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Input-output models are very useful in regional economic impact studies, but the cost of creating a new survey based input-output table is prohibitive in this and most research applications. Nonsurvey methods are generally not good substitutes for a survey-based table which has led to the development of hybrid methods (a combination of survey and nonsurvey methods) of updating input-output model transaction tables. In some research applications a hybrid method can produce a suitable updated transaction table. This thesis presents a hybrid method of updating a regional transaction table for changes in prices and economic structure. Included in the discussion is a method for reconciling the row and column sum discrepancies which occur in the updating procedure.

This study updates a 1977 input-output model from Grant County, Oregon. The model is updated for current prices (1988) and then used to estimate the regional impacts from introducing water markets in Grant County. The impact analysis considers changes in regional and sectoral income caused by water use changes, specifically the impacts from not growing alfalfa (the dominant irrigated crop in Grant County) and in lieu of alfalfa, growing dry-land hay and receiving cash payments from an exogenous buyer.

Water markets have the potential to significantly enhance the efficient allocation of water. Part of the cost of a more efficient allocation is possible adverse effects on a rural economy. This thesis presents a method of updating a regional model, and an application of the model to asses the local impacts from water markets.

Modifying Regional Input-Output Models for Price and Structural Changes: An Oregon Water Market Application in Grant County

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CHAPTER I

INTRODUCTION

This paper presents a method of updating an existing regional input-output (IO) model for current prices, with an application of the updated model. The updating procedure is a hybrid of survey and nonsurvey methods. It relies on published price series data, the researcher's knowledge of the region, and the underlying assumptions of input-output analysis. After updating the model, it was used to estimate the regional economic impact of water markets in Grant County, Oregon.

The construction of an IO model using survey data is expensive and time consuming. The costs involved in constructing a new survey-based IO table places a survey based IO transaction table outside the budget of this and most other research endeavors (Jensen and MacDonald). This has led to the development and proliferation of many "nonsurvey" techniques for the construction of regional transaction tables (Ralston and Hastings, p. 65). These methods are much cheaper, but the general conclusion is that nonsurvey transaction tables "have been judged as inappropriate substitutes for survey-based tables" (Jensen and MacDonald, p. 34). These constraints in budgets and accuracy have led to the development of hybrid methods of developing transaction tables as a practicable substitute for survey-based tables (Ralston and Hastings; Round 1978, 1983; Sasaki and Shibata; Stevens et al.). The updating procedure presented in this paper is a hybrid method, attempting to provide an accurate, replicable, and cost efficient means of updating a regional transaction table.

The updated input-output (IO) model was used to estimate the regional economic impact of changes in water use. Water contributes significantly to many rural economies in Oregon. Water is used for agriculture, recreation, tourism, industry, fisheries, and has environmental value. Because of these many competing uses and the limited supply of water, it must be allocated. This study analyses the regional impact of water allocation methods and changes in Grant County, Oregon.

Water in Oregon and most of the United States is allocated by legal doctrine. The possibility exists to improve the efficiency of water use by allowing market methods and incentives in its allocation. By creating a market in water, the price mechanism would most efficiently allocate water among the various competing uses. However, harmful third party consequences may result from change in water use. The development of an economy is shaped in part by the region's resource endowment and legal environment. Economic and social development proceeds with an implicit assumption of a stable legal framework. By constraining and controlling water use in a region with legal and bureaucratic restrictions, confidence is fostered in the stability of the local water supply and the wealth it generates. Changes in the allocation method risk harming local interests. Any benefits gained by market allocation of water need to be compared to the social and economic costs of the change.

Objectives

This study has three objectives. The first is to present a method of updating a regional transaction table to reflect current prices and economic structure. The second objective is to test the hypothesis that current institutional arrangements affect the distribution of water in Grant County. This will be done by estimating how a market would allocate water in Grant County, and comparing the estimated and current water allocation. The final objective is to estimate the regional and distributional economic impact of transferring significant amounts of water to a buyer outside the county.

