain. There are only a few studies that have used price data to examine water right price dispersion. The following section reviews these studies.

2.3 WATER RIGHT PRICE DISPERSION STUDIES

Two approaches have been used to examine water right price dispersion. The first looks at the variation of water right prices over time (Person and Michelsen 1994, Khoshakhlagh et. al. 1977). This approach treats water rights as a homogenous product and explains price dispersions by looking at changes in regional economic conditions. The second approach attempts to explain price dispersions at a single point in time by differences in water right and water market characteristics (Colby et. al. 1993). Each approach is helpful in identifying determinants that affect the price of water rights.

2.3.1 Person and Michelsen (1994)

Person and Michelsen (1994) developed a two-equation model based on rational expectations theory to analyze water price dispersion over time. Price data from the Colorado-Big Thompson water market from 1961 to 1989 were used in the analysis. The model included historical information on returns to irrigation, regional economic trends, and market conditions to explain water right price variations. Some of the specific independent variables were: regional population, the number of consecutive years of drought conditions, crop prices and yields, and the types of uses involved in the transfer. The model also incorporated future price expectations to account for potential speculative activity. The analysis suggested that speculative activity causes price dispersions over time.

2.3.2 Khoshakhlagh et. al. (1977)

Khoshakhlagh et. al. (1977) developed a simultaneous equation demand model to forecast the equilibrium price of water rights for New Mexico's Rio Grande basin. The model included three equations, each corresponding to a major water demand in the region. They used price information, collected through a mail survey, to construct time series data. Prices were explained as a function of historical information similar to that used by Person and Michelsen (1994). The demand for water was described as being a function of both price as the dependent variable, and a set of independent variables. The independent variables did not include different water right characteristics that may affect price.

2.3.3 Colby et. al. (1993)

Colby et. al. (1993) developed a hedonic price model to analyze water right price dispersion for specified period in time. The model described water right prices as a function of water right characteristics, institutional controls on water use, the transferability of water rights, and the balance of power between buyers and sellers. The analysis used price information from New Mexico's Gila-San Francisco basin during the period from 1971 to 1987. The model included a time variable to account for price variations over time caused by changing regional economic conditions. The analysis suggests that water right characteristics and market factors need to be accounted for when estimating the market value of water rights.

2.4 SUMMARY

Several observations can be gleaned from the above review. First, a variety of methods have been used to value water. No single method is predominately used for valuing water because the method employed depends on the purpose of valuation and the use in question.

Second, there are a large number of studies that have estimated the value of water in a variety of uses. These estimates generally rely on indirect valuation methods due to the absence of a wide range of observed water right prices. The estimates presented above demonstrate a wide variation in water values across alternative uses. These large disparities in value provide economic incentives for water market transfers.

Third, there are a limited number of studies that have analyzed actual water market information. The most defensible way to estimate water values is to examine actual market information (Colby 1989a). Again, the difficulty in obtaining actual market information has prevented the use of market-based valuation methods. It is difficult to determine the accuracy of indirect valuation methods from the results of the few market-based studies that have been conducted. As noted by Colby et. al. (1993), there is a need for more research that addresses price relationships and market characteristics by collecting and analyzing price and market data for several regional water markets.

CHAPTER THREE:
ECONOMIC THEORY OF WATER MARKET PRICE DETERMINANTS

3.0 INTRODUCTION

The purpose of this chapter is to provide a theoretical understanding of how competitive, well-developed water markets would establish market prices. A regional market model and a transfer market model are used to demonstrate price determination. The regional model represents the total quantity of water demanded and supplied in the region, while the transfer market model demonstrates the exchange of water between various sectors within the region. The distinction between these two will become more clear with the further development of each model.

Few western states support active, well-developed water markets. As a result it is common to see wide variations in market prices (Person and Michelsen 1994, Colby et. al. 1993). Price variation can be caused by such things as commodity heterogenity and specific transaction characteristics. The extent to which these causes of price variation persist in Oregon's water market are discussed.

3.1 WATER MARKETS

A competitive water market is a market in which the forces of demand and supply determine price. If a resource is scarce, as water is in the arid West, individuals desiring the resource must seek out a supplier and negotiate a price and the conditions of the purchase. When demand exceeds supply, individuals will engage in trade, bidding up price until demand is satisfied. If there is an excess of resources, prices fall until there are enough market transactions to employ all resources available. In a well-functioning market, this process is active, continuous and able to establish a single price that is known to all market participants.

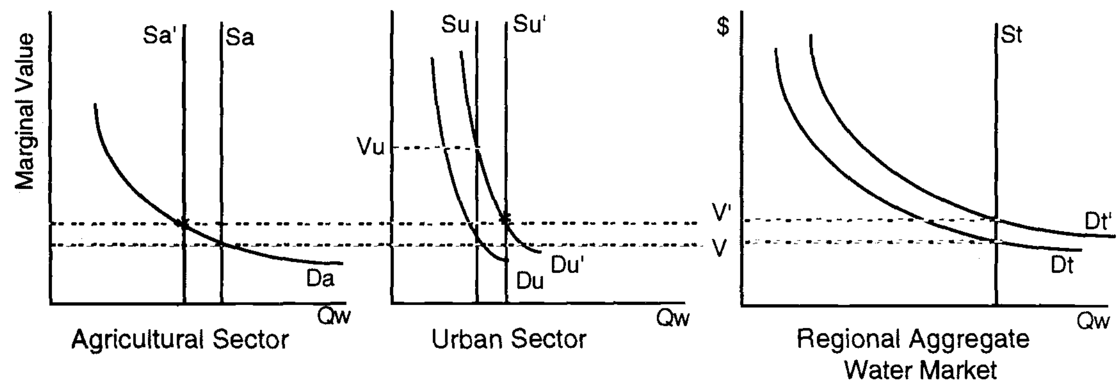
3.1.1 Regional Market Model

A simple model of a regional market can be used to illustrate this process. For simplicity, it is assumed that agricultural and urban uses are the only sectors requiring water in the region. The model assumes that there are no costs associated with transfering water, that all water within the region is fully appropriated, and that legal mechanisms exist to permit the transfer of water rights among individuals and uses.

Water is not generally thought of as a final market good but a factor of production. Both agriculture and urban demands need water for the production of final goods. Therefore, each industry's demand for water is a derived demand, based on the demand for the final good. Each industry's demand curve represents the marginal value of an additional unit of water in production. In accordance to the law of diminishing marginal returns, the demand curves are downward sloping. That is, an additional unit of water yields less returns or satisfaction than the previous unit. Figure 3-1 illustrates each uses' water demand curve. The aggregate demand or overall market demand for water, D_t, is the horizontal summation of demand for water in agricultural use, D_a, and urban use, D_u.

In Figure 3-1, the supply of water for any one use is fixed and is determined by the quantity appropriated during the initial allocation of water rights. The suppies of water for agricultural use, S_a, and urban use, S_u, are the quantities provided by the water rights held by each use. In essence, the water is self-supplied by the demanding use. The demand curve for each use is a derived demand, based on the marginal value of water in production. Relative to other uses, urban demand tends to be more inelastic and less responsive to price changes (National Research Council 1992, Young and Gray 1972). As shown in Figure 3-1, the urban demand curve is steep relative to the agricultural demand curve.

Figure 3-1
Regional Water Market



An increase in urban demand (D_u to D_u') causes a shift in the aggregate market demand, D_t', increasing the market value of water to V'. The marginal value of water is no longer equated across uses. This increase in the urban demand for water, D_u', fixes a higher marginal value, V_u, for urban water use. The disparity in use values presents the opportunity for economic gains through trade. When urban use values exceed agricultural use values, agricultural water users can receive higher returns for water by selling it to the urban sector. By selling water, the agricultural sector reduces its own water supply. The agricultural sector will reduce its water supply to S_a', the point (*) where the marginal value of the last unit of water in production equals the market value. The urban sector demands water until the marginal value product equals the market price of water. The urban water supply increases to S_u', which includes the amount transferred from the agricultural sector.

3.1.2 Transfer Market Model

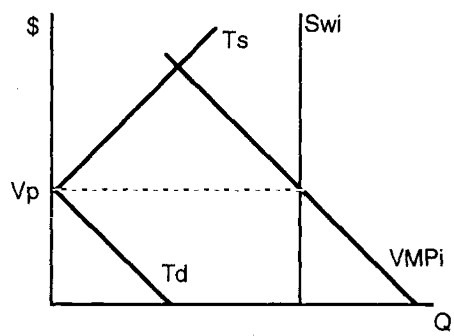
The exchange of water rights takes place in a transfer market. A transfer market model can be used as an alternative to the regional model to examine price determination within the market. The transfer market supply and demand curves are derived from the regional water market's "full" demand and supply curves. Recall that the regional water market's demand curve is the aggregation of each sector's derived demand for water. The full regional water supply curve is the aggregation of each sector's endowed quantity of water provided by water rights. The transfer demand excludes the quantity endowed or self-supplied and is thus the relevant demand for the purpose of trading. The transfer supply is the quantity of appropriated water rights that are offered to the market.

A water right holder can be both a supplier or a demander of water in the transfer market. The decision to buy or sell water is influenced by the regional market value of water, the fixed endowment quantity of water provided by the water right, and the water's marginal productivity value. Figure 3-2 shows how the water right holder's transfer market supply and demand curves for water are traced out.

The transfer demand curve for the water right holder is the amount demanded at any price level. The transfer demand curve, T_d is the horizontal difference between the VMP_i curve and the supply of water, S_{wi}, which is the endowed quantity of water provided by a water right. In the price range where full demand is less than full supply, the transfer demand is negative. A negative value for transfer demand is more easily interpreted as the individual's transfer market supply curve, T_s. When the regional water market is in equilibrium, the market value and the value of the last unit of water used by the right holder will be equal. At this price level, V_p, the individual's transfer market demand and supply are both zero.

As the market value moves from the equilibrium price, V_p, the water right holder will choose to enter the transfer market. The water right holder will become a supplier in the transfer market if the regional market value for water rises above V_p. At this price level, the right holder can receive greater returns by selling water in the transfer market. The water right holder will become a demander in the transfer market if the regional market price for water falls below the equilibrium value, V_p. At this price level the water right holder is able to increase production and profits by acquiring additional water supplies from the transfer market.

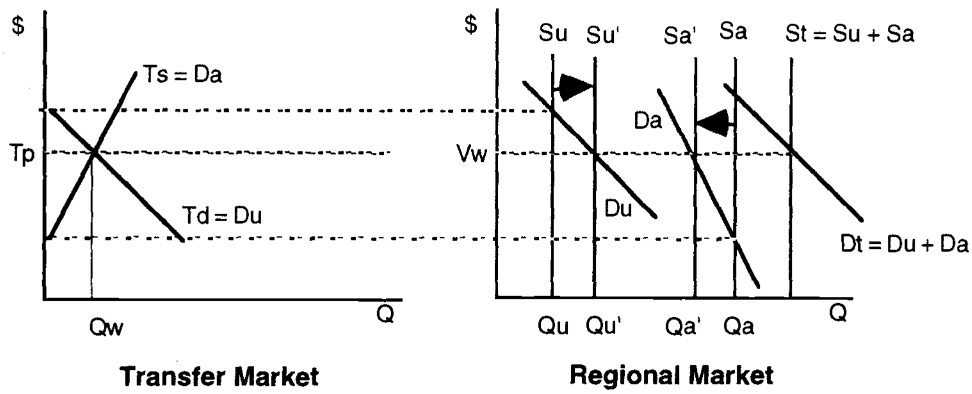
Figure 3-2
Water Transfer Market



The transfer market is comprised of the collective decisions of each water user. The transfer market demand curve is the summation of the net demand for all market participants. The transfer market supply curve is the summation of the net supply for all market participants. Unlike the supply of water in the regional market, the transfer market supply of water is no longer fixed and is sensitive to price changes.

Figure 3-3 shows the relationship between the transfer market model and the regional market model. Water is being traded between agricultural and urban uses in the transfer model. Agriculture is the dominant supplier of water, given its large holdings of water rights and modest returns per unit relative to urban uses. The equilibrium price in the transfer market is T_p. The equilibrium transfer market price, T_p, will move toward the overall regional market value for water, V_w. Trading between the two sectors continues until the transfer market price and the regional market value are in equilibrium. The quantity of water traded between the two sectors in the transfer market is equal to Q_w. The trading in the transfer market causes the urban supply curve to shift out from Su to Su' and the agricultural supply curve to shift inward from S_a to S_a'. The quantity Q_w is equal to the difference in Q_u and Q_u', which is the net quantity purchased by the urban sector. The quantity Q_w is also equal to the difference between Q_a and Q_a', the net quantity sold by the agricultural sector.

Figure 3-3
Relationship Between the Transfer and Regional Markets



3.2 POTENTIAL WATER RIGHT PRICE DETERMINANTS

A market is said to be well-developed and competitive if at any moment in time there is a single price known to all participants and if transactions can occur without additional cost (Hirshleifer 1984). In order for a single price to be established, the commodity traded within the market must be homogenous. Water rights in Oregon, however, vary greatly both in terms of quantity of water and the reliability of the right. A water right is most accurately described as a heterogenous commodity. The model assumes that the terms and characteristics for each sale are the same for all market participants. However, in thin markets it is common to see a wide variety of terms of trade. For example, the number, size and prominence of both buyers and sellers, the magnitude of transactions costs, and market information may differ for each sale as well as for market participants. Commodity heterogenity and differences in sale characteristics are two common causes for price dispersion within water markets (Colby et. al. 1993). The extent to which these causes of price variation persist in Oregon's water market is discussed in the following sections.

3.2.1 Water Right Attributes

There are generally five attributes that are used to define a water right. These are (1) the quantity of water, (2) priority date, (3) season of use, (4) place of use, and (5) character of use. The first three are determined at the time of appropriation and are not subject to change. The last two can be altered through a legal transfer process. A description of the first three attributes is provided below. Since most of the state's water rights are held by agriculture, the discussion focuses on agricultural water rights. However, the same concepts apply to other types of water rights.

3.2.1.1 Quantity of Water

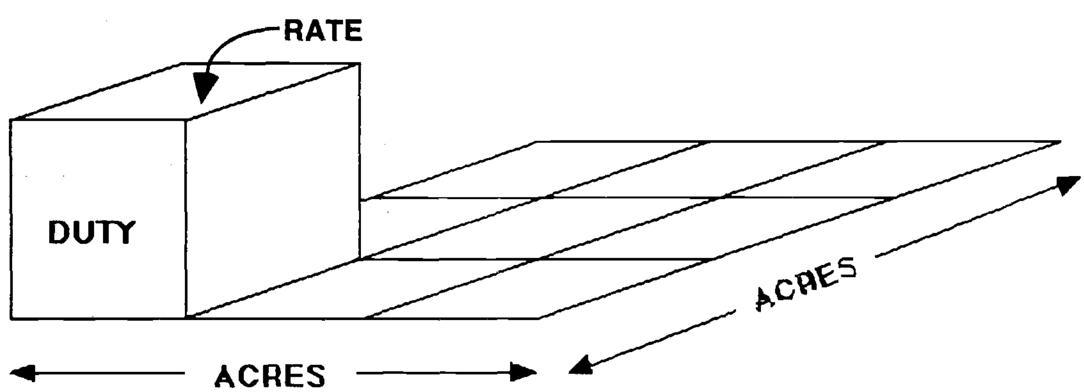
Water can be measured as a fixed volume or as a flow rate measure in time. The acre-foot is the most common fixed unit of measurement. Table 3-1 provides the conversion between common measurements of water. One acre-foot of water will cover an acre of land with one foot of water. Cubic feet per second (cfs) is the most common flow rate measurement. It is the volume of water that is flowing in one second. One cfs is equivalent to 1.98 acre-feet per day.

Irrigation water rights are specified in terms of acreage, duty and rate (Figure 3-4). The acreage of a water right defines the number of acres that can be irrigated. The duty of a right is represented by the column; it is the amount of water that can be applied to any one acre during a single growing season. The duty of a water right is measured in terms of acre-feet per acre. Common duties in Oregon range from one to six acre-feet per acre. The rate of a water right defines the maximum flow of water at any point in time. The rate of a water right is measured in terms of cubic feet per second. Common rates in Oregon range from as low as $1/80^{th}$ of a cfs to as much as $1/27^{th}$ of a cfs.

Table 3-1
Water Metric Conversion Chart

Measure	Equivalents
1 cubic foot	7.48 gallons
1 gallon	8.34 lbs
1 cubic foot	62.4 lbs
1 acre-foot	43,560 cubic feet
1 acre-foot	325,900 gallons
1 acre-foot	1,359 tons
1 cubic foot per second (cfs)	448.8 gallons / day
1 cfs	1.87 tons
1 cfs for 24 hr	1.983 acre-feet
1 cfs for 30 days	59.5 acre-feet
1 cfs for 1 year	724 acre-feet

Figure 3-4
Graphical Representation of an Irrigation Water Right



A water right holder may divert a maximum rate at any given time but may not exceed the total duty. For example, a water right that has a rate of 1/40th of a cfs and a duty of 4 acre-feet entitles the right holder to a maximum flow of 1/40th of a cfs per acre at any point in time, but the total amount diverted for the season of use cannot exceed 4 acre-feet per acre.

3.2.1.2 Priority Date

Water right priority dates determine who gets water during times of shortages. Water rights are based on a principle of first use. The date of first use becomes the priority of the water right. During times of water shortages, a water right is superior to subsequent appropriations but subordinate to all prior appropriations. The older or more senior water rights will receive their full quantity of water before junior water rights. The water demands of the oldest rights are met regardless of the needs of other users. If there is a surplus beyond the demands of the senior water right, the next oldest priority right can divert water. This process continues in chronological order until there is no surplus water.

3.2.1.3 Season of Use

A unique aspect of water is that use of the water does not necessarily preclude its use for other purposes (Gibbons 1986, Young and Gray 1972). Because water can be used for a variety of different uses at the same time or at a later time, it is necessary to specify the season of use for each right. Only a limited number of water rights in Oregon authorize year-round, continuous use. The use of agricultural water rights usually coincides with the irrigation season. The irrigation season in Oregon is generally March 1 to October 31 but can vary from region to region (OWRD 1994).

3.2.2 Price Variation Due to Transaction Characteristics

Seasonal fluctuation in water supply, the temporal variability in demand and supply, the participation of high-profile buyers and sellers, high transaction costs, regulatory controls, urban growth pressures and limited market information can all cause significant price dispersions within a regional market. The following section describes how these transaction characteristics can cause fluctuations in market price.

3.2.2.1 Temporal Variability of Water Demand

It is evident that the demand for water has changed over time. Fluctuations in user demand through time can greatly affect estimated water values and market prices (Duffield and Neher 1991, Gibbons 1986, Young 1986, Young and Gray 1972). For this reason, variations in user demands must be accounted for and recognized. These variations in demand can tend from very short time periods to long term. For example, demands for residential water exhibit daily peaks and lows, while other use demands, such as crop irrigation, vary seasonally. Demands such as instream flows can be influenced by seasonal and cyclical variations in precipitation, creating some correlation with supply rather than being independent of supply. The demand for agricultural water changes throughout the year. Agricultural water demand may be unresponsive to changes in water prices during the growing season because considerable financial investments have been committed to the production of crops. During the growing season there are substantial costs associated with reducing the amount of water used (Landry 1994). In an attempt to reduce uncertainty and maximize profits, the risk-averse producer may use more water than necessary (Kelly and Ayer 1982). Deficit irrigation can result in lower yields and can even result in total crop failures. The potential for economic loss is minimized by overwatering.

The demand for agricultural water should be much more responsive to price changes during the off-season. Agricultural producers have time to adjust investments, capital expenditures, and cropping practices for the coming growing season to compensate for changes in available water supplies.

3.2.2.2 Temporal Variability of Water Supplies

For most uses, a planning horizon of one year is necessary for agricultural production (Gibbons 1986, Young and Gray 1972). The level of production is determined by the anticipated availability of the needed resources. For this reason most transactions of water need to occur prior to the growing season. Producers purchase water based on expected need and anticipated climatic conditions. Changes in water availability directly affect the economic value and market price of water. For example, a region experiencing drought conditions will see available water supplies dwindle. As water becomes more scarce, the current value of water will rise as will market price. Conversely, if water supplies are greater than expected due to unseasonable rain storms, water is relatively more abundant and its market price declines.

The uncertainty of water supply may cause the anticipated and agreed-upon price to deviate from the realized value of water. Buyers may find themselves paying more than the water's marginal value because prices are based on future expectations of water availability. For example, the acquisition of agricultural water for instream flows usually occurs a year to nine months prior to the growing season because of planning requirements for both the buyer and seller (Purkey 1995). Obviously it is necessary to finalize a price at that time to complete the transaction. If water for the preceding year is unexpectedly abundant then natural stream flows may be more than adequate for instream use. At this time the agricultural water purchased to augment stream flows will have a low use value for instream flows. The use value for instream flows is likely to be less than the agreed upon price to finalize the transaction.

3.2.2.3 High-Profile Market Participants

There are a variety of buyers and sellers in regional water markets, all with different water needs, income levels, and market power. Participants with a strong market presence often influence water prices (Colby et. al. 1993). Dominant market participants such as cities, public utilities, and large corporation act as price setters, sending market signals to other buyers and sellers (Colby et. al. 1993).