Background

All water in Oregon is owned by the state and administered by the Water Resource Department (WRD) (Water Rights, p. 1). The WRD administrates the obtaining of water rights, and all water transfers. A water use certificate is issued for a specific amount of water, for a specific use, at a specific place of diversion and use. Any changes in the specifications from the water use certificate requires approval from the WRD (Water Rights, p. 19).

The legal doctrine used in Oregon and all the Western United States for water allocation is the prior appropriations doctrine.

Simply stated, prior appropriations means "the first person to obtain a water right on a stream is the last to be shut off in times of low stream flows" (Water Rights, p. 1). This doctrine allows the senior right holders on the stream their full allocation. Any flow left over goes to the next senior, and so forth until the entire allocable streamflow is exhausted. In periods of very low stream flow, the most senior will have a full allocation and the most junior will have nothing.

Water is allocated according to Oregon water law. The state's water law contains four basic provisions (Water Rights, p. 2): 1) Water can only be diverted for beneficial uses. 2) The more senior the right, the longer water will be available in times of shortage, (prior appropriations doctrine). 3) A water right is attached to the land; if the land is sold, the water right goes with it. 4) A water right is revoked by nonuse; it is lost if not used for five consecutive years.

Efficient Water Use

Economic theory predicts that two persons[1] with sufficient information, engaging in a voluntary transaction, yields an improvement of each person's utility. Since social utility is the aggregation of individual utilities, social utility increases with each uncoerced transaction. Each uncoerced water transaction in theory is in the best interest of each party and society at large.

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[1] Person used here means an individual or any corporate entity.

On the John Day River diversion and application are the only costs for water use on the John Day River.[2] The rational profit maximizing producer will use water to the point where the marginal cost of the water will equal the marginal benefit of the water. Since the water itself has no cost, it is used to the point where the allocation is exhausted or the marginal benefit of the water equals the pumping and distribution costs. The introduction of efficient water transfers to other uses creates an opportunity cost for the water. The producer uses water to the point where he equates marginal costs and benefits, then sells or leases the remainder to another user. This increases the producer's total profit (profit from water use and sales) and increases the social benefit derived from the water.

A possible alternative to political control of water is the establishing of property rights in the water. Property rights as used in this paper are defined as the establishment of a legal owner of the resource, who decides within the prevailing legal strictures how the resource may be used (Nicholson, p. 724). By establishing property rights in the streamflow, the owner of the resource could use the water for its most productive (profitable) use. The utility maximizing owner could then promote a higher level of social utility by transacting voluntarily for the most productive use of the water.

Establishment of Property Rights

The method of initial allocation of property rights in water is

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[2] This assumes an existing water right with no current outlays in favor of its procurement.

somewhat arbitrary. Under the model of ownership presented in this paper, a current water right, is converted to a property right. The prior appropriation doctrine remains the basis of the streamflow property right. Further clarification of streamflow property rights comes from recommendations for water market policies made by Lovett and Bergland (p. 806) which include:

1) Defining the property as a consumptive[3] and not a diversion right; (e.g. if the right holder can divert 10 cubic feet per second (cfs) and the return flow is 2, the consumptive right is 8 cfs.).

2) The water right is severed from the land to which it is an appurtenance. A corollary to this assumption is that a water right be treated like real estate, subject to taxation and appraisal by an appropriate government agency.

3) The use of the water is not a condition of the property right. This is possible by defining a property right as a consumptive use and not a diversion right.

4) The point of initial diversion is established as the point of property tax, regardless of where the water is used or diverted in the future.

With the definition of property rights as given, it is important to assume that any transaction is uncoerced. A common fear

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[3] A consumptive right understood here includes instream use.

of water markets is that someone outside the region will buy all the water and use it elsewhere, leaving the region economically damaged (Atchison; Richardson 1988). But no water right holder can loose his water right unless he voluntarily sells it. No one except for the state can legally appropriate property against the owner's will.

Allocation of Water

There are various uses for the water in the John Day River, (the principal river in Grant County). It has irrigation, recreational, hydro-electric power, environmental, fisheries, and aesthetic uses. In a market economy, attempting to satisfy various and changing consumer demands, change is inevitable. The value of any economic good or service is a function of the subjective value judgments of individuals (von Mises, p. 51 ff.), and the price of the good or service is a result of the aggregation of those subjective value judgments. Technology, values, tastes and preferences, location preferences, and regional differences in labor and production costs constantly change. Therefore the product and production mix in the economy is in a constant state of change. The efficient allocation of resources is sensitive to changes in the economy, and places the resource at the use with the greatest benefit. The price mechanism communicates society's allocation preferences. In a changing economy the owner of water would best serve society by placing the water where the highest return on the resource can be obtained. The institution of markets in the streamflow will, in theory, allow the price mechanism to efficiently allocate the water between competing uses.

Regional Impacts of Efficient Allocation

Even though the market allocation of water is overall the most efficient (Tregarthen, p. 119), the possibility exists for equity problems; a small rural community may suffer from the creation of greater social benefits. For example, if the owners of the water were to shift from irrigated farming, to dry-land crops and cash payments, the local economy might be adversely impacted. Uncertainty in the area of regional impact of water markets is a possible source of opposition in their further establishment. The regional affects of introducing water markets need to be understood to properly asses the benefits and total costs of a market allocation of water.

Thesis Organization

Organization of this study is as follows: Chapter II contains a literature review of the use of IO models for regional impact analysis and water markets. Chapter III presents the methodology, which contains the theory for the IO model and its updating procedure, and the basis for estimating the water transfers. Chapter IV contains actual and simulated impacts describing the total and distributional affects predicted by the IO model. Chapter V contains conclusions and recommendations for further research.

CHAPTER II

LITERATURE REVIEW

Introduction

The research in this thesis deals with two distinct issues. An extant regional input-output model is modified for changes in current prices and economic structure, then the IO model is used to estimate the regional economic impact of introducing water markets. The first part of this chapter reviews the literature concerning IO model use in impact analysis. The rest of the chapter contains the salient issues of water markets, including, a normative model of water allocation, the nature of water transfers, the Oregon water transfer process, and an assessment of the state of water markets in Oregon.

Impact Analysis

IO models are used extensively in regional impact analysis. The applications include projections of regional impacts caused by the availability of timber (Eppley), irrigation water (Findeis and Whittlesey; Hamilton and Pongtanakorn), and oil development (McNicoll). In the analysis of policy and natural resource management, the use of IO models is one of the most widely used techniques for regional economic impact analysis (Obermiller).

IO Model Limitations and Benefits

An IO model has advantages and disadvantages. IO models have not been very accurate in predicting changes in regional economic activity (Bedzek and Shapiro, p. 35). The basic reason such models are not accurate predictors of economic impact is the technical coefficients [a_{ij}] vary significantly over time (Eskelinen, p. 40). Given the inherent problems with IO model predictions, two considerations make the use of IO models justified. The first consideration is that as inaccurate as the IO may be, empirical studies have shown that IO forecasts are generally as good or better than other econometric methods (Bedzek and Shapiro, p. 30-31,34). Secondly, even if an IO forecast is "relatively poor...one virtue of the forecast however, was its accuracy in predicting the sectoral distribution of [the] impact" (McNicoll, p. 402). "Input-output models provide a wealth of information on the regional distributional impacts of exogenous disturbances--information generally not provided by [other] ...econometric models" (Obermiller). The ability to show the distributional impacts, i.e. which sector gains and which ones loose and by how much, is a strength of IO models, and is applicable to the question of the regional impact of water markets.