The reservation price for water right transfers originating from agriculture is expected to reflect the water's marginal value product. The final negotiated sale price should fall close to agriculture's reservation price. When water is being transferred from agriculture to municipalities or large corporations, the final negotiated sale price often differs greatly in excess of the agricultural producer's reservation price (Person and Michelsen 1994, Colby et. al. 1994, Gardner and Miller 1983). The cost of water is a small portion of the overall operating budget for most municipalities and large corporations. Agricultural producers may recognize this and add a speculative value to their reservation price.

The number of market participants can also influence price. A limited number of transactions causes a thin market which fails to establish an observable market price. If participants do not have full knowledge of previous transactions, trading may occur at prices that are not reflective of a competitive market. The negotiated price will depend on the relative bargaining power of each market participant. Inequities in bargaining power may arise from asymmetric information (Michelsen 1994). Not all market information is equally available to all market participants. Previous market experience, professional assistance, and market research are common ways that participants can acquire market information (Khoshakhlagh et. al. 1977). By acquiring information about the market, participants are able to increase their bargaining power. This allows excess profits to accrue to market participants with better information relative to their trading partner.

3.2.2.4 Transaction Costs

Market transfers occur when economic gains can be made by reallocating water to alternative uses. Transaction costs effectively reduce the price received by sellers and/or increase the price paid by buyers, thus eroding the potential for economic gains (Colby 1990. Transactions costs as they relate to Oregon's water markets generally include: (1) costs of identifying trading partners (2) costs associated with verifying the ownership and physical description of the water right (3) administrative costs associated with OWRD's transfer application procedures and (4) costs that might arise from a protest hearing or litigation associated with the proposed transfer.

First, much time, effort, and a considerable amount of financial resources can be committed in an attempt to locate potential trading partners. To minimize these costs, individuals seeking trading partners can employ an intermediary who typically brings trading partners together. These intermediaries can also assist in the transfer application process in addition to providing advice on the terms of the purchase agreement. Attendant costs may be in the form of a consulting fee assessed on an hourly basis or as a percentage of the final sale price. These fees are comparable to those that real estate brokers charge for similar sale values and usually range between 6 to 10 percent of the total transaction value (Heilig 1994, Moon 1994, Brajer et. al. 1989).

Second, purchasers will usually require verification of ownership before agreeing to the terms of trade. Purchase agreements often require documentation indicating that there is indeed an appurtenant water right which has not been severed from the land through abandonment or transfer. The process of verification establishes that all of the water claimed to be for sale is available and transferable (Brajer et. al. 1989). This is a practice that is commonly required by municipalities when purchasing water rights. The outcome of the verification will have obvious affects on the purchase agreement (Brajer et. al. 1989). A title search can cost over $1,000, but typically the cost is about $300 and is usually borne by the seller (Heilig 1994, Moon 1994).

Third, water right trades involve a change in character of the water right. The character of a water right include such things as specification of place of use, type of use, point of diversion, and point of appropriation. An application requesting a change of the character of a water right must be filed with the Water Resources Department. In reviewing the application, the Department can require the submission of a survey map covering the land to which the water right is appurtenant. Depending on the size, shape and location of the parcel of land, application and mapping fees can cost as much as $1000 (Heilig 1994, Moon 1994).

Finally, water transactions usually involve an attorney whose role may include any combination of the following: title search, examining OWRD files, resolving possible disagreements and conflicts among trading partners, drafting purchasing agreements, and monitoring the application through the OWRD's transfer process. The cost of an attorney's services vary considerably with each application (Heilig, 1994). Brajer et al. noted that fees for a relatively simple water rights transfer can range from $3,000 to $4,000, and can reach as high as $6,000 for a more complicated transfer. Heilig and Moon, local attorneys who specialize in water law, concurred that these are reasonable estimates for transfers in the state of Oregon.

3.2.2.5 Regulatory Controls

Regulatory controls on new appropriations are used to protect existing water users and important natural resources. Oregon has closed several streams and groundwater aquifers to new appropriations. New users in closed areas may obtain water rights only by acquiring them from existing right holders. Legal restrictions can have significant affects on the market price of water rights (Colby et. al. 1993, Colby et. al 1987).

The state has adopted basin programs for most of the state's 18 major river basins. The basin programs classify areas with limited water supplies and restrict new appropriations within these areas. Restricted areas only effect new uses and can not modify, withdraw, or alter existing water rights. For surface waters, regulatory controls are implemented on a stream-by-stream basis. The determination of whether a stream is overappropriated and in need of regulatory controls depends on how frequently water supplies are unable to satisfy existing and proposed needs (Oregon Water Resources Commission 1992). For groundwater aquifers, regulatory controls are determined by the average annual recharge rate of the entire aquifer. New uses are restricted if the groundwater use by all existing water rights exceeds the average annual recharge rate. To date the state has imposed regulatory controls on seventeen groundwater aquifers (OWRD 1994).

3.2.2.6 Urban Growth Pressures

The proximity of water rights to urban centers can affect market prices. As Oregon's population continues to grow, many people are seeking quiet and open spaces by moving to the countryside. Many agricultural lands are being converted to ten and twenty-acre country home estates. The purchasers of these estates are generally not concerned with profits derived from production of the land as much as they are with maintaining a lifestyle. Their incomes are not dependent on the production of the land and are usually earned through off-farm employment. Water rights for these lands are often no longer needed for production and are commonly used for recreational purposes such as irrigated pasture for exotic livestock and for fish pond maintenance. The value of the water is no longer determined by its production value but by the amenity value it provides.

Rapid growth in the area surrounding Reno, Nevada, for example, has caused the conversion of many agricultural lands. The prices of water rights in the area has almost quadrupled in value, from less than $750 per acre-foot to more than $2,500 per acre-foot (National Research Council 1993), while in other parts of the state, water prices are more reflective of agricultural production values (Water Strategist 1993).

3.2.2.7 Market Information

The efficiency of markets and the existence of a single unit price hinges on the assumption that market participants have full access to market information (Michelsen, Person, and Young 1994). This condition is rarely fulfilled for most water markets. Buyers and sellers are faced with the problem of locating a potential trading partner. Market participants need information regarding potential buyers and sellers, the number of water rights for sale, and the current and past market price of water rights. In certain cases, additional information may be necessary for the completion of a transfer. It may be necessary to obtain information on hydrological conditions in a given location if there is potential for third party impairments. These impairments have the potential to precipitate protests resulting in lengthy and expensive litigation. An understanding of the hydrological and legal conditions of an area would help purchasers avoid transfers that could result in protest.

Buyers and sellers can expect to incur substantial search costs in any attempt to gain information about the state's gray water market. These costs can include identifying potential trading partners, identifying water right characteristics, estimating market value, and negotiating a final sale or lease price. Buyers and sellers may choose to avoid all or some of the costs, but in doing so they sacrifice information and incur risk of wealth losses. Without adequate equal information, a buyer could find itself paying more than "fair market price" for water.

3.3 SUMMARY

A regional market model and a transfer market model were developed to examine how active, well-developed water markets establish price. Both models assume that the interaction of supply and demand is able to establish a single price that is known to all market participants. However, most water markets throughout the West have not established a single market price. Water right heterogeneity and differences in transaction characteristics can cause significant price variation within a market. Water rights have multiple attributes that may affect market price. These include the location of sale, the season in which the sale took place, the type of buyer and seller involved in the sale, the availability of market information, and the amount of transaction costs associated with the sale. Each of these characteristics are discussed as they relate to Oregon's water market. The recognition that water right attributes and transaction characteristic are determinants of water right prices is necessary for the development of the hedonic price model in Chapter Four.

CHAPTER FOUR:
METHODOLOGY: AN ECONOMETRIC MODEL

4.0 INTRODUCTION

The purpose of this chapter is to identify the potential water right price determinants and develop an econometric model that is able to explain price dispersion in Oregon's water rights market. The general model is selected from the hedonic price literature for differentiated market goods and adapted to the specific considerations of the state's water rights market. The specific model integrates the differentiated characteristics of water rights and the theoretical elements of market inefficiencies that were developed in Chapter Three.

4.1 THE CONCEPTUAL FRAMEWORK

In Chapter Three, the market for water rights is characterized by the interaction of supply and demand. When demand and supply are considered simultaneously, price becomes endogenous to the market system. Simultaneous supply and demand equation models are generally used to estimate price for markets characterized as such. These models assume that the commodity traded in the market is homogenous. The model developed in this study does not use the conventional supply and demand approach due to the heterogeneity of water rights.

Alternatively, a hedonic price model is developed based on Rosen's (1974) early work. Hedonic price models use the relationship between prices and characteristics of a good to explain dispersion in market prices. The model also considers the interaction between consumers of the heterogeneous good and the suppliers of that good. It is the combination of the characteristics of the good that determine what a consumer, or buyer, is willing to pay and the minimum price a seller must receive for the good. The hedonic price model untangles the implicit prices of each characteristic from the observed sale price of the good. The model assumes that there is a continuous range of choices among the combination of characteristics. The model further assumes that the market is in equilibrium, and that buyers and sellers are matched such that supply equals demand.

Most applications of Rosen's model have been concerned with heterogeneous consumer goods, such as housing and auto markets. Heterogeneous factors of production, such as water rights, require special considerations when using the Rosen model. There has been some interesting but limited empirical analyses of heterogeneous factors of production (Colby et. al. 1993, Crouter 1989, Chicoine 1981). However, most of these analyses were conducted without a formal explanation of the model tested. Palmquist (1989) developed a formal analytical model for heterogeneous factors of production, specifically agricultural lands. The following sections draws heavily on Palmquist's model.

4.1.1 Hedonic Price Function

The hedonic price model can be expressed as an equation describing the price of a heterogeneous good as a function of characteristics or attributes of the good:

$$P = f(W_i) \qquad [1]$$

where

P is the observed market price of the good

W_i is a vector of i characteristics of the good

The function does not need to be linear. Linearity will occur only when attributes can be sold independently of one another (Freeman 1993). Individual demanders are unable to influence the equilibrium price, although the price a demander pays will depend on the characteristics of the particular good. Similarly, a supplier of the good is unable to influence the equilibrium price but is able to change the price received for the good if certain characteristics can be altered. The hedonic price function is determined by the interaction of all demanders and suppliers of the good.

4.1.2 Bid Function

On the demand side are producers requiring the heterogeneous good as an input in a production process. A multiple-output, multiple-input production function can be written implicitly as:

$$X = X(F,\ W,\ \alpha) \qquad [2]$$

where X represents a vector of outputs which is a function of F, a vector of variable factor inputs, W, a vector of characteristics of the heterogeneous good, and α, a vector of producer characteristics that influences production capability. Each producer selects output and input levels and characteristics of the heterogeneous good so as to maximize variable profits:

$$\max \Pi = p_x X(F, W, \alpha) - cF \qquad [3]$$

where Π are variable profits, p_x is a vector of output prices, and c is a vector of input prices.

A producer's bid for the heterogeneous input, W, will depend on the characteristics of the good, the unit price of outputs, the cost of other variable inputs, the maximum attainable profit level, and the production skills of the producer. The bid function, θ, is defined as:

$$\theta(W, P, \Pi^*, \alpha) \qquad [4]$$

which shows the producer's willingness to pay for varying amounts of characteristics, W, holding all other characteristics constant and controlling for different output price levels, the optimal profit level, Π^*, and certain producer characteristics. In order to achieve the optimal profit level, the producer must choose a point on the hedonic price function that is tangent to the lowest point on the producer's bid function.

4.1.3 Offer Function

On the supply side are current owners of the heterogeneous good. The characteristics vector, W, is divided into two sub-vectors, w'=(w_k) and w"=(w_{k+1}, . . . , w_n), where the components of w' are fixed characteristics and the components of w'' are characteristics that the owner is able to alter. The owner maximizes profits from selling the good by altering characteristics in the sub-vector w'':

$$\begin{aligned} &\text{Max } \Pi w = f(W) - c(w', w'', r, \beta) \\ &\text{subject to} \qquad [5] \\ &\Pi w \geq 0 \end{aligned}$$

where Πw represents the sale profits of the current owner, $f(W)$is the price schedule from equation [1], $c(w', w'', r, \beta)$ is the cost function of selling the good where r is a vector of factor input prices, and β is a vector of owner characteristics which can influence final sale price. The owner's offer function is derived in a manner similar to the bid function.

The offer function, ϕ, shows the prices at which the owner makes the good available to the market:

$$\phi(w', w'', P, \Pi w, r, \beta) \qquad [6]$$

given optimal quantities of characteristics and profit while controlling for varying owner characteristics. The owner maximizes profits of the good by equating the marginal offer prices for characteristics that can be altered to the marginal characteristic prices in the market. The offer price is demand-determined for characteristics that can not be altered or changed. The offer price for fixed characteristics is equated to the market price, since at lower offer prices the landowner would forego profits, and for offer prices above the market price the offer would be rejected.

The hedonic price function is determined by the interaction of all buyers and sellers of the good; all buyers and sellers set their respective bid and offer functions equal to the hedonic price function:

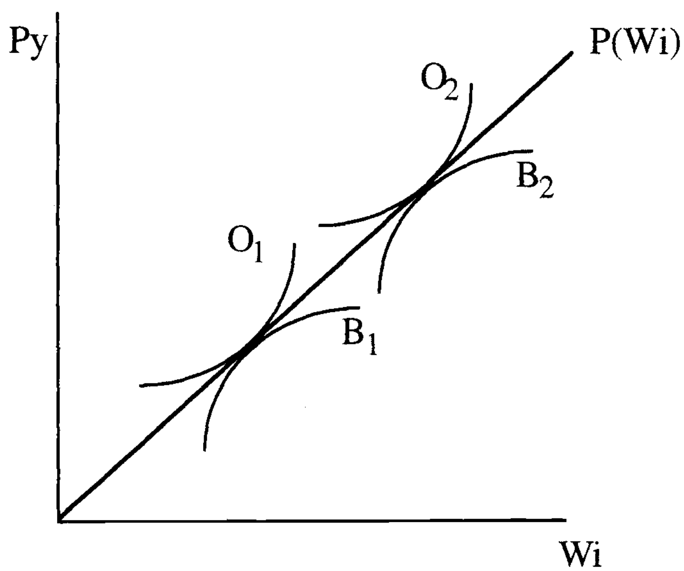
$$P = f(W_i) = \theta(W, P, \Pi^*, \alpha)$$

and [7]

$$P = f(W_i) = \phi(w', w'', P, \Pi w, r, \beta)$$

For the market to be in equilibrium, all bid and offer curves for the characteristics for each market participant must be tangent to the hedonic price function (Freeman 1993). Thus, the hedonic price function is a double envelope of the two groups of bid curves and offer curves (Rosen 1974). Figure 4-1 shows the equilibrium points between two buyers' bid curves (B_1 and B_2) and two sellers' offer curves (O_1 and O_2). As a double envelope, the hedonic price function is influenced by determinants on both the supply side and the demand side of the market.

Figure 4-1
Hedonic Price Function



4.1.4 Supply and Demand Functions for Characteristics

A two-stage econometric technique is commonly used to estimate the individual demand and supply functions for specific characteristics. The first stage estimates the appropriate hedonic price function by including only the relevant characteristics of the good. This stage estimates the double envelope of bid and offer functions and identifies a vector of implicit hedonic prices for the characteristics. However, the first stage does not identify the supply and demand functions underlying these implicit prices. The second stage purports to estimate the underlying supply and demand functions by using the implicit prices estimated in the first stage, socio-economic characteristics of both buyers and sellers, and parameter restrictions (Goodman 1989).[3]

The second stage estimations are subject to some theoretical and econometric problems (Freeman 1993, Goodman 1989). These problems come in two forms. The first stems from the fact that the dependent variable in the second stage is not directly observed; rather, the marginal implicit price of the characteristic from the estimated hedonic price function is used. This variable is computed as a function of the same characteristics that serve as explanatory variables in the second stage estimation. Since the second stage estimations do not utilize any additional information, it may do nothing more than reproduce the coefficient estimates obtained in the first stage. Brown and Rosen (1982) and Mendelson (1987) have shown second-stage estimations to reproduce identical coefficients to those estimated in the first stage. The second problem arises from the difficulty of separating out the effects of demand and supply shifters. Buyers and sellers must choose both a point on the hedonic price function and its associated quantity. The selection of that point simultaneously determines the marginal price and the quantity of the characteristic. The marginal prices for other characteristics are observed from other individuals with differing socio-economic characteristics. It is difficult to determine if different quantity levels are driven by demand and supply shifts or by the correlation between quantity and the socio-economic factors.

It is beyond the interest of this study to estimate demand and supply functions for individual characteristics. Rather it is the interest of the study to estimate the first stage coefficients to see how certain demand and supply determinants affect market price.

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[3]Generally, the hedonic price function is estimated in a non-linear form allowing the implicit prices of the characteristics to vary (Goodman 1989).

4.2 THE SPECIFIC HEDONIC PRICE MODEL

This study uses a hedonic price model to analyze the contribution of water rights characteristics to market price. In addition to water right characteristics, it is hypothesized that sale price is also a function of access to urban centers, transaction size, institutional factors, market dominance of certain participants, and market segmentation. The influences of both water right characteristics and specific sale conditions are applied in a hedonic price model to explain price dispersion in Oregon's water rights market.

4.2.1 The Dependent Variable

The dependent variable used for the analysis is the per-acre sale price of the water right. This is different than that used in most previous research, where the most common unit of measurement is price per acre-foot. Irrigation water rights as traded in Oregon, however, are spoken of in terms of acres (Chapter 3, section 3.2.1.1). Buyers and sellers refer to the commodity as "acres of water" indicating the quantity of land that can be irrigated with the water right. Prices used in the analysis are reported, nominal prices and have not been adjusted to current dollars.

4.2.2 Duty

The duty of a water right defines the maximum annual volume of water for an acre of irrigated land. In the model, DUTY measures the acre-feet per acre volume of water permitted by the water right. The variable is included to test the hypothesis that water rights with larger duties sell for a significantly higher unit price.

The duty used in the analysis represents the legal amount specified by the water right rather than the deliverable amount. In some situations the legal duty may be more water than the actual deliverable duty due to water supply limitations and conveyance losses. No reliable records are available to ascertain the deliverable duty of a water right, therefore, the legal duty was used in all cases.

4.2.3 Rate

The rate defines the instantaneous flow of water allowed by a water right. Rates are measured in terms of cubic feet per second. The variable RATE is included in the model to test the hypothesis that water rights with larger flow rates will command a higher unit price.

4.2.4 Priority Date

The priority date of a water right determines the reliability of delivery of water. This depends on the total water supply from a particular source, the number of appropriators along the source, and the chronological ranking of the water right relative to other rights on the source. The variable SENIORITY is included in the model to test that water rights with earlier priority dates relative to other rights on a water source sell for a higher unit price. The variable is a zero-one dummy variable and assumes a value of one for water rights that are determined to be senior water rights and a value of zero for junior rights.

The actual priority date of the water right was not used to measure seniority. Using the actual priority date of the water right assumes that water development and seniority is continuous with time throughout all parts of the state. In fact water development was sporadic across Oregon. Arid areas such as the eastern part of the state were first to develop water rights. Most of the water in this region has been fully appropriated since the early 1940's. Areas where rainfall is more abundant, such as the western part of Oregon, have been slower to develop water rights. There are still some streams in the western part of the state that have not been fully appropriated. The relative seniority of a water right must be determined on a stream-by-stream basis due to of the sporadic development of water rights through time.

Two criteria were used to determine the relative seniority. First, the relative chronological rank of a water rights needed to be determined. This was accomplished with the assistance of OWRD's Water Right Information System (Appendix G). The Water

Rights Information System provided a list of all water rights on water sources where sales had occurred. The water rights were listed according to priority date. The first one-third of the rights on the source were somewhat arbitrarily considered to be senior water rights. Second, watermasters for each basin where sales had occurred were contacted to verify the relative ranking of the water right that was sold.

4.2.5 Proximity To Urban Centers

The proximity to urban centers has been shown as an important determinant of water right prices (Michelsen 1994, Crouter 1987). The distances to urban centers has also been shown to be an important factor in both urban and agricultural land prices (Chicoine 1981, Boyce et. al. 1977). Water used for urban municipal uses has been estimated to have higher values than water used for agriculture (Young and Gray 1972); it is expected that water rights in close proximity of urban centers will be more reflective of municipal water values. The variable MILES is included in the model to test the hypothesis that water rights close to urban centers sell for a higher unit price than water rights in rural areas. The variable measures the distance to the nearest town that has a population greater than 5,000. Communities with a population of less than 5,000 offer less in terms of employment and service opportunities. The proximity of these communities is expected to have a relatively small effect on water right prices.

4.2.6 Parcel Size

The parcel size of a transaction is expected to influence price. The parcel size of a transaction is the number of acres that is being transfered. It has been shown that there are economies of scale in transfers of large blocks of water rights (Colby et. al. 1993). In the model, the variable *ln*(ACRES) measures the parcel size of the transfer in terms of acres. The logarithmic relationship is consistent with theories of economies of scale, which suggest a nonlinear relationship between the unit price and the parcel size (Colby et. al.

1993, Nicholson 1992). The variable is included in the model to test the hypothesis that large parcels of water rights sell for significantly lower unit prices than smaller parcels because of fixed costs associated with transfering water rights.

4.2.7 Agricultural Origins

The type of buyer and seller involved in a market transaction can influence the market price level because of different use values and market prominence (Person and Michelsen 1994, Colby et. al. 1993). The willingness-to-pay of a buyer or seller is determined by the associated use value of the water. Buyers and sellers with a high use value for water will have higher bid and offer prices. As indicated in Chapter Two, industrial, commercial, and municipal use values have been shown to be significantly greater than those for water used in agriculture. Further, large corporations and municipalities may be concerned about public perceptions and be willing to pay a slightly higher price to smaller, less powerful sellers (Colby et. al. 1993). The variable AGOUT is included in the model to test the hypothesis that prices in transactions where the water right originates from agriculture and is transferred to industrial, commercial, or municipal use will be higher than prices paid in transactions involving agriculture-to-agriculture transfers. The variable assumes a value of one for sales that involve industrial, commercial, or municipal buyers and a value of zero for all other sales.

4.2.8 Amenity Agricultural Water Sales

It is hypothesized that water sales that involve amenity agricultural water users will have a higher unit price than sales that involve commercial agricultural water users. The variable NONTRAD is included in the model to test this hypothesis. The variable assumes a value of one for sale that involve either a buyer or seller who is classified as an amenity agricultural water user, and a zero for commercial agricultural users.

Amenity agricultural water users meet all of the following criteria: 1) the water user claimed an occupation outside of agriculture, 2) the farm size of the water user was less than 20 acres, 3) the before-tax farm income for the water user was less than $10,000.

It is common to see commercial agricultural land along the urban-rural fringe being converted to small ranchettes to accommodate urban demands for land. These ranchettes are purchased for rural lifestyle reason rather than for use in commercial agriculture. The interaction of agricultural and urban land markets has resulted in substantial increase in agricultural land values (Plantiga et. al. 1990, Alig and Healy 1987, Chicoine 1981).

Water rights along the urban-rural fringe are also being converted to many amenity uses such as landscape irrigation, irrigated pasture for exotic livestock, and fish ponds. The water provides an amenity service to the water user. The value that the individual places on the water is not determined by its production value, but rather by the amenity value that the water provides. Estimated amenity values of water often exceed agricultural production values of water (Chapter Two). For this reason it is expected that individuals buying water rights for amenity uses will demonstrate a high willingness-to-pay. Further, it may also be quite costly to purchase water from individuals using water for amenity services. The interaction of agricultural and urban water markets may also be influencing water right prices.

4.2.9 Market Segmentation

Physical and institutional constraints can create separate and distinct water markets. Oregon has tight controls on water rights transported outside their basin of origin (ORS 537.801). In the last five years only one interbasin transfer application has been submited which was denied because of negative impacts on return flows (Nunn 1994). The limited number of interbasin transfer applications suggests that water markets are limited to within drainage basins. There may also be sub-markets within a basin due to additional institutional constraints, such as the existence of water management districts. Water management districts, have long been used in Oregon as a way to allocate water. There are approximately 215 different water management districts currently operating in the state (Nunn 1994, OWRD 1986). These management districts are generally the principle water right holder while providing water delivery services to district members. It is relatively easy for district members to trade water allocations with other district members. Some district offices help facilitate this trade by maintaining a list of potential buyers and sellers. A transfer of a district water allocation outside the district is theoretically possible, but very few have occurred. These transfers must not only seek the approval of the state but also the approval of a district management board.

Two different methods have been used in hedonic price models to account for constraints like these which may segment markets. The first method is to estimate separate hedonic price functions for the different geographic areas (Straszheim 1974). Two conditions must be met for different hedonic price functions to exist in a geographic area. First, there needs to be some barrier to mobility of buyers and sellers among market segments to prevent arbitrage (Freeman 1993). Second, there must be different demand or supply structures across market segments (Freeman 1993). Drainage basin boundaries and water management districts provide reasonable for barriers to mobility of buyers and sellers. Further, it is expected that regional variations in climatic conditions and water use practices will create differences in regional demand and supply structures. However, the limited number of observations in the data set prohibit the use of this method.

A second method to account for market segmentation is to use a zero-one dummy variable for distinctly separate geographic regions (Person and Michelsen 1994, Colby et. al. 1993). Ideally, a variable for each drainage basin would be included in the model to test for market segmentation. Again, this is not possible due to the limited number of observations. Rather, the variable EAST is included in the model to identify market segmentation between western and eastern Oregon. The Cascade mountain range provides a natural barrier between the west-side and east-side markets. The variable assumes a value of zero if the water right transaction occurs in a west-side market, and a value of one if the transaction occurs in an east-side market. It is expected that there are significant market differences between west-side and east-side markets due to variations in annual rainfall and the large number of high valued uses on the west side. The limited water supply in eastern Oregon, due to low annual rainfall, should create market scarcity and drive up market prices in this region. However, the large number of high valued uses of water in western Oregon may also cause regional market prices to increase. The direction of the relationship between water right prices in western and eastern regional markets is uncertain.

4.2.9 Date of Transaction

The real price of water rights has been shown to increase over time due to fixed water supplies and increasing water demands (Person and Michelsen 1994, Colby et. al. 1993). It is hypothesized that the real value of water rights in the state are appreciating in value over time. YEAR is a continuous time variable, recording the year in which the sale took place. The variable is included in the model to test for the annual appreciation of water.

4.3 SUMMARY

A hedonic price model is developed to explain price dispersion in Oregon's developing water market. The unit price of water rights is hypothesized to be a function of water right characteristics and market and institutional factors. The key characteristics and factors hypothesized to influence water right prices are summarized in Table 4-1, along with respective expected relationship with the unit price.

Table 4-1
Summary of Variables

Variable	Relationship[4]
DUTY	(+)
RATE	(+)
SENIORITY	(+)
MILES	(-)
ln(ACRES)	(-)
AGOUT	(+)
AMENITY	(+)
EAST	uncertain
YEAR	(+)

The unit price of water rights is expected to be positively related to rate and duty, relative seniority, transfer of water outside of agriculture, and amenity agricultural sales. The unit price is expected to be negatively related to distance to urban centers and transaction size. An econometric analysis will be based on the hedonic price model developed above. The results of the analysis are presented in subsequent chapters.

[4] Variable relationships with a sign of (+) are expected to have a positive relationship with the unit price of water rights. Variable relationships with a sign of (-) are expected to have a negative relationship with the unit price of water rights.

CHAPTER FIVE
SURVEY DESIGN AND DATA COLLECTION

5.0 INTRODUCTION

Applied water market research has been limited by the quality and quantity of available market information. The current research endeavor is no exception. Primary data were collected in order to carry out the objectives of the research project . A mail survey was used to obtain market data on water right sales. The survey design was modeled after the Total Design Method (Dillman 1978) to ensure the best quality and quantity of data for quantitative analysis. An analysis of nonresponse bias was also conducted. The survey response results and the results of the nonresponse bias test are presented in the following sections.

5.1 DATA COLLECTION

Water right sales in Oregon are not monitored by any regulatory agency. Therefore market data such as price and quantity has not been systematically recorded. There are two methods that have been used by researchers to collect water market data. The first method is to collect market data from a variety of secondary sources (Michelsen and Person 1994, Gardner and Miller 1983); for example, records of water management districts, newspaper adds, city water departments and water brokers could be used. The second method, and the one used here, is to collect market data by contacting both buyers and sellers through a mail survey (Khoshakhlagh et. al. 1977).

There are some advantages, in terms of both time and cost, in collecting market data from secondary sources. Irrigation district managers in Oregon were contacted to determine the availability of price information from district records. The managers indicated that the districts were not involved in water right sales and did not collect price or quantity data. However, two managers were aware of water right sales within their district and did offer "ball park prices" for these sales.[5] The lack of available information from secondary sources prompted the use of a mail survey to gather market data.

The first step in data collection was to identify potential market participants were identified for the survey from OWRD records. Although records are not kept on water right sales, the OWRD does monitor the movement of existing water rights through a legal transfer process. Individuals requesting a change of an existing water right must file a transfer application with OWRD. Changes in the place of use or type of use of a water right cannot occur without strict compliance with the statutory procedure pertaining to non-impairment (ORS §540.530). The application for a change of the right is reviewed by OWRD, and a decision of approval is determined based on compliance with the statutory requirements. Three main types of transfer are possible: 1) change in the point of diversion, 2) change in the place of use, and 3) change in the use of the water. A transfer application indicates some change in the terms of an existing water right and does not always imply the occurrence of a sale. Only a small percentage of transfer applications are the result of a sale. The sale of a water right requires, at a minimum, a change in the place of use of the water right. These transfers also require a change in the title of ownership of the right.

Records of all transfer applications from 1989 through 1994 were obtained from the Oregon Water Resources Department. Transfer applications that requested a change in the place of use and also changed the title of the water right were reviewed to determine if the application was prompted by the sale of a water right. A total of 140 water right transfers were considered to be potential sales because they involved two or more individuals. A total of 268 individuals were identified as potential market participants in these 140 water right transfers.

[5] The "ball park prices" offered by the district managers later proved to be substantially less than prices recorded from the same districts through the mail survey.

5.2 SURVEY DESIGN

The mail survey design followed the Total Design Method (Dillman 1978). The response rate for surveys that follow the Total Design Method (TDM) have been shown to average 74 percent (Dillman 1978). To encourage responses, a financial incentive was used. Five dollar checks were issued to each survey recipient from an account administered by the Agricultural Research Foundation at Oregon State University. The checks were included in the initial mailing along with a cover letter (Appendix C) and a questionnaire (Appendix D).

The survey questionnaire was developed by the author, drawing upon previous questionnaires (Khoshakhlagh et. al. 1977, McCloud 1994, Stoff 1994) and the assistance of Larry Nunn, water rights transfer specialist at the Oregon Water Resources Department. The final questionnaire layout was completed with the assistance of Pamela Bodenroeder, a senior research assistant with the Survey Resource Center, Oregon State University. A pretest sample of 43 potential market participants was randomly selected to test the mail survey. The pretest response rate was 76 percent, with no indication of problems in completing the questionnaire.

Due to timing conflicts it was not possible to include the five dollar checks in the mailing for the pretest survey. The five dollar checks were mailed out after the completion of the pretest, including to those individuals who did not return the questionnaire. The checks were not mailed to encourage additional responses but done in fairness to the pretest sample members.

5.3 SURVEY MAILING AND FOLLOW-UP PROCEDURE

The survey packet consisted of a questionnaire, a personalized five dollar check, a pre-stamped self-addressed return envelope, and a cover letter signed by the project director, Dr. Joe B. Stevens, a professor of agricultural and resource economics at Oregon

State University. The survey packet was sent to all remaining potential market participants during the second week of July. Follow-up post cards (Appendix E) were mailed to everyone one week after the intial mailing. The post cards served as both a thank you to those who had already responded and as a reminder for those who had not yet responded. Three weeks after the initial mailing, a second letter (Appendix F) was sent to nonrespondents, along with a replacement questionnaire and a pre-stamped, self-addressed return envelope.

5.4 SURVEY RESPONSE

Including the pretest, 268 surveys were mailed. Twenty-four surveys were returned due to incorrect addresses. One hundred and sixty responses were received, providing information on 114 transfer applications. The total number of nonrespondents was 84, giving a survey response rate of 65.6 percent. Table 5-1 provides a summary of the above statistics.

5.4.1 Ineligible Responses

The completed questionnaires were separated into eligible and ineligible responses. An eligible response was one in which the respondent was involved in a water right transfer, and in which the ownership of the right was changed as a result of water transfer. These included sales, donations, and trades. Ineligible responses included those who returned the survey blank, those who denied participating in a water right transfer, and those who were involved in a transfer but retained ownership of the water right. A series of filter questions was used to identify these water right transfers. The first question established that the respondent had participated in a water right transfer. No negative responses to this question were expected since all names were obtained from the OWRD transfers file. Surprisingly, there were 43 respondents who denied participating in a water right transfer. The breakdown of ineligible responses is given in Table 5-2.

Table 5-1
Survey Response Rate

Total Surveys Mailed	268
Undeliverable Surveys	24
Responses	160
Eligible	65
Partial Responses	7
Donations	19
Sales	39
Ineligible Responses	95
Nonresponses	84
Survey Response Rate	65.6%

Table 5-2
Ineligible Responses Received

Deceased	2
Returned Blank Survey	13
Returned Cover Letter with a Note	4
Denied Participating in a Water Transfer	43
Transfer Took Place Under Same Ownership	33
TOTAL INELIGIBLE RESPONSES	95

Three reasonable hypotheses can be given for the 43 responses that denied participation in a water right transfer. First, water rights are a politically sensitive topic and some ambiguity exists around the legal structure of water rights sales. This ambiguity has caused some water right holders to believe that the sale of water rights is a violation of Oregon water law. Some respondent may have participated in a sale but attempted to conceal this fact by responding negatively to the first question. This hypothesis is supported by telephone conversations with other respondents. Also, three ineligible responses were received with attached notes stating that it is illegal to sell water rights in Oregon. Contrary to this belief, Oregon water law does not prohibit the sale of water rights (Clark 1983). It does, however, constrain the value for which the water right can be sold (ORS § 537.280). ORS § 537.280 states that "...in any proceeding for the acquision of rights to the use of water ... under the laws of Oregon, no value shall be recognized or allowed for such righs in excess of actual cost to the owner of perfecting them..." The statute was enacted in an attempt to discourage speculation in water rights (Kraynick et. al. 1983). There have been no recorded cases of enforcement of this statute.

A second explanation for the denials was that the cover letter sent with the questionnaire discussed the potential of water markets. The cover letter may have caused some confusion by mentioning water markets. People have different concepts of water markets. Some respondents may not have perceived their actions as representative of a water market. This hypothesis is precipitated by comments made on three questionnaires with a "no" answer to the first question . From these comments two donations and one sale were identified. Clearly the respondents had misinterpreted the intent of the survey.

Finally, transfer records were reviewed as far back as January, 1989. Some respondents may have simple forgotten they had participated in a water right transfer. It is expected that there would be a larger number of "no" responses for older transfers if these responses are motivated by ability to recall participation in a transfer. The distribution of negative responses to the first questions does not indicate any significant time trend.

5.4.2 Eligible Responses

Of the 160 questionnaires returned, 65 were from eligible respondents. These respondents were those individuals who had participated in a water right transfer in which the ownership of the right changed. However, 7 of these questionnaires were only partially completed and lacked key information, leaving a final tally of 58 usable questionnaires. Usable questionnaires were those that indicate that the respondent was eligible, and that all key questions, such as sale price, were answered. Of the 58 usable questionnaires, 39 questionnaires contained information on water right sales and 19 questionnaires contained information on donations and trades of water rights.

5.5 NONRESPONSE BIAS

There were 84 nonresponses among the sample of 268 potential market participants. Because the intent of the survey was to identify water right transfers that were prompted by a water rights sale and to collect information on the sale, surveys were usually sent to two or more individuals involved in a transfer; increasing the likelihood of obtaining the necessary sale information even if some sale participants did not respond. Of the 140 potential market transfers surveyed, no questionnaires were received for 26 transfers.

Information on the size of the transfer was available for the 26 nonresponse transfers. This information had been collected during the initial transfer application review process. The mean and variance for the transfer size of the non-respondents is compared with that of the eligible respondents in Table 5-3.

Table 5-3
Transfer Size Mean and Variance Comparison
For Respondents and Non-respondents

	Mean	Variance
Non-Respondents (n=26)	23.438	1969.2
Eligible Respondents (n=58)	22.507	1699.0

Two tests were performed to determine if there was any differences between respondents and non-respondents. First, a variance ratio test was used to test whether or not the variances were the same across both groups. The calculated F-value was less than the critical value of $F_{(25, 57)}$. The null hypothesis that the variances are equal between the two groups can not be rejected.

A t-test was then used to determine if there was any difference between the mean values for respondents and nonrespondents. The calculated t-value did not fall in the rejection region at the .05 significance level. Therefore, the null hypothesis that the mean values were equal could not be rejected. Both tests indicated that there was no detectable nonresponse bias.

5.6 CONCLUSIONS

Water market research has been limited by the ability to collect sufficient data, both in terms of quantity and quality. Efforts to collect data for this research project also met with limited success. While the 68 percent response rate to the survey was comparable to rates of other surveys that followed the Total Design Method, the number of usable responses was limited. A total of 39 surveys were received that indicated a sale had occured and that also reported sale price and quantity. There were 84 nonresponses, resulting in 26 transfers for which no questionnaires were reieved. A means test and a variance ratio test between parcel size for respondents and nonrespondents was used to detect nonresponse bias. The two tests indicated that there was no detectable bias.

Efforts at data collection were of an exploratory nature; therefore, the results of the survey are not discouraging. Previous research has reviewed the water right transfer files in an attempt to identify water right sales (Kraynick et. al. 1983). However, no effort was made to collect information on these sales. This research went beyond the review process and attempted for the first time, to systematically collect information on Oregon's developing water market.

CHAPTER SIX: DESCRIPTIVE ANALYSIS OF THE OREGON WATER MARKET

6.0 INTRODUCTION

This chapter provides a descriptive analysis of Oregon water right prices and market activity. The analysis begins with an evaluation of the current level of market activity and is followed by the spatial distribution of water right sales as reported in the mail survey. Summary statistics, such as price and quantity, are also presented for the reported sales. Evidence is presented that suggests that two markets for water exist in Oregon. Demographic characteristics of market participants and market information are presented for each market.

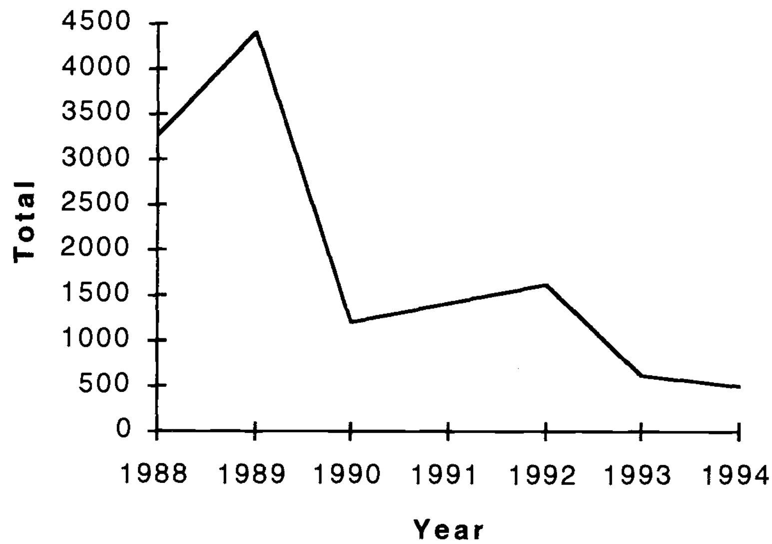
6.1 EVALUATION OF MARKET TRANSFERS

In Oregon, there are two means of obtaining a water right. One way is to request a new water right from OWRD for unappropriated water. It is becoming increasing difficult to acquire new water rights from OWRD due to declining supplies of unappropriated water. Figure 6-1 shows the number of new water rights issued during the years 1988 to 1994. The figure shows a declining trend in the number of new water rights being issued. One additional consideration for the declining number of new rights being issued is that these rights are generally very junior rights and rarely receive their full delivery of water.

An alternative approach to obtaining a water right is to acquire an existing right. There are approximately 80,000 existing water rights in Oregon, representing over 200,000 users (OWRD 1993). The majority of these water rights are classified as irrigation water rights. In recent years there has been an increasing number of water right transfers. Figure 6-2 shows the number of water right transfer applications filed during the years 1988 to

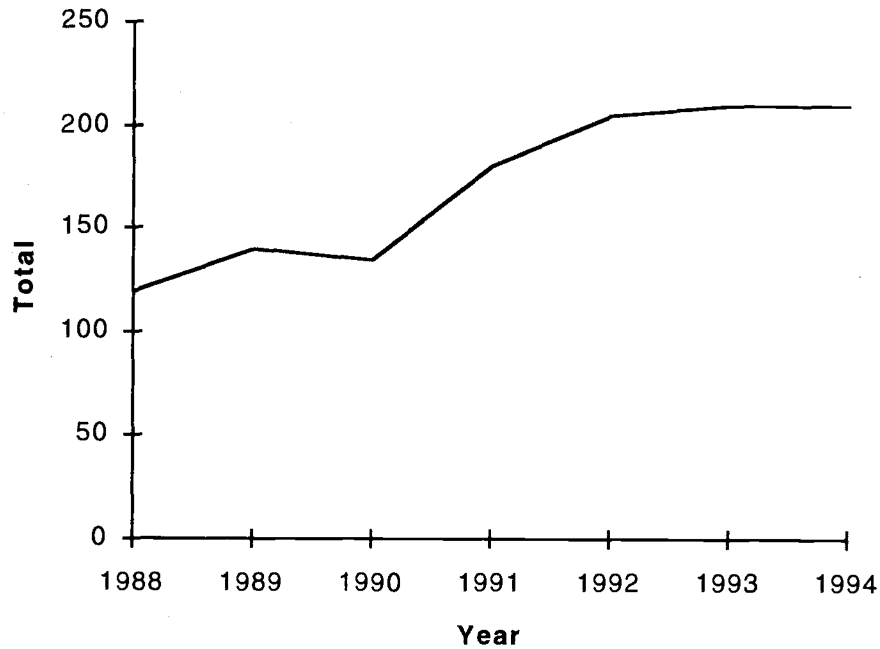
1994. As illustrated by Figure 6-2, the number of transfer application has been steadily increasing.