There is strong support in the form of empirical studies regarding the limitations and benefits of IO model forecasts to assert a degree of confidence in an impact analysis using a static IO model. The gains in economic efficiency resulting from a change toward market allocation are easily deduced. However, part of the cost of greater overall efficiency may be adverse impacts on a region. The IO model can yield an estimate of the regional and distributional impacts from changes in water use, making it a suitable method for this analysis.

Water Markets

In a free economy where the value of goods produced is the result of the subjective value judgments of individuals, prices of the goods will vary over time. Exogenous conditions, population changes (in total numbers and spatial distribution), and the technological environment will affect prices, and these factors will combine to change the output of the economy and resource allocation. The changing nature of economic sectors has produced the incentive for resource transfers among different uses. Arizona is a good example of the benefits possible from changing water allocation.

> "Eighty-nine percent of Arizona's water is consumed by irrigated agriculture,mines consume 3 percent, while all other uses consume only 8 percent. In 1980, agriculture contributed only 2 percent to Arizona's personal income...The transfer of only 5 percent of the water currently used in agriculture could support...an increase of 50 percent above Arizona's 1985 population" (Saliba and Bush, p. 46).

In the other arid western states similar gains are possible by transferring water from agricultural to municipal and industrial uses. In the western United States, "agriculture is the dominant seller and industries [hydro-electric dams] or municipalities are the principal buyers so that transfer patterns clearly indicate a movement from lower to higher valued uses" (Saliba and Bush, p. 241).

Water Allocation

Water is not like most other resources, and its physical characteristics and importance have led to its special treatment relative to other resources. Water is different in that it flows, seeps, and evaporates; it is more difficult to define and to measure property rights in it (Saliba and Bush, p. 27). Another problem is volatile flow; the amount of water can vary significantly from season to season and from year to year. Another salient feature about water making it difficult to market is the affect on third parties, those not involved in the transfer. "The sale of water nearly always has positive and/or negative direct impacts on third parties" (Howe et al., p. 439). The concerns of third party affects and public preferences have led some to argue that these considerations are not accounted for in private transactions, and since water is so vital to life and ecological concerns that it shouldn't be left to the market to allocate (Emel and Webb, p. 27). Still others contend that since water is so important that it should allocated by the market, "the more important something is the more we need to get government out of the way and let the market handle it" (Finster). Even though there are difficulties in water transfers, difficulties created by the unique physical nature of water and inevitable third party affects, "there is little disagreement that water transfers, including major interbasin transfers, will be increasingly important as a source of reliable water supplies" (Quinn, p. 9).

Given it is in the interest of efficiency that water be put to its best use, there are some general considerations of desireable water allocation. Saliba and Bush, and Howe et al. list six desireable characteristics of the water allocation process (Saliba and Bush, pp. 11-12 and Howe et al., pp. 439-440):

1) Water allocation should be flexible to allow transfers among uses, and location of uses in response to society's changing values.

2) There should be secure expectations in the availability of water.

3) The water must have an opportunity cost so that the water right owner can fully asses the costs and benefits of water use.

4) Social values also incorporated into the opportunity cost so that societal and private interests are reflected in the allocation decision.

5) The transfer process should be well defined so to produce a predictability in the transfer process.

6) The transactions are uncoerced, and costs are not imposed on those not involved in the transfer, including the public.

These six requirements will be used as a working normative hypothesis evaluating water allocation transfer methods.

Water Transfers

There are various methods of nonmarket water transfers. At-cost administration is when a government bureau facilitates the transfer; the only costs to the transfer participants are the administrative costs incurred by the bureau. Forfeiture and abandonment is a mechanism by which a diversion right reverts back to the state and it become part of stream flow, subject again to appropriation. In Oregon, if a water right goes unused for five years it is subject to this provision. The state can also appropriate water rights affecting a transfer through litigation, judicial decrees, eminent domain, and legislative actions to settle conflicting claims (Saliba and Bush, p. 3).