Figure 6-1
New Water Rights Issued



Due to recent legislation, Figure 6-2 under-represents the number of transfers that actually took place during this time period. In 1989, the Oregon Legislature passed House Bill 3111, the Irrigation District Water Mapping Act. The intent of the legislation was to correct and record the location of water rights within irrigation districts. As a result, districts were not required to file transfer applications with the Water Resources Department from July 1, 1989 to July 1, 1994. In effect, the legislation permitted districts to conduct "in-house" water right transfers; thus, the Water Resources Department transfer files are incomplete in that they do not account for all of the district transfers that occurred during this five year time period.

Figure 6-2
Water Right Transfer Applications



It is difficult to identify the exact number of water right sales that took place during 1989 to 1994. A water right transfer indicates a movement of an existing water right; it does not necessarily mean that a sale of a water right took place. In many transfers, applicants are attempting to consolidate several rights at one point of diversion or otherwise adjust water appurtenant to several lands that they own.

A review of the transfer applications over the period of 1989 to 1994 identified 140 potential water market transfers. A survey of these transfer applications identified 37 water right sales (see Chapter Five for a detailed discussion). Seventy percent of these sales took place within irrigation districts. Table 6-1 shows the irrigation districts where sales took place and the number of reported sales in each districts. As noted above, it is expected that the survey results do not full reflect the magnitude of market activity due to the House Bill 3111 and the frequency of sales in irrigation districts.

Table 6-1
Irrigation District Sales

Irrigation District	Reported Sales	Number of Members[6]
Central Oregon Irrigation District	12	3200
Swalley Irrigation District	4	2000
Tumalo Irrigation District	5	1500
Tualatin Valley Irrigation District	3	1300
Westland Irrigation District	5	654

The 37 water right sales reported in the mail survey occurred in ten counties throughout the state. Figure 6-3 shows the frequency of sales in counties where sales were reported. Twenty-seven sales were reported on the east side of the Cascade mountains. This area receives significantly less annual precipitation than the region west of the Cascade mountains. The large number of sales that occurred on the east side, relative to the west, may have been motivated by the scarcity of water in the region. Deschutes County had the largest number of water right sales. This can be explained in part by the number of irrigation districts in the county. The county has also experienced rapid growth in the past ten years, relative to other parts of the state. The population of Deschutes County increased 32 percent between 1980 and 1990, while the state population increased by 12 only percent during the same time period (Oregon Blue Book 1992).

There are eleven general classifications of water rights that characterize the allowed use of the water. Appendix G lists the classifications used by OWRD to characterize water rights. Irrigation water rights are the most common type of water right issued; they are also

[6] Source: Directory of Water Users' Organizations, OWRD 1987. These numbers were verified by contacting each district.

the dominant type traded in the market. Irrigation rights were traded in all reported water right sales. Since irrigation rights are the most commonly traded water right, the established market price is measured on price-per-acre basis. Oregon's unit price is uniquely different from other western water markets. The unit price used by most other water markets is price per acre-foot (Person and Michelsen 1994, Colby et. al. 1989). An acre-foot value can be calculated for Oregon water rights by a simple mathematical conversion using the duty associated with a water right.[7] Table 6-2 provides a summary of the reported sale prices and the quantity of water traded both in terms of acres and acre-feet. All prices are reported in nominal values. The acre-foot value allows for comparison with estimated water values reported in Chapter Two.

Table 6-2
Reported Sale Price And Quantity

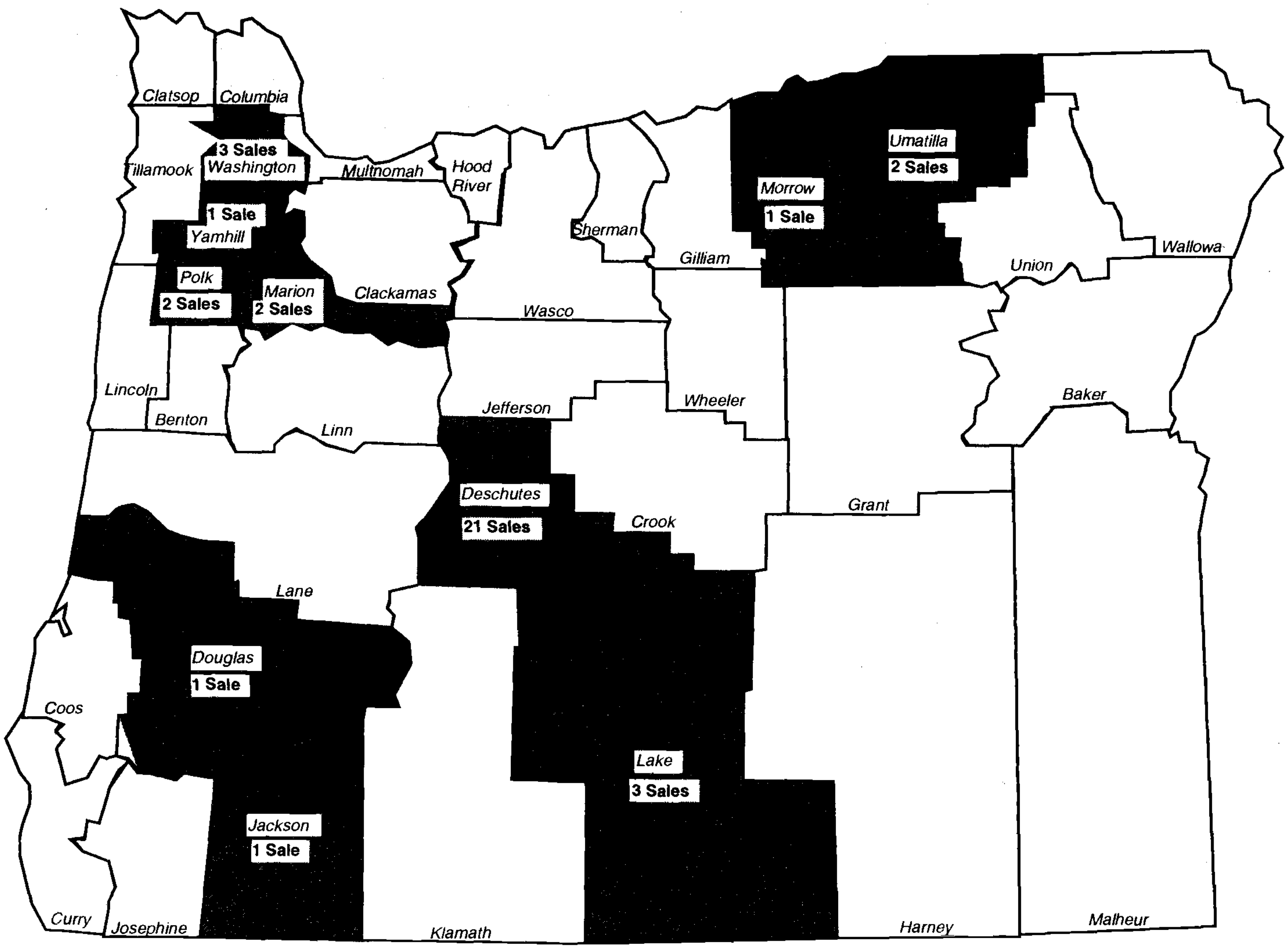
	ACRES	ACRE-FEET	PRICE/ACRE	PRICE PER ACRE-FOOT
Mean	27.841	97.745	971.01	348.37
Standard Dev.	48.710	195.350	746.59	412.49
Max	190.4	1039.6	2615.00	1388.89
Min	1	1.8	12.80	5.12

Reported sale prices exhibited a large degree of variability. Prices ranged from as much as $2615 per acre to as low as $12.80 per acre. Figure 6-3 gives a graphical representation of the reported prices over the time period for which the transfer files where surveyed (nominal prices). It illustrates the large degree of price dispersion that exists in Oregon's water market.

[7] The mathematical conversion is calculated by dividing the reported per acre price for a water right by the associated duty. The duty measures, in acre-feet, the annual accumulation of water on any acre of land covered by the right. For a more detailed explanation of duty, see Chapter Three.

$$\$ / \text{acre} - \text{foot} = \frac{\$ / \text{acre}}{\text{Duty}}$$

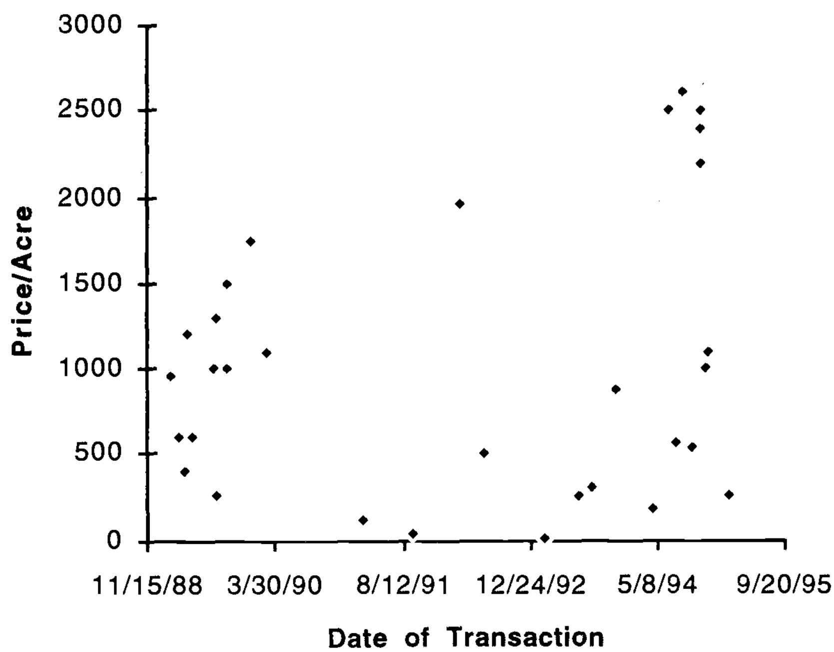
FIGURE 6-3
WATER RIGHT SALES BY COUNTY



Two sales reported prices of less than $100 per acre. Prices in this range may be representative of donation sales. To determine if these two sales were actually donation sales would have required recontacting the survey respondents; this would have violated the assurance of anonymity promised in the survey letter.

The mean values of reported sale prices were $971 per acre and $348 per acre-foot. Using an 8 percent discount rate, which currently approximates the long term cost of capital to agricultural producers, the annual lease value of the average sale price is $27.84 per acre-foot. This is comparable to values estimated for water used in agriculture production (Chapter Two). On average, market prices for water rights seem to reflect the agricultural use values of water.

Figure 6-4
Reported Prices



However, there is still a large degree of variation among the reported water right sale prices. Five sales reported prices greater than $2000 per acre. These prices may be representative of a fundamental change occurring in Oregon's water market. It is expected that prices in this range are reflecting use values other than agricultural uses. Nontraditional uses of water such as landscape irrigation and recreational ponds are not profit-motivated uses. The values that water users place on these uses of water are derived from individual preferences and household income. All five sales that reported prices greater than $2000 per acre are from agricultural areas that are currently experiencing a large degree of urbanization. The price differential may be explained by varying degrees of water right attributes and sale characteristics. Potential price determinants that may cause this variation in prices are examined in Chapter Seven.

6.2 TWO MARKETS FOR WATER RIGHTS

There is reasonable evidence to suggest that in Oregon, there are two different markets for water rights. The first is a commercial market for water rights; that includes commercial farmers, industries, and municipalities. Water rights are traded in the commercial market as a factor of production by participants who are attempting to maximize profits by using water as an input in a production process. The second market is a non-commercial or amenity market for water rights. Amenity market participants treat water as a consumptive good from which utility or satisfaction can be derived. The distinction between the two motivations is subtle; however, it may significantly influence market behavior exhibited by market participants. Sections 6.2.1 and 6.2.2 attempt to draw further distinctions between the two market types by presenting descriptive statistics of market participants.

6.2.1 The Amenity Water Rights Market

Eighteen of the 37 reported sales involve market participants who can be characterized as amenity water users. Each of these participants reported 1) employment other than agriculture as their primary source of income, 2) a farm size of less than 20 acres, and 3) before-tax farm earnings of less than $10,000. The majority of these sales occurred along the urban fringe. The average distance, one way, from the point of sale to a town with a population greater than 5,000 was 7.31 miles.

Generally, amenity water users operate small farms that generate modest farm receipts. The average farm size was 15.83 acres with reported farm incomes less than $20,000, 82 percent reported earning less than $10,000. Most participants had limited experience with irrigation relative to commercial water users. On average amenity water users had 10.82 years of experience with crop irrigation.

The average price for amenity sales was $1059.52 per acre. The average size of water right parcel traded was 5.02 acres. The most common uses for these rights are irrigated hay and pasture production. Table 6-4 provides summary statistics for amenity water right sales.

Table 6-3
Amenity Water Right Sales

	ACRES	ACRE-FEET	PRICE/ACRE	PRICE PER ACRE-FOOT
Mean	5.02	24.36	1059.50	335.60
Standard Dev.	4.46	25.65	604.39	400.74
Max	20	109	2500	1388.89
Min	1	1.8	250	55.56

The evidence suggests that amenity water users are buying water rights as a consumer good and not as a factor of production. First, the average farm size is considerable less than that needed for commercial farming of hay and pasture (Oregon Farm Enterprise Budgets 1993). Second, 82 percent of amenity water users reported farm incomes of less than $10,000. Third, all amenity water users reported principal occupations other than farming.

6.2.2 Commercial Water Rights Market

Nineteen water sales involved market participants who can be characterized as commercial water users. Buyers in the commercial water rights market consisted of commercial farmers (9), industries (2), real estate developers (1), and municipalities (1). Sellers in the commercial water rights market consisted entirely of commercial farmers with the exception of one industrial seller.

There were nine occurrences of water right sales between commercial agricultural water users.[8] Commercial farming was indicated as the principal occupation for all participants in these nine sales. All but one person reported gross farm earnings of greater than $10,000; one-third reported farm incomes over $100,000. Hay production was the most common use for the water rights involved in these sales. The average farm size for commercial agricultural water users was 1159 acres, which is significantly larger than that of amenity users.[9] Commercial agricultural users also have more experience with crop irrigation than do the amenity water users.[10] On average, commercial agricultural water users had 24 years of experience with crop irrigation.

The average sale price paid by commercial water users was $887.16. This is slightly less than that of the amenity water users.[11] Commercial water users purchased significantly more water than that of amenity users.[12] The average size of water right parcels traded by commercial users was 49.463 acres. Table 6-5 provides summary statistics for commercial water right sales.

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[8] Six of these sales were reported by buyers and three were reported by sellers.

[9] The mean farm size between commercial agricultural water users and amenity water users is significantly different at the .005 significance level. The calculated value for the test statistic is 3.28.

[10] The mean number of years of irrigation experience between commercial agricultural water users and amenity water users is significantly different at the .005 significance level. The calculated value for the test statistic is 3.35.

[11] A t-test indicated that there was no statistical differences between the mean sale prices for commercial and amenity water users. The calculated value of the test statistic is .6968.

[12] The mean transfer size between commercial water users and amenity water users is significantly different at the .005 significance level. The calculated value of the test statistic is 23.345.

Table 6-4
Commercial Water Right Sales

	ACRES	ACRE-FEET	PRICE/ACRE	PRICE PER ACRE-FOOT
Mean	49.46	167.27	887.16	360.47
Standard Dev.	60.93	255.37	868.64	433.94
Max	190.4	1039.6	2615	1333.30
Min	3	6.12	12.80	5.12

6.3 SUMMARY

Oregon Water Resources Department has been receiving an increasing number of water right transfer applications in recent years. Many of these transfer applications are precipitated by water right sales. Assuming that water right transfer applications are an appropriate indicator of water market activity, it appears that market activity has been increasing in recent years. A number of water right sales may be in response to the declining number of new water rights issued by OWRD. Market transfer may be the only option for new water users to acquire reliable water rights. If the state's water demands continue to grow, it is expected that the transfer mechanism will become more widely used through market exchange of water rights to new uses.

It is evident that there is a commercial market and an amenity market for water rights in Oregon. Participants in each market have very different qualitative characteristics. Commercial market participants generally have occupations related the production use of the water right. They also have significantly more experience with crop irrigation. The amenity market is very active along the urban-rural fringe and its market participants have primary occupations unrelated to the use of the water. Much of their use of water is for amenity uses such as small scale hay production or irrigated pasture.

On average, the water right prices in the two markets were not significantly different. However, amenity market participants did exhibit a high willingness-to-pay for small water right parcels. There were four amenity sale prices that exceeded $2000 per acre, while there was only one commercial sale that reported a sale price of a similar magnitude. This may have implications for future water right prices in both the amenity and commercial markets. Differences between market prices for these two markets are investigated further in Chapter Seven.

CHAPTER SEVEN: ECONOMETRIC ANALYSIS OF OREGON WATER RIGHT PRICES

7.0 INTRODUCTION

The econometric analysis integrates the hedonic price model and Oregon water right sales data to identify water right price determinants. The primary objective of the analysis is to better understand the relationship between potential price determinants and Oregon water right prices. The specific hedonic price model and the initial regression results are presented. The initial model is tested for multicollinearity among explanatory variables. A reduced model is formulated based on the test results for multicollinearity. The reduced model is tested for heteroskedasticity and for differences in price determinants between commercial and amenity water market participants. The results of the reduced model, using White's correction for heteroskedasticity and the pooled set of commercial and amenity water sales, are presented and interpreted.

7.1 ESTIMATION OF THE HEDONIC PRICE MODEL

The hedonic price model presented in Chapter Four includes variables that are measures of the quality of the water right as well as different market conditions that are expected to influence water right prices. Data from 37 water rights sales collected through a mail survey are used for the model estimation. The per unit price of a water right is hypothesized to be a function of the characteristics of the water right and certain sale conditions. The model specification is as follows:

$$\mathbf{P}_i = f(\mathbf{DUTY}_i, \mathbf{RATE}_i, \mathbf{SENIOR}_i, \mathbf{MILES}_i, \ln(\mathbf{ACRES})_i, \mathbf{YEAR}_i, \mathbf{EAST}_i, \mathbf{AGOUT}_i, \mathbf{NONTRAD}_i)$$

Where:

i	= Is the i^{th} water right sale
f	is a linear functional form
$\mathbf{P}_i$	= The unit price of the water right ($/acre)
$\mathbf{DUTY}_i$	= The duty of the water right
$\mathbf{RATE}_i$	= The rate of the water right
$\mathbf{SENIOR}_i$	= A dummy variable measuring the seniority of the water right, relative to other rights on same water source.
$\mathbf{MILES}_i$	= The distance in miles, one way, to the nearest urban center with a population greater than 5,000
$ln(\mathbf{ACRES}_i)$	= The water right parcel size of the slae measured on a logarithmic scale
$\mathbf{YEAR}_i$	= The year the sale took place
$\mathbf{EAST}_i$	= A dummy variable for sales that took place on the east side of the Cascade mountains
$\mathbf{AGOUT}_i$	= A dummy variable for sales that involved non-agricultrual water users
$\mathbf{NONTRAD}_i$	= A dummy variable for sales that involved amenity agricultural water users

7.1.1 Initial Model Results

The econometric model is estimated using Ordinary Least Squares (OLS) procedures. The regression analysis was conducted using SHAZAM (White 1993), a statistical and econometric analysis software. The results of the initial model estimation are presented in Table 7-1.

Table 7-1
Initial Regression Results on Price Per Acre

Variable Name	Estimated Coefficient	Standard Error	T-Ratio
DUTY	-770.35	285.8	-2.695
RATE	0.1537+06	0.9299E+05	1.652
SENIOR	343.33	347.2	.9889
MILES	1.3915	7.763	.1792
ln(ACRES)	-105.29	105.10	-1.002
YEAR	41.28	63.49	.6501
EAST	189.43	350.50	.5095
AGOUT	343.69	350.50	.9807
NONTRAD	268.64	373.8	.7188
CONSTANT	651.09	819.6	.7822

R^2 = .5334 Adj. R^2 = .3778 n = 37 F-statistic= 3.429

The R^2 squared of .53 is reasonable for cross-sectional data (Colby et. al. 1993, Griffiths et. al. 1993) and indicates that some price variation is unexplained by the model. A joint significance test of the independent variables indicates overall significance of the regression. However, individual t-tests on the independent variables concluded that DUTY is the only significant explanatory variable. One factor that could result in low t-statistics is the presence of multicollinearity between independent variables. Multicollinearity increases the variance of the OLS estimates and results in low t-values. The correlation coefficient matrix and auxiliary regressions were used to test for multicollinearity (Griffiths et. al. 1993); and multicollinearity was detected (Appendix H). Based on these results the following variables were dropped from further consideration: RATE, MILES, AGOUT, NONTRAD. Appendix provideds a discussion as to why these variables were dropped from further consideration.

7.1.2 Reduced Model Results

A reduced model was formed using the variables DUTY, SENIOR, ln(ACRES), YEAR, and EAST. The results of the reduced model are presented in Table 7-2.

Table 7-2
Reduced Model Regression Results on Price Per Acre

Variable Name	Estimated Coefficient	Standard Error	T-Ratio
DUTY	-294.27	98.52	-2.987
SENIOR	656.25	304.0	2.159
ln(ACRES)	1.41.12	92.47	-1.526
YEAR	30.508	56.96	.5356
EAST	371.86	269.1	1.382
CONSTANT	1528.5	458.7	3.332

$R^2 = .4596$ Adj. $R^2 = .3724$ n = 37 F statistic=5.273

The correlation matrix for the reduced model did not indicate a strong linear relationship among any two variables. Further, the results from auxiliary regressions did not indicate any collinearity relationships between three or more variables. These results provided reasonable evidence that the multicollinearity problem had been adequately corrected.

The wide range of prices observed in the cross-sectional data provided reasonable concern about heteroskedasticity. The primary consequence of heteroskedasticity for OLS estimators is that the variance is no longer the smallest among the class of linear estimators, which results in unreliable hypothesis testing of coefficients (Griffiths et. al. 1993). A Breusch-Pagan test for heteroskedasticity indicated the presence of heteroskedasticity in the reduced model (Appendix I). White's heteroskedasticity-consistent covariance matrix estimation was used to correct the variance-covariance matrix for an unknown form of heteroskedasticity. White's correction permits the use of the ordinary least squares procedure for estimating coefficients. White's correction does not affect the coefficient estimates but it does improve the estimates of the standard error and t-ratios for the independent variables.

Table 7-3
Reduced Model Regression Results on Price Per Acre Using Heteroskedasticity-Consistent Covariance Matrix

Variable Name	Estimated Coefficient	Standard Error	T-Ratio
DUTY	-294.27	104.1	-2.828
SENIOR	656.25	328.3	1.99
ln(ACRES)	-141.12	83.75	-1.685
YEAR	30.508	60.32	.5058
EAST	371.86	305.1	1.219
CONSTANT	1528.5	464.9	3.288

R^2 = .4596 Adj. R^2 = .3724 n = 37 F statistic= 5.273

In addition, the model was tested for differences in price determinants between commercial and amenity market participants. The procedures and results of the qualitative test are presented in Appendix J. No significant behavioral differences are detected between these two markets. The test indicated that commercial and amenity water right sales can be pooled and treated as identical for estimation of the reduced model. The estimation of separate hedonic price functions for each of these two market participants would have been necessary had behavioral differences been detected. The results of the restricted model using the pooled data set and White's correction for heteroskedasticity are presented in Table 7-3.

7.2 DISCUSSION OF REDUCED MODEL RESULTS

The reduced model as estimated using the pooled set of commercial and amenity water right sales is displayed in Table 7-3. The R^2 of 0.4596 indicates that slightly less than half of the price dispersion in the market is explained by the five-variable hedonic price model. An R^2 of the magnitude is common for hedonic price models using data drawn from a large cross-section (Colby et. al. 1993, Chicoine 1981) The F statistic is 5.273, indicating an overall significance of the regression. With the exception of one variable, all the explanatory variables have the expected signs for their coefficients. The following sections discuss the model results.

7.2.1 The Duty of a Water Right

The explanatory variable DUTY has a significant coefficient of -294.27. This indicates that the unit price of a water right decreases by $294.27 as the duty of the right is increased by one acre-foot. This result is unexpected given that DUTY is considered to be a desirable attribute of a water right. Hedonic price theory states that desirable attributes of the composite commodity will be positively related to the commodity price (Freeman 1993). Two explanations have been developed to explain the inconsistent result for the estimated DUTY coefficient. One is that a small set of observations may have had an influence on the results. There are four observations, all within the Tumalo Irrigation District, that have sale prices ranging from $2000 per acre to $2500 per acre. The duty associated with each of these sales is 1.8 acre-feet per acre, which is small relative to other duties in the data set. The average duty for the data set was 3.76 acre-feet per acre. Due to the limited size of the data set, these observations may be causing the inconsistent estimate on the DUTY coefficient. A dummy variable was included in the hedonic price model to test for any influences these observations might have on the regression results (results not shown). The variable assumed a value of one for sales that took place in Tumalo Irrigation District and a zero for all other sales. As expected, the Tumalo dummy variable was positive and highly significant. The sign on DUTY remained negative but its coefficient estimate was no longer significant at the standard confidence levels. The introduction of the Tumalo dummy variable reintroduced multicollinearity problems among several of the variables severe enough to warrant dropping it from the model specification. The result of the Tumalo dummy variable model specification did indicate that these four observations influenced the DUTY coefficient. The fact that the DUTY coefficient remained negative for the revised model specification suggests that other factors, not incorporated in the model specification, are also influencing the coefficient.

A second explanation for the inconsistent estimate on DUTY is market segmentation. The data set draws from many regions throughout the state, but several different markets may exist within each of these regions. Within a given market, sales are more homogenous in terms of water right and transaction characteristics than they are at the state wide level. Deschutes County provides an excellent example of differing markets within a given region. There are 5 different irrigation districts in Deschutes County.[13] Each district potentially defines a distinct market region because water district laws and policies make the sale of district water allocations to non-district members very difficult.

Twenty-one sales were reported from Deschutes County. All of these occurred in three different irrigation districts; all were internal district transfers. Twelve sales occurred in Central Oregon Irrigation District (COID), 4 in Swalley Irrigation District (SID), and 5 in Tumalo Irrigation District (TID). Each of these districts have different water right duties.

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[13] The five are Arnold Irrigation District, Central Oregon Irrigation District, Squaw Creek Irrigation District, Swalley Irrigation District, and Tumalo Irrigation District (OWRD 1994)

The duty for COID is 5.45 acre-feet per ace, the duty for SID is 5.46 acre-feet per acre, and the duty for TID is 1.8 acre-feet per acre.[14] Interestingly, TID water rights sell for two to three times that of COID or SID despite the fact that the district's duty is a third of the other two districts. Table 7-4 provides a summary of the range of observed prices and the duty for each district.

Table 7-4
Deschutes County Water Right Sales

Irrigation District	Observed Sale Prices			Duty
	Mean[15]	Low	High	
COID (n = 12)	$929 / acre	$400 / acre	$1500 / acre	5.45 acre-feet / acre
Swalley I.D. (n = 4)	$490 / acre	$256 / acre	$600 / acre	5.46 acre-feet/ acre
Tumalo I.D. (n = 5)	$2120 / acre	$1000 / acre	$2500 / acre	1.8 acre-feet/ acre

The price difference across each of these districts may be due to different supply and demand conditions that persist within each district. The demand for water may increase as more people move into a district. Currently, each of these districts are experiencing some degree of urbanization (Brown 1994, Nunn 1994). One explanation for the high prices in TID is that real estate within the district offers a distinct view of the Cascade mountains. Real estate values have been strongly influenced by this amenity feature of the district (Main 1995, Brown 1994). The amenity feature may be having the same influence on the district's water right prices.

Separate hedonic price functions should be estimated for each market if there are barriers to trade across regions and if different supply and demand conditions exist in each region. . Estimating separate hedonic price functions for each market within the state is not possible at this time for two reasons. First, the limited number of transactions that have occurred throughout the state make it difficult to identify distinct market regions; second,

[14] These are legal duties as specified by court decrees, the actual deliverable duty may be less than the legal duty.

[15] A t-test for differences in mean values showed that mean price for COID and Swalley water rights is

the lack of market data prevents estimation of separate price functions. In this study, market regions within the state are aggregated by treating Oregon as two market regions (eastern and western Oregon). It is likely that the inconsistent sign on the DUTY coefficient is a result of market aggregation. It is not possible to identify influences of these market differences without having significantly more data.

7.2.2 Seniority of a Water Right

Model results indicated that senior water rights command a premium of $656.25 per acre relative to junior rights. This result is both consistent with both hedonic price theory and a priori expectations. The acre-foot value for a senior water right can be calculated by dividing the per-acre price premium ($656.25) by the associated duty. For example, the acre-foot premium paid for senior a water right with a duty of 2.5 acre-feet per acre is $262.50 and is $187.50 for water rights with a duty of 3.5 acre-feet per acre. These values are similar in magnitude to results of other water pricing studies. Colby et. al. (1993) showed that senior water rights in Gila-San Francisco Basin, New Mexico sold for $370 per acre-foot more than junior water rights.

7.2.3 Parcel Size of the Transaction

The coefficient on *ln*(ACRES) is -141.12, indicating that as the parcel size of a water right sale increases, the per acre price decreases. This coefficient requires a slightly different interpretation becacuse of the logarithmic specification of the variable ACRES. For example, with all other factors being equal, the per-acre price for a sale involving 10 acres of water rights will be $324 less than a sale involving 1 acre of water rights. The per-acre price for sale involving 50 acres of water rights will be $552 less than a sale involving 1 acre of water rights. The difference in the per-acre sale price between the sale of 50 acres and the sale of 10 acres will be $232. The negative sign on the coefficienct suggests that

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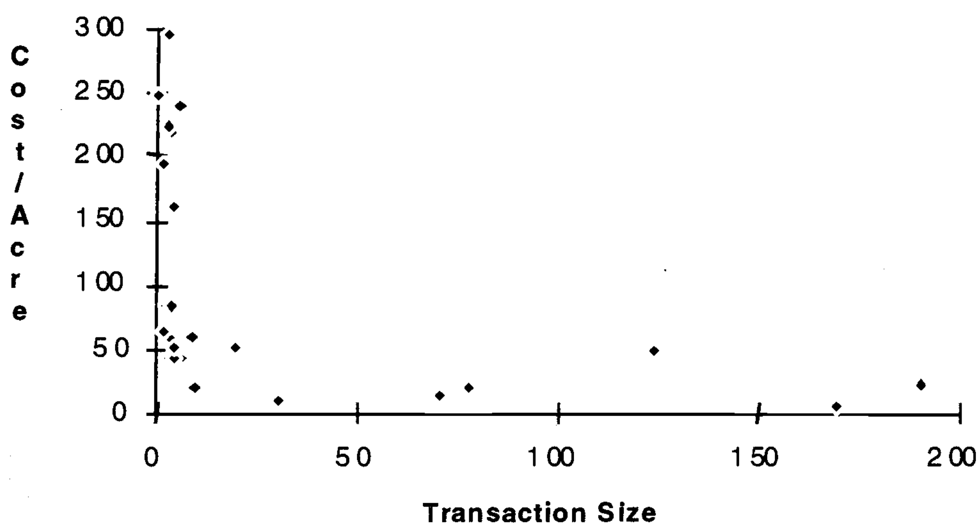
significantly different than the mean price for Tumalo water rights.

economies of scale exist for transferring water right parcels in Oregon. Transaction costs are the most likely cause of these economies of scale. Transactions costs are defined as the legal, administrative and mapping expenses incurred in the water right transfer. The transaction costs for transferring water rights do not vary with the number of acres being transferred. Therefore, the per-acre cost of transferring water rights decreases for transfers that involve larger parcels. Figure 7-1 verifies that this is the case for transactions described in the survey data set.

Figure 7-1
Transactions Cost



One additional explanation for the negative sign on *ln*(ACRES) is a limited demand for large water right parcels. The demanded parcel size may be directly related to farm size. Only nine commercial agricultural sales were reported. These water users have much larger farms and generally require larger water right parcels. Recall that for commercial agricultural water users, the average farm size was 1,159 acres and the average transfer size was 49.46 acres. Eighteen amenity water rights sales are reported; the average farm size was 15.83 acres and the average water right parcel size traded was 5.02 acres for amenity water users. While the demand for amenity water rights may be quite high, the parcel size may be limited. It may be the case that a proportional value-size relationship will exist if the size of parcels sold coincides with a size well-suited for a particular use. Further research is necessary to determine if this relationship between the unit price and the water right parcel size is a result of limited demand.

7.2.4 Time Trend in Water Right Prices

The time trend in water right prices is measured by YEAR, the year in which the transfer took place. The estimated coefficient is 30.51, indicating that the price of water rights has risen an average of $30.51 an acre per year between 1989 and 1994. It is difficult to determine if this trend is accurate since the coefficient is not significant at the standard confidence levels. The time trend was modeled as having a linear influence on water right prices through the continuous time variable YEAR. Despite the low significance level on the coefficient estimate it is still expected that economic development in the state has caused water right prices to increase during the 1989 to 1994 period. Sale prices reported from COID, which appears to be the state's most active water market, were $600 an acre in 1989, while more recent prices have been reported at $800 an acre. While prices may have increased over the study period, increases may have occurred in a more sporadic fashion rather than in a consistent linear trend as suggested by the variable YEAR. Despite the coefficient's low significance level, its magnitude is consistent with estimated price time trends from other markets. Colby et. al. (1993) estimated that water right prices in the Gila-San Francisco basin of New Mexico had risen by an average of $47 an acre-foot per year from 1971 to 1987.

7.2.5 Regional Price Differences

Regional differences in water right prices are measured by the dummy variable EAST. The estimated coefficient indicates that, with all other sale factors being equal, water rights sell for $371.86 per acre more in the eastern region of the state. Oregon has two distinct climatic regions within the state. Water is more scarce in the eastern region due to low annual rainfall and warmer summer temperatures. The higher price commanded for water rights in the eastern region of the state is expected to be a result of water scarcity.

In addition, many areas in the eastern region are experiencing rapid growth. For example, the city of Bend is one of the fastest growing cities in the state (Oregon Blue Book 1992). The farm land around the city is also experiencing a large degree of urbanization. The large proportion of sales from this region suggest that the demand for water is growing. The growing demand coupled with the limited water supply may explain higher water right prices in this region.

7.3 SUMMARY

Tests of the original model indicated that because of a high degree of multicollinearity among explanatory variables, a reduced model would be efficient given the limitations of the data set. The model was reduced from 9 to 5 variables: DUTY, SENIOR, ln(ACRES), YEAR, and EAST. A model specification test showed no statistical difference between the full model and the reduced model. Further tests indicated that limited multicollinearity was still present in the reduced model.

The reduced model was then tested for heteroskedasticity using the Breusch-Pagan test. Heteroskedasticity was determined to be present and was corrected for using White's heteroskedasticity-consistent covariance matrix. This was anticipated due to the cross-sectional nature of the data set. The correction improved the standard error and the t-ratios for all coefficients in the reduced model.

There was reasonable evidence to suggest that two different types of market participants were active in Oregon's water market. These were characterized as commercial and amenity water users. The reduced model was tested for differences in price determinants between commercial and amenity sales. Overall, no significant differences in price determinants were detected between these two types of sales. The test concluded that these two market sales could be treated as identical in the estimation of the reduced model.

The final set of coefficient estimates were based on the reduced model regression results using the pooled data set of commercial and amenity water sales and adjusted by White's correction for heteroskedasticity. Approximately 46 percent of variation in market prices was explained by the reduced model. With the exception of DUTY, the signs for all estimated coefficients were consistent with the hypothesized signs presented in Chapter Four. The unit price of water rights was shown to be positively related to the seniority of a water right, sales occuring in the eastern part of Oregon, and the year in which the sale took place. The unit price of water rights have been shown to be negatively related to the parcel size of the transaction.

CHAPTER EIGHT:
SUMMARY AND CONCLUSIONS

8.1 A SUMMARY OF FINDINGS

Water market transfers have been advocated as a less controversial means of reallocating scarce water supplies to new and higher valued uses. The transfer mechanism in Oregon offers the opportunity for market exchange of rights between existing and growing uses in need of water. Limited market information is available to individuals entering Oregon's water market. Knowledge about prices and market conditions are critical for an active, well-developed market to develop in Oregon. The purpose of this study is to assess current market activity and market prices as well as identify potential water right price determinants.

A review of the economic literature identified a large volume of studies that have estimated the value of water in a variety of uses but these studies relied heavily on indirect valuation methods rather than market activity. A wide range of value estimates were reported for different uses. Estimated annual values ranged from $2 to $80 per acre-foot for water used in agricultural production to higher values of several hundred dollars per acre-foot for commercial and industrial water uses. Only a handful of studies were identified that used actual price data to examine price relationships with water right attributes and transaction characteristics. The difficulty in obtaining actual market data gives rise to the limited number of market-based valuation studies.

A water market transfer model was used to illustrate how active, well-defined markets would establish prices. The model suggests that a single observable price will be established in perfectly functioning water markets. Evidences from actual water markets indicate, however, that large variations in market price are common even in active water markets (Person and Michelsen 1994). To explain this, potential water right price determinants were identified based on economic theory and current economic literature.

Dispersion in market prices have been largely attributed to water right heterogeneity and differences in transaction characteristics.

Hedonic price theory provides a framework for examining price variation when commodities are heterogeneous. To date, only one study has used a hedonic price model to examine price dispersion in water markets (Colby et. al. 1993). However, hedonic price models have been frequently used in examining price variation in real estate markets. A hedonic price model for heterogeneous factors of production was developed here, based on the work of Palmquist (1989) and Rosen (1974). Potential price determinants for water rights in Oregon were developed based on those identified by economic theory. The per acre price of water rights was expected to be positively related to rate and duty, relative seniority, transfer of water outside of agriculture, and amenity agricultural sales. The unit price was expected to be negatively related to distance to urban centers and transaction size.

Data on Oregon's water market needed to be collected in order to estimate the hedonic price model. It was not possible to obtain market information from secondary sources because Oregon's water market is not formally monitored. Primary data was collected through a mail survey. The first step in implementing the survey was to identify potential water market participants. This was done by reviewing the water right transfer records kept by OWRD. The survey response rate was 65.6 percent, however, only a limited number of these surveys were usable for the purpose of the analysis. In all, information was obtained on 37 water market sales out of 140 potential water market sales.

Three potential explanations for the large degree of ineligible survey responses were discussed. First, there exists some uncertainty among water right holders about the legality of water right transfers. Several respondents indicated that they believed the sale of water rights to be a violation of Oregon water law. It was hypothesized that this belief is precipitated by ORS §537.280 (proscription of valuation in transfers statute). Second, the first cover letter mentioned the potential for water markets. People have different concepts of water markets; some respondents may not have perceived their actions as participating in a water market. Third, transfer records were reviewed back to January, 1989, and some respondents may have simply forgotten they had participated in a water right transfer.

A descriptive analysis of Oregon water right prices and market activity was conducted. The analysis determined that current market activity has been increasing in recent years, however, the overall volume of market trade is still quite limited. The analysis also identified a commercial market and an amenity market for water rights. Demographic characteristics of market participants and market information were discussed and compared for each market.

An econometric analysis was conducted to identify price determinants for Oregon water rights. The econometric analysis is based on data from the 37 sales that occurred between 1989 and 1994. A reduced hedonic price model was necessary due to the limited number of observations and the high degree of multicollinearity among explanatory variables in the intial model. It was determined that a simple model would be more effective in explaining price variation, given the limited number of observations. An analysis was conducted to test for differences in price determinants between the commercial and amenity market sales. The analysis concluded that there were no significant differences in price determinants between these two market types.

Significant conclusions drawn from the study include the following: 1) market transfers in Oregon have increased in recent years, 2) there are two types of markets for water in Oregon, and 3) the price of water rights in Oregon can be explained in part by specific water right attributes and sale characteristics. These three conclusions are discussed below:

8.1.1 Market Activity

Water market transactions require a transfer of place of use and involve two or more individuals. A review of OWRD water right transfer files identified 140 such transfers during the five year period from 1989 to 1994. An earlier review of transfer files by

Kraynick et. al. (1983) only identified 28 potential water market transfers during the ten year period from 1970 to 1980. It appears that the number of potential market transfers has increased by ten-fold in recent years.

Even with the significant increase in the number of market transfers in recent years, the market for water rights is still quite limited. Of the 80,000 water rights that exist in Oregon, only 140 were potentially involved in a sale over the five year period of the study. However, it should be noted that due to the Irrigation District Water Mapping Act passed in 1989, irrigation district water right sales are underrepresented in the number of potential water sales. Despite the underrepresentation of irrigation district sales, it appears that the transfer mechanism in Oregon has had limited success in establishing water markets. Two potential explanations for this limited success include the following: 1) the limited market information available to potential market participants, and 2) the high transactions costs involved in acquiring this information.

8.1.2 Two Types of Markets for Water

There appear to be two types of markets for water rights in Oregon. The first is a commercial market for water rights; this includes market participants such as commercial farmers, industries, and municipalities. The second is an amenity market for water rights. The large proportion of amenity water right sales occurring in irrigation districts in central Oregon suggest that these districts support a very active amenity market. This may be explained in part by the large degree of urbanization occurring in this region.