Market transfers have a different nature than those previously mentioned, they have at least three elements involved that make them different from nonmarket transfers (Saliba and Bush, p. 3): 1) water is recognized separate and distinct from the land, 2) buyers and sellers act voluntarily, each transaction is uncoerced, 3) The price is unregulated, the inducements for the transfer, in terms of price or other considerations are left entirely up to the participants in the transaction.

In Oregon a water right is an appurtenant to the land. It is for a specific diversion point, for a specific use on a specified piece of land. If the land is sold the water right is sold with the land. If the water right is transferred to another piece of land the previous piece of land would be appraised at a lower value, and the appraisal on the new land will increase. In a water market the water itself would be valued, bought and sold for its own sake and not with or for the land where the water is used. A corollary to this is a consumptively defined water right (diversion flow - return flow). Since the State's primary concern in water transfers is the protection of other water right holders (Estes), the state is indifferent to type of water use, provided the use is lawful and doesn't impair other right holders. The beneficial use law could stay in place and not hinder the operation of a water market. Economic theory predicts if an opportunity cost for water exists, the owner of the resource will employ the resource to earn the highest return, i.e. beneficial use.

Water is a transferable between different users and uses in Oregon. Oregon Revised Statute (ORS), 540.510 states,

> "the owner of any water right may, upon compliance with [water transfer procedures], change the use or place of use, the point of diversion or the use theretofore made of the water in all cases without losing priority of the water right theretofore established."

A water certificate or permit is issued for a certain amount of diversion, type of use and place of use. (The difference between the certificate and the permit is that the certificate is permanent and the permit is temporary.) If there is a change in any of the criterion[1] a transfer must be filed with the state Water Resource s Department. Transfers can occur between different users, uses,

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[1] A diversion point change of less than 1/4 mile does not require a water transfer.

diversion points, and places of use. The primary considerations for the transfer are beneficial use and no damage to other water right holders.

> "If after a hearing or examination, the Water Resources Commission finds that the proposed change can be affected without injury to existing water rights, the commission shall make an order approving the transfer and fixing a time limit within which the approved changes may be completed" (ORS 540.530(1)).

Apart from noninjury and beneficial use, the Water Resources Department is indifferent about water use and what inducements (money or other consideration) are employed to facilitate the transfer (Estes).

Flexibility in uses is an important characteristic of a water market to the extent it doesn't damage other water right holders. In Idaho and Utah, there are significant transfers from irrigated agriculture to hydro-electric production (Butcher et al. and Saliba and Bush). In Arizona and Colorado, municipalities are very active in acquiring agricultural water rights to meet future water needs (Saliba and Bush, p. 102 ff and p. 134). In Nevada and Idaho, water rights were purchased from irrigators by environmental and sportsman groups concerned with providing streamflow for wildlife habitat and wetlands (Water Market 3.3, p. 3, and 3.4 p. 3). In each of these areas the ideal requirements for a water market are not entirely met, but the activity demonstrates potential gains from transferring water from one use to another.

The need to be flexible in water allocation is recognized by the Oregon legislature and the water resources department. In 1987 the Legislature amended Oregon water law to allow water right holders to recover conserved water. "The Oregon Water Resources Commission adopted rules to 'encourage the highest and best use of the water by allowing the sale or lease of the right to the use of conserved water [Oregon Administrative Rules Chapter 690, Division 18]" (Water Market 2.11, p. 4). Another recent development in Oregon has been changing of instream water rights. "The Oregon Water Resources Commission adopted rules for implementing its instream water right program, including rules for transferring existing diversion rights to instream water rights. [Oregon Administrative Rules 690-77-070 through 075],...,The statute provides that any senior water right converted to an instream right shall retain its original priority date. Also while most western states allow only governmental agencies to hold instream water rights, private individuals and organizations in Oregon retain ownership of converted instream water rights" (Water Market 2.11, p. 6). The Water Resources Department recognizes the importance of allowing a smooth transfer process to promote the best use of the water (Estes).