At present there does not appear to be any differences in price determinants between the commercial and amenity markets. The absences of behavioral differences may be attributed to the abundance of low valued uses of water. These uses require minimal payments to move water from its current use to some new and higher valued use. It is anticipated that differences in price determinants between commercial and amenity markets will occur as sources of inexpensive water are exhausted. Previous research suggests that amenity water markets will be less sensitive to changes in price. Water rights traded in the amenity market are commonly used for the production of hay and irrigated pasture. Estimated capitalized water values for these two crops range from $65 to $313 an acre-foot. Participants in the amenity water market have demonstrated a willingness-to-pay that far exceeds these estimated production values.

8.1.3 Water Right Price Determinants

Evidence from previous research on water markets in the West suggest that market prices are strongly influenced by specific water right and transaction characteristics (Person and Michelsen 1994, Colby et. al. 1993). The analysis of Oregon water market prices shows a significant relationship between market price and the water right duty, the relative seniority of the right, parcel size, and the geographic location of the sale. No strong relationship was found between the year in which the sale occurred and the price; however, observational evidence suggest that prices have been increasing over time. One surprising result was the strong negative relationship between price and duty. It was hypothesized that water rights with larger duties would command a higher market price. The result did not support this hypothesis. Several potential explanations for this result were explored. Market aggregation is the most plausible explanation. The state was divided into two market regions, but there may be many distinct markets within each of the market regions. Each of these sub-markets may have very different supply and demand characteristics. It is expected that these differences in markets was being detected in the estimated DUTY coefficient. However, it is not possible to sort out these differences in market areas without substantially more data.

The results of this research have implications for indirect water valuation methods. Most indirect valuation methods ignore water right and transaction characteristics when estimating water values. Clearly, these factors should be considered when estimating the market value of water through indirect methods. Several operational questions are developed below to provide an approach to the problems that arise when estimating the value of water using indirect methods. For many of these considerations there are no absolute answers; this requires that a range of values be considered when estimating water values with indirect methods.

8.1.4 Operational Questions For Using Indirect Valuation Methods

Property Rights: What is the legal nature of the water right? A property right is viewed as a bundle of rights; value should be based upon the nature, extent, and limitations of rights that are actually owned. Any limitations or extensions of rights should be represented in the valuation techniques. For example, a water right that historically receives its full rate (instantaneous flow) and duty (yearly accumulation) has a higher value than a water right that only receives a portion of its claimed rate and duty.

Highest and Best Use: What is the highest and best use for the water right? Highest and best use in property appraisals is defined as the reasonable and probable use of the property that generates the greatest present value as of the appraisal date (Colby 1989a). Unlike land, water rights have some degree of mobility, allowing water to be transferred to different locations, presenting a larger set of alternative uses and locations that can generate higher economic returns. This creates some difficulty in determining the highest and best use within a basin. Economic determinants such as water supply and demand conditions should also be considered. For instance, farmers facing low commodity prices may be very eager to sell their water to expanding municipalities and industries. These growing uses may not need all of the water offered. In such a situation, an appraisal of an irrigation water right based on urban water values as the highest and best use would fail to recognize that municipalities may only buy a portion of available water rights. The appraisal would overestimate the water right's true market value.

Anticipation: What is the value of future uses of the water right? Market sale prices are an expression of the present worth of future benefit (income stream) from ownership. However, sale prices may change in time as expectations of use change.

Proportionality: Is the current use maximizing benefits or profits? There is an optimum combination of resources that maximizes income and profit. When valuing any component of a farm unit, it is assumed that this optimum combination is utilized. All resources are assumed to be employed to their maximum economic efficiency and profits for the farm unit are assumed to be maximized. If all other resources are not used to their maximum level of efficiency and profits are not maximized, the imputed value of water may be understated.

Contribution: What is the water right's overall contribution to the land value? The component parts of a farm unit, such as water, labor, and capital, have value only to the extent that they contribute to the unit's overall market value. Additional components of each will provide decreasing additional value (diminishing returns). It is only in the case when separate and competitive markets exist for all the components that their costs are separable and additive. That is, the observed market price for each component can be added together to reflect the value of the real estate. For all other situations, a direct summation overvalues the property.

Competition: What types of uses are buying and selling water rights? Not all uses are equally sensitive to price. Even when there is an adequate number of suppliers of water rights, competing buyers may be outbid by those less sensitive to price. The types of demands active in the water market should be identified. For example, water prices may rise while a municipality is attempting to expand their water supply. This may only be a temporary fluctuation in price if the municipality's activity in the market is short term. An additional market situation to consider is when a limited number of water right suppliers exist. If only a few water right seller are identified, then potential buyers have no other recourse except to accept the price that the seller demands. Under these conditions, the seller has the ability to influence price, resulting in a price higher than that under competitive conditions.

Substitution: What are the range of alternative uses for the land from which water rights are acquired? This accounts for the opportunity cost of the water rights. Opportunity cost is the cost of options that are foregone in choosing the profit maximizing combination of resources. If only a limited number of alternatives are considered, the opportunity cost of using the water may be overstated. For example, land that has water leased from it for instream flows may have other dryland farming options other than dryland pasture. These should be recognized and considered as viable alternatives. The duration of the acquisition will affect the available options. Short-term leases do not provide enough time or incentive for farm managers to make capital investments to compensate for the reduced water supply.

8.2 STUDY LIMITATIONS

The most significant limitation of this study was the limited availability of actual market information. This is a frequent problem for water market studies that have used actual market data. The difficulty in obtaining market information has limited the number of studies of this nature. Great efforts were taken to collect a sufficient amount of market information for this particular study. Despite these efforts, the quantity of data collected proved to be limited.

One consequence was that separate hedonic price functions could not be established for each distinct market region. A hedonic price function was estimated for the entire state, using a single dummy variable to account for regional market differences. This assumes that there are only two market regions in the state. However, in reality several distinct markets are known to exist in the state. Within a given market, sales are more homogenous in terms of water rights and transaction characteristics. In addition, some market areas may be experiencing demand or supply pressures that are influencing prices. It is not possible to sort out the influences of these market differences without additional data it is not possible . It is expected that these market differences have contributed to the theoretically inconsistent result for the variable DUTY.

8.3 POLICY RECOMMENDATIONS

Although frequency of water market transfers in Oregon is still quite limited, the Oregon Legislature as well as several water user organizations (e.g., Oregon Water Trust and The Oregon Water Resources Congress) have explored opportunities to increase market activity. Based on this research, several policy actions to improve market activity are recommended.

1) Maintain a central clearing house for information on water market transfers. Records should be maintained on the parcel size of water rights traded, the priority date, location of the sale, the current and intended use of the water right, and the price paid. Providing this information to potential market participants would reduce market uncertainty and transactions cost; this should increase the number of economically feasible market transfers. Evidence from water markets in Colorado suggest that the availability of information on market price has increased and improved market activity.

2) In addition, the clearing house could act as an intermediary in assisting buyers and sellers to locate trading partners. This could be accomplished through a central posting board. Currently there are only a few media available for an individual to advertise their intention to buy or sell water rights. A central posting system could be established to assist buyers and sellers locate trading partners. Several irrigation

districts office already provide posting services to district members. Posting services for non-irrigation districts water rights could be maintained through regional or county watermaster offices.

3) The level of market activity would be severely limited if ORS §537.280, (the proscription of valuation in transfer statute) was strictly enforced. The statute limits water right sale price to cost of perfecting the right, which is in most situations the transactions costs associated with the sale. The statute prevents the establishment of a market price that provides the necessary incentive for water right holders to engage in trade. The threat of enforcement is likely to deter many water right holders from actively participating in water markets. This statute should be removed if Oregon is to support active and competitive water markets.

8.4 RECOMMENDATIONS FOR FUTURE RESEARCH

Amenity water sales were the most frequent type of transfer in Oregon's water market. Very little is known about the participants of this market both in terms of willingness-to-pay and quantity demanded. Future research could address the potential demand for water rights by this market. Additionally, it may be of some interest to identify factors that drive amenity water demand.

Several geographic market areas have been identified by this research. Future research could more carefully address the relationship between price and water right and market characteristics within these distinct market regions. This would require monitoring and recording sales activity in market regions. One approach would be to more carefully examine market activity within different irrigation districts.

This study has proven successful in giving color to Oregon's gray water market. Prior to the onset of this study, no price or quantity information on Oregon water right sales existed. The study has also provided insight on factors that influences these market prices.

REFERENCES

Achterman, G.L., 1993, Attorney at Law, *Memorandum: Water Rights Transfer Applications*, Law office of Stoel, Rives, Boley, Jones, and Gray, Portland, OR.

Alig, R.J., and Healy, R.G., 1987, "Urban and Built-up Land Area Changes in the United States: An Empirical Investigation of Determinants." *Land Economics*, 63 (3), 215-226.

Amirfathi, P., Narayanan, R., Bishop, B., and Larson, D., 1984, "A Methodology for Estimating Instream Flow Values for Recreation." Utah Water Research Laboratory, Utah State University, Logan, UT.

Bollman, F.H., 1979, "A Simple Comparison of Values: Salmon and Low Value Irrigation Crops." paper from the Association of California Water Agencies: 12.

Boyce, D.E., Kohlase, J., and Plaut, T., 1977, *Estimating the Value of Development Easements on Agricultural Land:: Methods and Empirical Analysis*, October, Regional Science Research Institute.

Brajer, V., Church, A., Cummings, R., and Farah, P., 1989, "The Strengths and Weaknesses of Water Markets as They Affect Water Scarcity and Sovereignty Interest in the West," *Natural Resources Journal*, 29: 489-509.

Brookshire, D.S., and Smith, V.K., 1987, "Measuring Recreation Benefits: Conceptual and Emprical Issues." *Water Resources Research*, 23-5: 931-935.

Brown, Charles, 1994, Swalley Irrigation District Manager, Personal Communication, May, 1994.

Brown, J.N., and Rosen, H.S., 1982, "On the Estimation of Structural Hedonic Price Models." *Econometrica*, 50 (3), 765-768.

Chicoine, D.L., 1981, "Farmland Values at the Urban Fringe: An Analysis of Sale Prices." *Land Economics*, 57 (3), 353-362.

Clark, C.D., 1983, *Survey of Oregon's Water Laws*, Reprinted and Updated by Oregon Law Institute, Water Resource Research Institur.

Colby, B.G., 1989a, "Alternative Approaches to Valuing Water Rights." *The Appraisal Journal*, April: 181-196.

Colby, B.G., 1989b, "Estimating the Value of Water in Alternative Uses." *Natural Resources Journal*, 29: 511-527.

Colby, B.G., 1990, “Transaction Cost and Efficiency in Western Water Allocation." *American Journal of Agricultural Economics*, Dec: 1184-1191.

Colby, B.G., Bush, D.B., Martin, W.E., and Brown, T.C., 1987, "Do Water Market Prices Appropriately Measure Water Values?" *Natural Resources Journal*, 27, 617-651.

Colby, B.G., Crandall, K., and Bush, D.B., 1993, "Water Right Transactions: Market Values and Price Dispersion." *Water Resources Research*, 29-6: 1565-1572.

Colby, B.G., McGinnis, M., and Rait, K.A., 1991, "Mitigating Environmental Externalities Through Voluntary and Involuntary Water Reallocation: Nevada's Truckee-Carson River Basin." *Natural Resources Journal*, 31: 757-783.

Crouter, J.P., 1987, "Hedonic Estimation Applied to a Water Rights Market." *Land Economics*, 63: 259-271.

Daubert, J.T., and R.A. Young, 1981, "Recreational Demands For Maintaining Instream Flows: A Contingent Valuation Approach.", *American Journal of Agricultural Economics*, 63: 666-675.

Dillman, Don, 1978, *Mail and Telephone Surveys: The Total Design Method*, Wiley and Sons, New York.

Duffield, J.W., and Neher, C.J., 1991, *Market Value of Agricultural Water Leased for Instream Flows*, Report to Montana Dept. of Fish, Wildlife and Parks, Helena, MT.

Duffield, J.W., Neher, C.J., and Brown, T.C., 1992, "Recreation Benefits of Instream Flow: Application to Montana's Big Hole and Bitterroot Rivers." *Water Resources Research*, 28: 2169-2181.

Freeman, A.M.,1993, *The Measurement of Enviromental and Resource Values: Theory and Methods*, Washington D.C.: Resources for the Future.

Gardner, R.L. and Miller, T.A., 1983, "Price Behavior in the Water Market of Northeastern Colorado," *Water Resources Bulletin*, 19 (4), 557-562.

Gibbons, D.C., 1986, *The Economic Value of Water*, Study for Resources For The Future, Washington D.C.

Goodman, Allen, 1989, "Identifying Willingness-to-Pay fo Heterogeneous Goods with Factorial Survey Methods." *Journal of Environmental Economics and Management*, 16: 58-79.

Greenley, Walsh, R.G., and Young, R.A., 1982, *Economic Benefits of Improved Water Quality*, Westview Press, Boulder, CO.

Griffiths, W.E., Hill, R.C., and Judge, G.G., 1993, *Learning and Practicing Econometrics*, John Wiley & Sons Inc., New York.

Hartman, and Anderson, 1962, "Estimation the Value of Irrigation Water from Farm Sales Data." *Journal of Farm Economics*, 44: 207.

Heilig, G. B. 1994, Land Use Attorney, Corvallis, OR, Personal Communication.

Hirschleifer, J., 1984, *Price Theory and Applications*, Third Edition, Prentice-Hall Inc., Englewood Cliffs, NJ.

Johnson, N. S. and Adams, R.M., 1988, "Benefits of Increased Stream flow: The Case of the John Day River Steelhead Fishery." *Water Resources Research*, : 24, 1839-1846.

Kelly, S., and Ayer, H.W., 1982, " Water Conservation Alternatives fo California Agriculture: A Microeconomic Analysis." Economic Research Service Report no. AGES-820417, Washington, D.C., U.S.D.A.

Kelso, M.M., Martin, W.E., and Mack, L.E., 1973, *Water Supplies and Economic Growth in an Arid Environment*, Tucson, University Press.

Khoshakhlagh, Rahman, Brown F., and DuMars C., 1977, *Forecasting Future Market Values of Water Rights in New Mexico*, Technical Completion Report No. 92, Water Resources Research Institute Project No. 3109-209, NM.

Kraynick, R.G., Whittaker, G.W., Bhadra, B.P., Stoevener, H.H., and Huffman, J.L., 1983, *Water Right Transfers: A Legal, Economic, and Informational Analysis of Water in Oregon*, Technical Completion Report No. 78, Water Resources Research Institute Project No. B-069-ORE.

Lacewell, R.D., Sprott, J.M., and Beattie, B.R., 1974, *"Value of Irrigation Water with Alternative Input Prices, Product Prices, and Yield Level: Texas High Plains and Lower Rio Grande Valley,"* Texas Water Resources Institute Technical Report no. 58, Texas A&M University.

Landry, C.J., 1993, "Crop Combination and Irrigation Technology Changes Due to Per-Unit Pricing of Water." Unpublished Paper, Orgon State University, Corvallis, OR.

Madariago, B. and McConnell, K., 1987, "Exploring Existence Value." *Water Resources Research*, 23: 936-942.

Main, Robert.F., 1995, Watermaster, South Central Region, Oregon Water Resources Department, Personal Communication, September 1995.

McLeod, Donald, 1994, "Valuing Nonmarket Goods and Services: A Test for Bias in the Iterated Referendum Contingent Valuation Format." Doctoral Disertation, Oregon State University, Corvallis, OR.

Mendelsohn, R., 1987, "A Review of Identification of Hedonic Supply and Demand Functions." *Growth and Change*, 18 (1), 82-92.

Michelsen, A.M., 1994, "Administrative, Institutional and Structural Characteristics of an Active Water Market." *Water Resource Bulletin*, 30 (6).

Michelsen, A.M., Person, P., and Young, R.A., 1994, "Determinants and Trends in Water Right Market Prices." *Water Policy and Management: Solving the Problems*, American Society of Civil Engineers, 21st Annual Conference Proceedings, Denver, CO.

Moon, 1994, Moon Consulting, Eugene, OR, Personal Communication, May 1994.

National Research Council, 1992, *Water Transfers in the West*, National Academy Press, Washington, D.C.

Nicholson, Walter, 1992, *Microeconomics Theory: Basic Principles and Extensions*, Orlando FL.: The Dryden Press: p. 294-295.

Nunn, L.H., 1994, Transfer Specialist, Oregon Water Resources Department, Personal Communication, May 1994.

OREGON.REVISED.STATUTES §536.300 (1987)

OREGON.REVISED.STATUTES §537.280 (1987)

OREGON.REVISED.STATUTES §537.348 (1987).

OREGON.REVISED.STATUTES §537.801 (1987).

OREGON.REVISED.STATUTES §540.510 through §540.550 (1987).

Oregon Blue Book, 1992, Salem, OR.

Oregon Water Resources Commission, 1992, *State of Oregon Water Use Program*, Salem OR.

Oregon Water Resources Department, 1986, *Directory of Water Users' Organizations*, Salem, OR.

Oregon Water Resources Department, 1993, *Biennial Report: January 1991 to December 1992*, Salem OR.

Oregon Water Resources Department, 1994, *Water Rights: Oregon's Water Rights System*, Salem OR.

Palmquist, R.B., 1989, "Land as Differentiated Factor of Production: A Hedonic Model and Its Implications for Welfare Measurement." *Land Economics*, 65(1), 23-28.

Pearce, D.W., and Turner, R.K., 1990, *Economic of Natural Resources and the Environment*, The John Hopkins University Press, Baltimore, MD: 120-158.

Peron, P. and Michelsen, A.M., 1994, *Determinants and Trends in Water Right Prices: An Econometric Analysis*, Technical Report No. 94-06, Wyoming Water Resources Center, Laramie, WY.

Plantiga, A.J., Buongiorno, J., and Alig, R.J., 1990, "Determinants of Changes in Non-Industrial Private Timberland Ownership in the United States." *Journal of Wolrd Forest Resource Management*, 5, 29-46.

Purkey, Andrew, 1995, Excutive Director, Oregon Water Trust, Personal Communication, January 1995.

Randall, Alan, 1981, *Resource Economics: An Economic Approach to Natural Resource and Environmental Policy*. Columbus, Ohio: Grid Publishing Company, 92-115, 152-162.

Rosen, S., 1974, "Hedonic Prices and Implicit Markets: Product Differentiation in Perfect Competition." *Journal of Political Economy*, 82 (1), 34-55.

Ross, J.F., 1984, "Valuation of Water Rights for Acquistion, Condemnation, and Taxation Purposes." *Rocky Mountain Mineral Law Institute*, 30: 563-593.

Shira, D.L., 1976, "Water Resource Planning Instream Flow Needs: A Reclamation Viewpoint." in *Instream Flow Needs*, American Fisheries Society vol. 1: 180-190.

Statecon, Inc.: *Water Strategist*, Selected Issues, Claremont, CA.

Stoff, M., 1994, "The Effect of Farm and Operator Characteristics, and Attitudes on Farm-level Improvements in Irrigation Efficiency in Central Willamette Valley." Master's Thesis, Orgon State University, Corvallis, OR.

Straszheim, M., 1974, "Hedonic Estimation of Housing Market Prices: A Further Comment." *Review of Economics and Statistics*, 56 (3), 404-406.

Thompson, C.K., 1987, "Busterback Ranch: Valuing Water Rights in a Scenic Easement Area." *The Appraisal Journal*, April: 169-179.

United States Water Resource Council, 1983, *Economic and Environmental, Principles and Guidelines for Water and Related Land Resources Implementation Studies,* Washington D.C.

Walsh, R.G., Aukerman, R., and Milton, R., 1980, "Measuring Benefits and the Economic Value of Water in Recreation on High Country Reservoirs." Colorado Water Resources Research Institute Completion Report no. 102, Colorado State University, Fort Collins, CO.

Ward, Frank, 1987, "Optimally Managing Wild and Scenic Rivers for Instream Flow Benefits." Proceeding of the National River Recreation Symposium, Louisiana State University, Baton Rogue, LA.

Washington State University Agricultural Research Center (WSUARC), 1972, *"Irrigation Development Potential and Economic Impacts Related to Water Use for the Yakima River Basin,"* paper to Yakima Valley Natural Resources Development Association, Pullman, WA.

White, K.J., 1993, *Shazame User Reference Manual Version 7.0,* McGraw Hill Book Company, New York.

Williams, K.A., 1991, "Air Quality, Willingness To Pay, And Wilderness: A Review Of Methods, Applications, And Implications For Wilderness Management In the Pacific Northwest." *The Economic Value of Wilderness*, U.S. Forest Service Conference Proceedings, GTR no. SE-78, Jackson, WY.

Willit, S.G., Hathorn, S., and Robertson, C.E., 1975, "The Economic Value of Water Used to Irrigate Field Crops in Central and Southern Arizona, 1975." Dept. of Agricultural Economics Report no. 9, University of Arizona, Tucson, AZ.

Young, R.A., 1984, "Direct and Indirect Region Economic Impacts of Competition for Irrigation Water." in E. Englebert, ed., *Water Scarcity: Impacts on Western Agriculture*, Berkeley, University of California Press. .

Young, R.A., 1986, "Why Are There So Few Transactions Among Users?", *American Journal of Agricultural Economics*, 1143-1151.

Young, R.A., and Gray, S.L., 1972, *Economic Value of Water: Concepts and Empirical Estimates*, Technical Report to the National Water Commission, NTIS no. PB210356, Springfield, Va., National Technical Information Service.

Young, R.A., and Howe, C.W., 1988, *Handbook for the Economic Evaluation of Application to Appropriation of Surface and Groundwater in the State of Idaho*, Report to Snake River Technical Studies Committee, Office of the Governor, State of Idaho, Moscow, ID.

APPENDICES

APPENDIX A:

FARM-CROP BUDGET ANALYSIS ESTIMATED WATER VALUE FOR ALFALFA PRODUCTION NORTH CENTRAL OREGON

Appendix A provides an example of an indirect valuation method for estimating water values. Water values for alfalfa production in north central Oregon are estimated using the Farm-Crop Budget Analysis. The estimated values represent annual values and are measured on a per acre-foot per year basis. The analytical basis for this method is the observed difference between irrigated and nonirrigated lands for a given crop, in particular alfalfa. This procedure is a simplified method used by Duffield and Neher (1991).

Yield Units of Measurement

The yield unit of measurement used was tons per acre-year. Yield estimates were obtained from the Soil Conservation Service regional soil surveys and verified by local county extension agents. These estimates are yield averages for the region. Because yields vary depending on soil type, moisture, and climatic conditions, sensitivity analysis was used to generate a range for water values.

Crop Prices

Crop prices vary depending on the quality of the crop produced. Crop prices were obtained from the Capital Press Market report, as of September 25, 1994. These are measured in $ per ton and represent producer prices. Sensitivity analysis was conducted to account for variability in crop quality.

Water Used

The water used is the annual per acre duty of the water right in question. Some adjustments for water used may be necessary depending on crop needs and system efficiency. This is measured in units per acre-foot a year.

Short Run (S.R.) Irrigation Costs

The short run irrigation costs are drawn from the regional enterprise budgets for alfalfa production using a center pivot system. This includes electricity and repair costs and are measured in $ per inch of water pumped.

PROCEDURE OUTLINE

In implementing this method four general steps were followed:

1) A gross crop value per acre was calculated for both irrigated and nonirrigated lands within the region.

2) The average per acre difference in gross crop values was calculated for alfalfa.

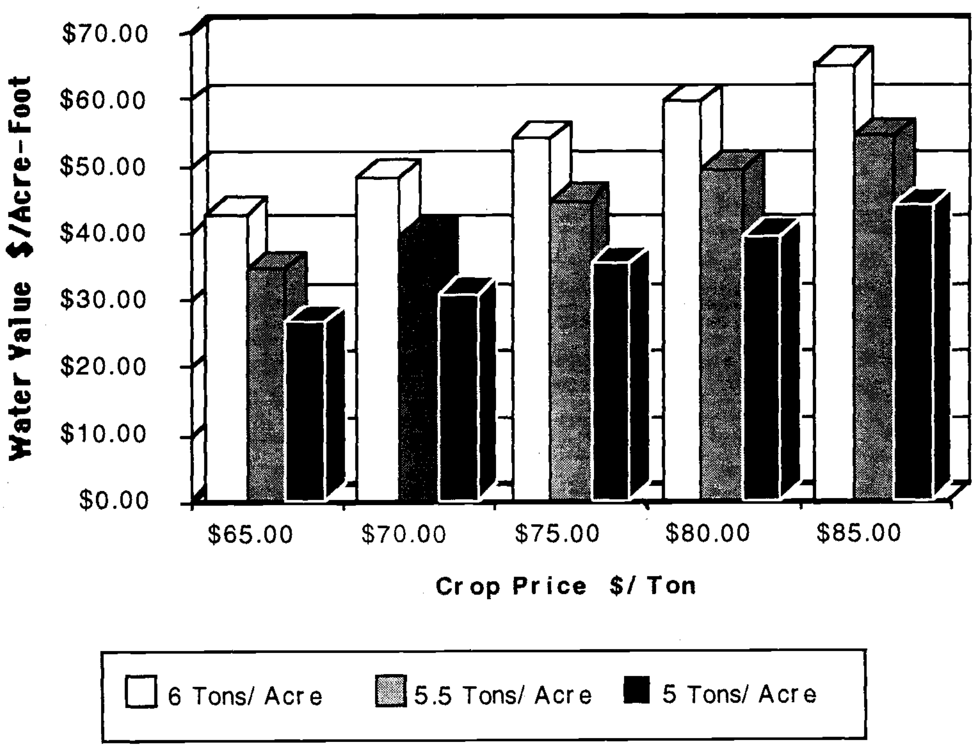
3) Short run irrigation costs for a center pivot system were subtracted from the average per acre difference in crop value. This provided a net per acre value attributable to irrigation water. It was assumed that all other production costs for irrigated and nonirrigated alfalfa were equal.

4) To arrive at a per acre-foot value for water, the net value per acre was divided by the per acre duty of the water right.

WATER VALUE SUMMARY
ALFALFA PRODUCTION
NORTH CENTRAL OREGON

CROP PRICE	YIELDS		
	5 Tons/Acre	5.5 Tons/Acre	6 Tons/Acre
$ 65.00	$26.48	$34.60	$42.73
$70.00	$30.85	$39.60	$48.35
$75.00	$35.23	$44.60	$53.97
$ 80.00	$39.60	$49.60	$59.60
$ 85.00	$43.98	$54.60	$65.29

Alfalfa Water Use Values
North Central Oregon



Estimation Procedure
(By Crop Yields Per Acre)

Irrigated Yield 5 Tons/Acre

IRRIGATED					
Yield/Acre (tons)	5	5	5	5	5
Price Per Ton	$65.00	$70.00	$75.00	$80.00	$85.00
Gross Income	$325.00	$350.00	$375.00	$400.00	$425.00
Water used (acre-foot)	4	4	4	4	4
S.R. Irrigation Cost	$121.58	$121.58	$121.58	$121.58	$121.58
NONIRRIGATED					
Yield/Acre (tons)	1.5	1.5	1.5	1.5	1.5
Price Per Ton	$65.00	$70.00	$75.00	$80.00	$85.00
Gross Income	$97.50	$105.00	$112.50	$120.00	$127.50
Net S.R. Value/Acre	$105.92	$123.42	$140.92	$158.42	$175.92
Acre-Foot Value	**$26.48**	**$30.85**	**$35.23**	**$39.60**	**$43.98**

Irrigated Yield 5.5 Tons/Acre

IRRIGATED					
Yield/Acre (tons)	5.5	5.5	5.5	5.5	5.5
Price Per Ton	$65.00	$70.00	$75.00	$80.00	$85.00
Gross Income	$357.5	$385.00	$412.50	$440.00	$467.50
Water used (acre-foot)	4	4	4	4	4
S.R. Irrigation Cost	$121.58	$121.58	$121.58	$121.58	$121.58
NONIRRIGATED					
Yield/Acre (tons)	1.5	1.5	1.5	1.5	1.5
Price Per Ton	$65.00	$70.00	$75.00	$80.00	$85.00
Gross Income	$97.50	$105.00	$112.50	$120.00	$127.50
Net S.R. Value/Acre	$97.50	$105.00	$112.50	$120.00	$127.50
Acre-Foot Value	**$34.60**	**$39.60**	**$44.60**	**$49.60**	**$54.60**

Irrigated Yield 6 Tons/Acre

IRRIGATED					
Yield/Acre (tons)	6	6	6	6	6
Price Per Ton	$65.00	$70.00	$75.00	$80.00	$85.00
Gross Income	$390.00	$420.00	$450.00	$480.00	$510.00
Water used (acre-foot)	4	4	4	4	4
S.R. Irrigation Cost	$121.58	$121.58	$121.58	$121.58	$121.58
NONIRRIGATED					
Yield/Acre (tons)	1.5	1.5	1.5	1.5	1.5
Price Per Ton	$65.00	$70.00	$75.00	$80.00	$85.00
Gross Income	$97.50	$105.00	$112.50	$120.00	$127.50
Net S.R. Value/Acre	$170.92	$193.42	$215.92	$238.42	$260.92
Acre-Foot Value	**$42.73**	**$48.35**	**$53.98**	**$59.60**	**$65.23**

APPENDIX B

Market Acquisitions For Instream Flow Protection

The move by many states to adopt progressive legislation that allows the market acquistion of water rights for protection of instream flows has not been widely utilized. Only a handful of market acquisitions of water have occurred throughout the West to maintain and enhance stream flows for fish and wildlife, recreational use and pollution control . The following list was obtained from a variety of sources (e.g., Water Market Update, Oregon Water Trust, The Nature Conservancy, etc), which provide a review of market transactions that have occurred in the western states for the purpose of instream flow protection. All prices are reported are the negotiated sale prices and have not been adjusted to current dollar values.

Market Activity

1994 Oregon Water Trust

Annual lease of 200 acre-feet of water from irrigation use for the protection of steelhead salmon spawning grounds in a tributary of the Deschutes river (Oregon Water Trust 1994).

Acre-Foot Value $33.00

1994 Bonneville Power Administration

Annual lease option on Skyline Farms to put land in the CRP set-aside program to augment flow levels in the main stem of the Snake river (Bonneville Power Administration 1994).

Acre-Foot Value $7.00

1993 Siltez Tribe

Purchase of 6516 acre-feet of water to augment flow levels on the Siletz river for salmon habitat protection (Oregon Water Resources Department 1994).

Acre-Foot Value Undisclosed

1989 The Nature Conservancy, Colorado

Purchase of 3,200 acre-feet of water from the Upper Snake Water Bank to aid starving Trumpeter Swans (WMU, Mar. 1989).

Acre-Foot Value $2.50

1989 The Nature Conservancy
Purchase of 74 acres of wetland and 4344 acre-feet of water from Formation Spring for "ecological purposes" (The Nature Conservancy, Apr. 1989).
Acre-Foot Value $23.00

1989 Colorado Fishing Club
Annual lease of 18 acre-feet of water to augment evaporative losses from their fishing ponds (Water Market Update, May. 1989).
Acre-Foot Value $25.00

1988 Potlatch Corporation
Annual lease of 30,000 acre-feet of water from upstream reservoirs to protect water quality by diluting effluent discharge (Water Market Update, Oct. 1988).
Acre-Foot Value $1.00

1988 Colorado Department of Natural Resources
Purchase of 750,000 acre-feet of water from existing water right holders on the Yampa river to protect endangered fish (Water Market Update, Oct. 1988).
Acre-Foot Value $8.00

1988 Central Utah Water Conservancy District
Purchase of 9,500 acre-feet of water from private and governmental water right holders to augment low winter flows in the Provo river (Water Market Update, Dec. 1988).
Acre-Foot Value $50.00

1988 University of Colorado
Purchase of 12.5 acre-feet from the city of Boulder to mitigate evaporative losses in recently constructed wetlands replacement ponds (Water Market Update, Dec. 1988).
Acre-Foot Value $7.00

1987 Lander County, Nevada
Purchase of 3,000 acre-feet of water of senior irrigation rights to maintain a stable shoreline for fishing and boating on a new county reservoir (Water Market Update, May 1987).
Acre-Foot Value $217.00

1987 Montana Department of Fish, Wildlife and Parks (MDFWP)
Annual lease of 10,000 acre-feet of water from Painted Rock Reservoir to augment stream flows on the Bitterroot River for the protection of the rivers famed trout fishery (MDFWP, Aug. 1987).
Acre-Foot Value $2.00

APPENDIX C: FIRST COVER LETTER

July 18, 1995

«Name»
«Address»
«City», «State» «Zip»

Dear «Name»,

In many parts of Oregon, existing water supplies cannot meet growing water needs. Water marketing offers a unique solution to this problem. There is evidence that water market activity is occurringin the state. However, no one really knows much about the prices at which water rights are sold or how certain market factors influence these prices.

People like you are the only source of information on Oregon's developing water market. We would greatly appreciate your cooperation in completing and returning the enclosed water rights survey.

You may be assured of complete confidentiality. We are not affiliated with any company dealing in water rights and we will keep both your name and your reply completely confidential. The survey has an identification number for mailing purposes only. This is so that we may check your name off the mailing list when your survey is returned. Your name will not be placed on the survey.

We have issued you a check for $5.00 in appreciation for your cooperation in completing and returning the survey. The results of this survey will be made available to the citizens of Oregon. You may receive a summary of the results by writing "Summary" on the back of the return envelope and printing your name and address. Please do not put this information on the survey itself.

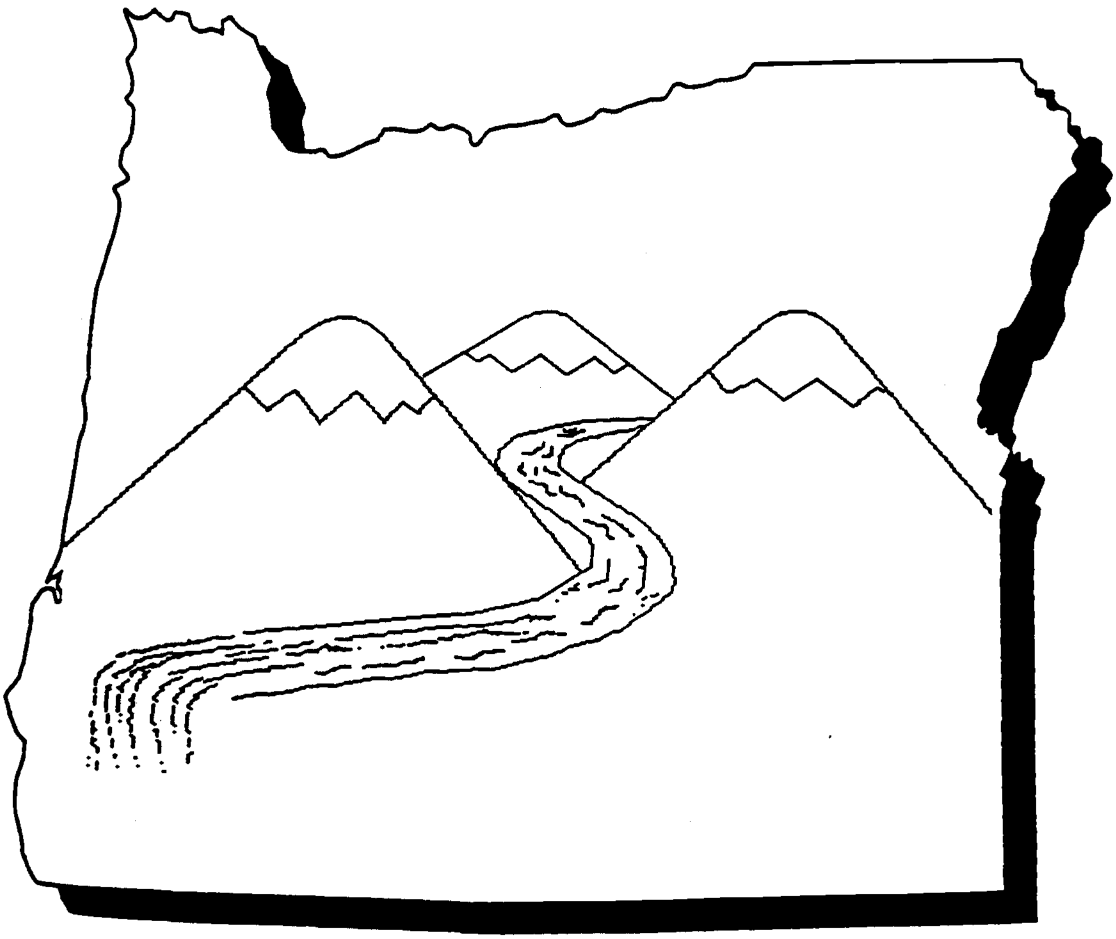
I would be happy to answer any questions you might have. Please write to me at the above address, or call my research associate, Clay Landry, at **(503)737-1449**. Thank you for your time and attention to this matter of great importance to all Oregon residents.

Sincerely,

Dr. Joe B. Stevens
Professor of Agricultural and Resource Economics

APPENDIX D

Oregon Water Rights Survey



Department of Agricultural and Resource Economics
Oregon State University

1. Have you taken part in any water right transfers in Oregon? *(Circle one number)*

   1 YES [Please continue the questionnaire.]
   2 NO [Since you did not participate in a water right transfer this questionnaire is not for you. Please return it in the enclosed postage-paid envelope.]

2 Did the ownership of the water right change as a result of any of the water right transfers? *(Circle one number)*

   1 YES [Please continue the questionnaire.]
   2 NO [Since the ownership of the water right did not change this questionnaire is not for you. Please return it in the enclosed postage-paid envelope.]

Please refer to the most recent water right transfer if you were involved in more than one water right transfer.

If your water right transfer application is pending, please complete the questionnaire as though the transfer is approved.

3 What is the certificate number of the water right being transferred?

   ________________ CERTIFICATE NUMBER

4. How many acres of land were involved in the water right transfer?

   ________________ ACRES

5. What is the priority date of the water right?

   ________________ PRIORITY DATE

6 . What is the maximum rate of diversion that was allowed by the water right?

   ________________ OR ________________
   CUBIC FEET PER SECOND GALLONS PER MINUTE

7. What is the maximum diversion (duty or amount) that was allowed by the water right during the irrigation season?

   ________________ ACRE-FEET PER ACRE

8. For what months of the year is the use of water permitted by the water right? *(Circle months of use)*

JAN FEB MAR APR MAY JUN JUL AUG SEPT OCT NOV DEC.

9. What was the source of water for the water right? *(Circle one number)*

1 RIVER
2 STREAM
3 WELL
4 POND
5 SPRING
6 LAKE
7 RESERVOIR

10. What was the name of the water source? (e.g. name of the river or stream)

______________________ NAME OF WATER SOURCE

11. What is the name of the town nearest to the place of use of the water right?

______________________ TOWN NAME

12. How many miles, one way, is the nearest town to the place of use of the water right?

______________ MILES, ONE WAY, TO NEAREST TOWN

13. Did this transfer of the above water right or rights involve a sale, a lease, or a donation? *(Circle one number)*

1 SALE OF THE WATER RIGHT
2 LEASE OF THE WATER RIGHT
3 DONATION OF THE WATER RIGHT
4 OTHER (please specify) ______________________________

14. Did you sell, lease, donate, or did you buy or otherwise receive the water right?

1 I SOLD, LEASED, OR DONATED THE WATER RIGHT **(GO TO Q. 15)**
2 I BOUGHT OR OTHERWISE RECEIVED THE WATER RIGHT **(SKIP TO Q. 16)**

15. If you are a SELLER which one of these statements best describes why you decided to sell the water right? *(Circle one number)*

1 UNABLE TO FARM ANY LONGER
2 CHANGED CROPPING OR PRODUCTION PRACTICES AND NO LONGER NEEDED THE WATER
3 ENTERED AN OCCUPATION OTHER THAN IRRIGATION FARMING
4 SOLD THE LAND AND DID NOT NEED THE WATER RIGHT ANY LONGER
5 ABLE TO MAKE MORE MONEY BY SELLING THE RIGHT THAN By USING IT
6 OTHER (Please specify) ______________________

SKIP NOW TO QUESTION 17

16. If you are a BUYER, which one of these statements best describes why you decided to buy this particular water right? *(Circle one number)*

1 NEEDED SUPPLEMENTAL WATER ON LANDS
2 WANTED A MORE SENIOR WATER RIGHT
3 PURCHASED LAND WITHOUT WATER RIGHTS
4 NEEDED WATER FOR LAWN OR GARDEN
5 OTHER (Please specify) ______________________

17. We'd like to ask more detailed information about your use of the water right. If you sold the water right, how was the water used prior to the transfer? If you bought the water right what is the current or intended use of the water right? *(Circle one number)*

1 FARM USE **(GO TO QUESTIONS 18a-18g)**
2 DOMESTIC OR HOUSEHOLD USE **(SKIP TO QUESTIONS 19a-19e)**
3 COMMERCIAL OR INDUSTRIAL USE **(SKIP TO QUESTIONS 20a-20c)**

FARM USE

18a What is the crop you most commonly grow with the water provided by your water right?

______________________ CROP

18b. What is the approximate average yield per acre of the crop most commonly grown with the water provided by your water right?

______________________ YIELD PER ACRE

18c. Which one of the following practices do you commonly use to apply the water provided by your water right? *(Circle one number)*

1 HANDLINE
2 SURGE IRRIGATION
3 FURROW IRRIGATION
4 FLOOD IRRIGATION
5 CENTER PIVOT
6 OTHER (please specify) ____________________

18d. How many years, altogether, have you had experience working directly with irrigation?

____________ YEARS OF IRRIGATION EXPERIENCE

18e. Including yourself, how many full time and how many part time employees, if any, work on your farm?

____________ NUMBER OF FULL TIME EMPLOYEES
____________ NUMBER OF PART TIME EMPLOYEES

18f. What is the approximate total acreage you farm?

____________ TOTAL FARM ACREAGE

18g. From the following categories, please indicate your before-tax farm income. *(Circle one number)*

1 $0-10,000
2 $10,001-20,000
3 $20,001-30,000
4 $30,001-40,000
5 $40,001-50,000
6 $50,001-75,000
7 $75,001-100,000
8 OVER $100,000

SKIP NOW TO QUESTION 21

DOMESTIC OR HOUSEHOLD USE

19a. What is the most common use of the water provided by your water right?

____________________ USE

19b. What is the approximate acreage of the property adjoining your house?

_______________ ACREAGE

19c. What is the approximate property value of your house and the adjoining property?

_______________ PROPERTY VALUE

19d. From the following categories, please indicate your before-tax household income. *(Circle one number)*

1 $0-10,000
2 $10,001-20,000
3 $20,001-30,000
4 $30,001-40,000
5 $40,001-50,000
6 $50,001-75,000
7 $75,001-100,000
8 OVER $100,000

SKIP NOW TO QUESTION 21

COMMERCIAL OR INDUSTRIAL USE

20a. What is the most common use of the water provided by your water right?

_______________________ USE

20b. Including yourself, how many full time and how many part time employees, if any, work work in the business that participated in the water right transfer?

_______________ NUMBER OF FULL TIME EMPLOYEES
_______________ NUMBER OF PART TIME EMPLOYEES

20c. From the following categories, please indicate the before-tax income of the business involved in the water right transfer. *(Circle one number)*

1 $0-50,000
2 50,001-100,000
3 100,001-150,000
4 150,001-200,000
5 200,001-250,000
6 over 250,000

We would also like to ask a few questions about the legal, administrative, and other expenses of transferring your water right .

21. What was the total amount of legal, administrative, and other expenses that werepaid by you? (e.g. initial mapping costs, filing fees, survey fees, or legal expenses)

_____________ LEGAL, ADMINISTRATIVE, AND OTHER EXPENSES I PAID

22. Did the final sale price include all, some, or none of the expenses you paid? *(Circle one number)*

1 ALL OF MY EXPENSES WERE INCLUDED IN THE SALE PRICE
2 SOME OF MY EXPENSES WERE INCLUDED IN THE SALE PRICE
3 NONE OF MY EXPENSES WERE INCLUDED IN THE SALE PRICE

23. In the table below please indicate whether or not you were assisted by each of the following individuals, and if you were, also give the approximate fee you paid.

		NO	YES		AMOUNT OF FEE
a.	Certified Water Right Examiner.	1	2	$	____________
b.	Real Estate Agent	1	2	$	____________
c.	Attorney	1	2	$	____________
d.	Engineer.	1	2	$	____________
	Other (Please Specify) ____________	1	2	$	____________

24. What were the total fees paid by you to the Oregon Water Resources Department? *(If none please write 0)*

_______________ FEE AMOUNT

25. If you were represented by an attorney or agent, did their fee include the Oregon Water Resources Department fees? *(Circle one number)*

1 YES
2 NO
3 NOT APPLICABLE

26. In the table below are a number of services provided in water right transfers. For each individual listed across the top, please indicate whether or not each service was provided for the fee charged.

SERVICES	CERTIFIED WATER RIGHTS EXAMINER		REAL ESTATE AGENT		ATTORNEY		ENGINEER	
	YES	NO	YES	NO	YES	NO	YES	NO
a. Assisted in locating trading partners	1	2	1	2	1	2	1	2
b. Provided advice on the terms of the purchase agreement, including final sale price	1	2	1	2	1	2	1	2
c. Verification of title of ownership	1	2	1	2	1	2	1	2
d. Initial application mapping	1	2	1	2	1	2	1	2
e. Completed and filed water right transfer application with Oregon Water Resources Department	1	2	1	2	1	2	1	2
f. Final proofing survey map and claim of beneficial use	1	2	1	2	1	2	1	2

27. Briefly describe how you located the buyer or the seller with whom you negotiated the water right transfer:

28. Which one of the following best describes why you selected the buyer or the seller r with whom you negotiated the water right transfer. *(Circle one number)*

1 ABLE TO NEGOTIATE THE BEST SALE PRICE WITH THIS PARTY
2 THE ONLY TRADING PARTNER AVAILABLE
3 THEY WERE A NEIGHBOR
4 REFERRAL
5 OTHER (specify ___________)

29. What was the final sale price for the water right?

_________________ SALE PRICE

Finally, a few more general questions about you and your household...

30. What is your principle occupation and in what industry do you work?

_________________ PRINCIPLE OCCUPATION

_________________ INDUSTRY

31. What is your age category ? *(Circle one number)*

1 30 YEARS OR YOUNGER
2 31 TO 45 YEARS
3 46 TO 60 YEARS
4 OVER 60 YEARS

32. What is the highest level of education you have completed? *(Circle one number)*

1 8th GRADE OR LESS
2 SOME HIGH SCHOOL
3 HIGH SCHOOL OR GED
4 TECHNICAL SCHOOL OR TWO YEAR COLLEGE
5 SOME FOUR YEAR COLLEGE OR UNIVERSITY
6 FOUR YEAR COLLEGE DEGREE (BACHELOR'S)
7 SOME GRADUATE SCHOOL
8 GRADUATE OR PROFESSIONAL DEGREE
9 OTHER (please specify) ______________________________

Thank you very much for participating in our survey. Are there any other comments you'd like to make?

APPENDIX E: FOLLOW-UP CARD

Last week a survey seeking information about water rights was mailed to you. Your cooperation in completing and returning the questionnaire is greatly appreciated.

If you have already completed and returned the survey, please accept our thanks. If not, may I urge you to do so today. It is very important that your response be included in this survey concerning Oregon's growing water market.

If by some chance you did not receive the survey, or it got misplaced, please call us right away at (503) 737-1449 and we will send another one to you today.

Sincerely,

Dr. Joe B. Stevens
Professor of Agricultural and Resource Economics

APPENDIX F: SECOND COVER LETTER

August 11, 1995

«Name»
«Address»
«City», «State» «Zip»

Dear «Name»,

About three weeks ago I wrote to you seeking information about Oregon's developing water market. As of today we have not yet received your completed water rights survey.

I am writing to you again because of the significance of each survey in providing an accurate picture of the state's water market. This is the first state wide study of this type that has ever been done. The results of our study are of particular importance to many Oregonians who own or are in need of water rights. The usefulness of our results depends on how accurately people like you are able to provide information on Oregon's water market.

If you have already completed and returned the survey, please accept our thanks. If not, I urge you to do so today. In the event that your survey has been misplaced, a replacement is enclosed.

I will be happy to answer any questions you might have. Please contact me at the above address or call my research associate, **Clay Landry**, at **(503)737-1449**. Your contribution to the success of this research will be greatly appreciated.

Sincerely,

Dr. Joe B. Stevens
Professor of Agricultural and Resource Economics

APPENDIX G

WATER RIGHTS INFORMATION SYSTEM

Water Rights Information System (WRIS) is a database maintained by Oregon Water Resources Department. WRIS is a database of information contained in the legal rights of record. WRIS can be accessed via an Internet connection. The site address to access WRIS is:

snake.wrd.state.or.us

To access WRIS, get to the prompt on your host system where Internet commands can be issue and then type the command *telnet.* and the site address. You will be prompted for a user name. Using all capital letters type:

WRISUSER

A menu of options will then presented. One of the most valuable aspects of WRIS from a researchers perspective is its ability to generate data reports. A variety of reports can be generating ranging from reports on a single water right to reports on all water rights in a single river drainage basin. The generated reports provide information on priority date, water quantity, current status of the right (active, canceled, etc.), and the character of use. Eleven different categories are used in WRIS to characterized water rights. Table G-1 listed the use code expansions used by WRIS.

The Oregon Water Resources Department can be contacted at (503) 378-8455 for additional information regarding WRIS

Table G-1
Water Right Use Classification Codes

AGRICULTURE (1)	DOMESTIC (2)	IRRIGATION (3)
AG-agriculture	DO-Domestic	IC-Primary and Suppl.
CH-Cranberry harvest	DI-/Inc. lawn and garden	IR-Irrigation
CF-Flood harvesting	DN-/Inc. Non-commercial	IS-Supplemental
CR-All cranberry use	DS-/Stock	CI-Cranberries
TC-Temperature control	GD-Group domestic	I*-Irrigation domestic stock
DB-Dairy barn	RR-Rest room	ID-Irrigation and domestic
FR-Frost protection	SC-School	IS-Irrigation and stock
GH-Green house		
MS-Mint still		
NU-Nursery use		

INDUSTRIAL (4)	RECREATION (5)	MISC. (M)
GT-Geothermal	CS-Campground	AH-Air conditioning
IM-/Manufacturing	RC-Recreation	AS-Aesthetic
SM-Sawmill	SW-Swimming	FM-Forest management
SH-Shop		FP-Fire protection
LD-Log deck		GR-Groundwater recharge
CM-Commercial		PA-Pollution abatement
LA-Laboratory		RW-Road construction
		ST-Storage

POWER (6)	FISH (7)	LIVESTOCK (8)
PW-Power	AQ-Aquaculture	LV-Livestock
RM-Ram	FI-Fish	LW-/Wildlife
	FW-/Wildlife	

MUNICIPAL (9)	MINING (0)	WILDLIFE (W)
MU-Municipal	MI-Mining	WI-Wildlife
QM-Quasi-municipal		

APPENDIX H: MULTICOLLINEARITY

Multicollinearity occurs when two or more independent variables or combination of variables are systematically correlated (Griffiths et. al. 1993) . Near perfect collinearity among variables is a statistical problem that makes it difficult to separate out the affects of individual variables. Multicollinearity does not bias the Ordinary Least Squares parameter estimates, but parameter estimates are sensitive to the addition or deletion of observations or to changes in model specification and small changes in data (Griffiths et. al. 1993). Other symptoms of multicollinearity are coefficients with high standard errors and low t-statistics in a model with a high F-statistic and R^2. Other indications are coefficients which have the wrong sign or are of implausible magnitude (Greene 1990).

A correlation matrix and auxilary regression are two test procedures used in the detection of multicollinearity. A correlation matrix provides a measure of the linear association between two independent variables. A commonly used rule is if the correlation coefficient is 0.8 or greater, multicollinearity may be present (Griffiths et.al. 1993). In the intial model, the correlation coefficient between DUTY and RATE was (-0.92779), indicating a strong linear relationship between the two variables. No other variables show strong relationship with any other single variable. Table H-1a and H-1b shows the correlation matrix for the intial model.

Table H-1a
Correlation Matrix

	DUTY	RATE	SENIOR	MILES	ln(ACRES)
DUTY	1.0000				
RATE	-.92779	1.0000			
SENIOR	.11182	-.21596	1.0000		
MILES	-.47383	.52467	.14940	1.0000	
ln(ACRES)	-.26438	.13052	.34312	-.08591	1.0000
YEAR	-.08543	.31409	-.0787	.24922	-.23522
EAST	.36652	-.55271	.05815	-.53828	.08432
AGOUT	-.29832	.19717	-.24946	.34448	-.04774
NONTRAD	-.36929	.27332	-.13855	.38837	.29115
CONSTANT	.64553	-.78946	-.08968	-.58571	-.31312

Table H-1b
Correlation Matrix

	YEAR	EAST	AGOUT	NONTRAD	CONSTANT
YEAR	1.0000				
EAST	-.51336	1.0000			
AGOUT	-.17869	-.00460	1.0000		
NONTRAD	.04397	-.29797	.63178	1.0000	
CONSTANT	-.54744	.52081	-.15350	-.35066	1.0000

Auxiliary regressions were used to detect multicollinearity among a combination of independent variables. Each of the explanatory variables is regressed on the remaining explanatory variables. Multicollinearity is considered to be present if the reported R^2 from the auxiliary regression is relatively high or if the sum of the squared errors is relatively minimal (Griffiths et.al. 1993). Table H-2 reports the results of the auxiliary regressions.

Table H-2
Auxiliary Regression Results

	Dependent Variable	R^2
DUTY	ON OTHER INDEPENDENT VARIABLES	= .9490
RATE	ON OTHER INDEPENDENT VARIABLES	= .9617
SENIOR	ON OTHER INDEPENDENT VARIABLES	= .5776
MILES	ON OTHER INDEPENDENT VARIABLES	= .6244
ln(ACRES)	ON OTHER INDEPENDENT VARIABLES	= .5660
YEAR	ON OTHER INDEPENDENT VARIABLES	= .5306
EAST	ON OTHER INDEPENDENT VARIABLES	= .6562
AGOUT	ON OTHER INDEPENDENT VARIABLES	= .6131
NONTRAD	ON OTHER INDEPENDENT VARIABLES	= .7314

The auxiliary regression results support the strong collinear relationship between DUTY and RATE. The R^2 values from the auxiliary regressions conducted with DUTY and RATE as independent variables are 0.9490 and 0.9617, respectively. The variables DUTY and RATE are similar measures of the quantity of water allowed by the water right. DUTY is the limit on the per acre annual accumulation of water, while RATE measures the flow rate at which the annual accumulation is obtained. The R^2 values from the auxiliary regressions for the other independent variables were also large, indicating a high degree of linear dependency among two or more of the independent variables.

Based on the results of the correlation matrix and the auxiliary regressions, the reduced model was formulated. DUTY was considered to be a more precise measure of the quantity of water a right holder is entitled to receive. For this reason, RATE was dropped from the original model. MILES, AGOUT, and NONTRAD were dropped from the model in an attempt to reduce the multicollinearity in the model. The decision to drop these variables was subjective but guided by the results of the correlation matrix and the auxillary regressions.

AGOUT and NONTRAD were dropped from the model based on the correlation coefficient (.63178) between the two variables and the R^2 value of the auxillary regressions for the two variables (.6131 and .7314 respectively). Individually these results do not indicate a high degree of multicollinearity for a single variable, however, as a group the results indicate that these variables are responsible for a large portion of the multicollinearity in the model. The variable MILES was dropped from the model due to its low t-statistic (.1790) in the initial model and the large R^2 value of the auxillary regression (.6244). An F-subset test was performed on the omitted variables to determine if they were significant as a group in explaining water right prices. The F-test indicated that the set of dropped variables are not significant in explaining water right prices.[16]

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[16] The calculated F value is: $\dfrac{(.5334-.4596)/4}{(1-.5334)/(37-10)} = 1.067$

The critical F-statistic, with 4 and 27 degrees of freedom at the 95% level, is 2.73.

APPENDIX I: HETEROSKEDASTICITY

Heteroskedasticity is the result of non-constancy of the error variance (Griffiths et. al. 1993). More simply stated, the variance of the error term is not constant for all observations. The primary consequence of heteroskedasticity for the OLS estimator is that the variance is no longer smallest among the class of linear estimators. The Breusch-Pagan (BP) test was used to test for the presence of heteroskedasticity in the reduced hedonic price model. The computed BP test statistic was 12.842, and the critical value, χ^2_5, at the 95% level was 11.0705. On the basis of the BP it is concluded that heteroskedasticity was present in the reduced hedonic price model. White's heteroskedasticity-consistent covariance matrix estimation was used to correct for an unknown form of heteroskedasticity.

APPENDIX J: PRICE DETERMINANTS DIFFERENCES FOR COMMERCIAL AND AMENITY WATER SALES

Clearly commercial and amenity water users have different needs and uses of water rights. Descriptive evidence was presented in Chapter Six that illustrated the differences between these two types of market participants. One question that naturally arises is whether or not these differences have a significant effect on the structure of the hedonic price function. If these qualitative differences influence price determinants, then the parameters in the hedonic price model for commercial water right sales may be different from corresponding parameters in the hedonic price model for amenity water right sales (Griffiths et. al. 1993).

To determine this, a statistical model that allows for an interaction effect between commercial and amenity water right sales must be used. The statistical model uses the interaction variable A_i, which is a dummy variable defining whether or not the sale was a commercial or an amenity sale. The variable assumes a value of one for amenity sales and zero for commercial sales. The statistical model assumes that the structural parameters of the hedonic price model are completely different for commercial and amenity water right sales. The statistical model incorporating this flexibility is:

$$\text{Price}_i = \beta_{0i} + \beta_{1i}\text{Duty} + \beta_{2i}\text{Senior} + \beta_{3i}\ln(\text{Acres}) + \beta_{4i}\text{Year} + \beta_{5i}\text{East} \qquad \text{[J-1]}$$

Where

$$\beta_{ji} = \beta_j + \delta_j A_i \; ; \; j = 0,1,2,3,4,5$$

In the equation J-1, the parameter δ_0 is the difference between commercial and amenity sales intercept, and δ_1 is the difference between the DUTY slope for commercial and amenity sales. Similarly, the remaining $\delta_k's$ are the differences in effects of the other variables between commercial and amenity water sales. Using the definition for β_{ji} , the equation J-1 can be rewritten in the following manner:

$$\begin{aligned} \text{Price}_i = {} & \beta_0 + \gamma_0 A_i + \beta_1 \text{Duty} + \gamma_1(A_i\text{Duty}) + \beta_2\text{Senior} + \gamma_2(A_i\text{Senior}) \\ & + \beta_3 \ln(\text{Acres}) + \gamma_3(A_i \ln(\text{Acres})) + \beta_4\text{Year} + \gamma_4(A_i\text{Year}) \\ & + \beta_5\text{East} + \gamma_5(A_i\text{East}) \end{aligned} \qquad [\text{J-2}]$$

Within the context of the model J-2, it can be determined if the expenditures for water right characteristics by commercial and amenity water right sales are the same with regard to price. That is it can be determined if $\gamma_0 = \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$. This determination is an important one, unless it can be shown to be false, commercial and amenity water right sales may be pooled and treated as identical in the estimation of the hedonic price model:

$$\text{Price}_i = \beta_0 + \beta_{1i}\text{Duty} + \beta_{2i}\text{Senior} + \beta_{3i}\ln(\text{Acres}) + \beta_{4i}\text{Year} + \beta_{5i}\text{East} \qquad [\text{J-3}]$$

Otherwise separate hedonic price functions should be estimated for each group (Griffiths et. al. 1993).

The results of the flexible statistical model [J-2] is presented in Table J-1. This table also includes the results for the restricted model [J-3], using all 37 observations. The parameter estimates for the restricted model using only data on commercial water right sales are identical to those in the unrestricted model which were estimated using the data on both commercial and amenity sales. Also, parameter estimates of the restricted model using the amenity sale data is equal to the sum of the corresponding estimates in the unrestricted model and the estimates on the commercial/amenity interaction variables. For example, the parameter estimate for the variable EAST using the amenity sale data is 819.68. This value is equal to the EAST estimate for commercial sales in the full model (382.66), plus the incremental effect for amenity water sales (437.02).

Table J-1
Hedonic Price Modeling Results

Variable	Unrestricted Model		Restricted Model		Restricted Model Commercial		Restricted Model Amenity	
	Est.	t-stat	Est.	t-stat	Est.	t-stat	Est.	t-stat
Duty	-399.04	-5.165	-294.27	-2.828	-399.04	-5.165	-176.22	-1.363
Duty -A_i	222.81	1.479						
Senior	1012.8	3.525	656.25	1.999	1012.80	3.525	-1025.1	-2.556
Senior- A_i	-2037.8	-4.131						
ln(Acres)	-118.39	-1.251	-141.12	-1.685	-118.39	-1.251	-50.73	-0.408
ln(Acres)- A_i	67.66	0.433						
Year	36.71	0.522	30.51	0.506	36.71	0.522	-11.85	-0.229
Year- A_i	-48.56	-0.556						
East	382.66	1.329	371.86	1.219	382.66	1.329	819.68	6.07
East- A_i	437.02	1.374						
Constant	1552.2	4.435	1528.50	3.288	1552.2	4.435	2150.20	7.051
Constant- A_i	598.08	1.288						
SSE	7699200		10844000		5218200		2481000	
Degrees of Freedom	25		31		13		12	
R^2 (Adj. R^2)	.6162 (.4475)		.4596 (.3724)		.6158 (.4680)		.6005 (.4340)	

The results of the F-test indicated that no differences could be detected with regard to price determinants between commercial and amenity water sales. The calculated test statistic is:

$$\frac{(SSE_r - SSE_{ur}) / J}{SSE_{ur} / (n - k)} = F = \frac{(10844000 - 7699200) / 6}{7699200 / 25} = 1.702$$

The $\alpha = .05$ critical value of an $F_{6,25}$ random variable is equal to 2.49. Since $u \leq F_{6,25}$, the null hypothesis that no structural difference between commercial and amenity sales exist can not be rejected. The F-test indicates that commercial and amenity water right sales can be treated as identical and can be pooled for the estimation of the reduced model.

One interesting result was that the coefficient for SENIORITY was significantly different between commercial and amenity water right sales. The result suggests that water rights involved in commercial sales demanded a premium of $1012 per acre. This result is not surprising since most commercial water users are attempting to maximize profits by using water as an input in a production process. Senior water rights traded in amenity sales sold for $1025 per acre less than junior water rights. This result is somewhat surprising since it indicates that senior water rights were less valuable to amenity water users. Amenity water users may not place a premium on the seniority of a water right since they are not dependent on the water in order to produce profits. However, it is unlikely that they would be willing to pay more for junior water rights. It is expected that the coefficient for SENIORITY would be zero for amenity sales if amenity water users were indifferent to the seniority of water right. However, no strong conclusions should be drawn based on these results since no overall significance between these two types of markets could be determined.