Oregon's water transfer system is close to the model of a water market as presented earlier. Private negotiation between buyer and seller determines prices. The opportunity cost is reflected in the variety of alternative uses possible. The state or other interest groups can purchase water rights reflecting public concerns. The only variance from the ideal model is the water is appurtenant to the land. This difference could cause a problem in local tax base issues. If the water is taxed as a value added to the land, and the water is used elsewhere, the local area could be adversely affected. Wealth creation and land improvements occurring outside the region, may adversely effect the local economy and tax base. Unless the water is taxed separately from the land, significant local political opposition to the free transfer of water to another region may arise. Even though the ideal criteria for water markets are not met in Oregon, uncoerced transfers are made (Estes) and water is being marketed[2]. This leads to the conclusion that essentially the water available for allocation is a marketable commodity in Oregon.

As with any free market, water markets cannot exist without the state to enforce and protect property rights. The problem of defining and protecting property rights in water makes water markets more difficult than other commodities. A property right in water is "completely described only by a definition covering the quantity diverted and consumed, timing, quality, and places of application and diversion." Any changes in these criteria has the potential to damage other right holders (Howe et al., p. 442). This special problem associated with water transfers necessarily makes the transaction costs high. Since the state has the fundamental responsibility of protecting property rights, it must approve all water transfers (Water Rights, p. 19). This process is necessarily lengthy; the applicant must submit proper documentation including maps of the diversion and application points, a report from a

[2] Actually the water is not bought and sold but rather the right to the water is traded, the water itself is "free" (Estes).

certified water rights examiner, and evidence of use within the last five years (Water Rights, p. 19). Once the documentation is received and evaluated by the Water Resources Department, the region's water master[3] will inspect the site to evaluate potential damage to other right holders (including groups representing public interests). Once tentative approval is given by the state, advertisements of the proposed transfer must be made in a local newspaper for three weeks to inform other right holders. The state's assertion of nondamage can be disputed and a public hearing held to hear grievances from other right holders. A determination will be made concerning the damage the transfer would have on other right holders. Either party can appeal the decision to the state courts. Usually there is no hearing on water transfers, and the transfer process can take two to eighteen months, depending on how well documented and organized the request is (Estes).

Significant efficiency gains are possible by market mechanism allocation of water. In Oregon and the other western states where the prior appropriation doctrine is in effect, radical changes in water law are unnecessary to achieve a fair degree of market efficiency; "water institutions generally need only a 'fine tuning rather than a comprehensive overhaul" (Saliba and Bush, p. 50). There is a general agreement (among water resource economist) that enough water exists to meet future needs in the western states, it just needs efficient allocation. "It will only take time for more

[3] Oregon is divided into 19 water districts (Water Rights, p. 28).

formal water markets to develop...outmoded institutions seem to evolve into new institutions when economic opportunities really exist" (Saliba and Bush, p. 8).

CHAPTER III

METHODOLOGY

Introduction

The methods used in the updating and application of the 1977 Grant County IO model are described in this section. Three basic steps occurred in developing the impact analysis. First, the 1977 Grant County IO (Eppley, p. 43) model was updated for current prices and modified to meet the research needs. Secondly, changes of sales and purchases caused by a change in water use was estimated. Finally associated economic impacts were obtained using the modified IO model and differences in pre-market and post-market purchases and sales.

Modifying the Existing Grant County IO Model

The existing Grant County IO model required modification to meet the needs of this research. The IO model was updated to reflect current (1988) prices. Adjustments also occurred in the ranching and general agriculture sectors of the transaction table. Irrigation activity was separated from ranching and moved to general agriculture. The two ranching sectors in the 1977 model were combined into one sector.

Updating for Current Prices

The Grant County IO model used in the impact analysis is a 1977 model updated to 1988 prices. The updating procedure is a hybrid of survey and nonsurvey methods, relying on published price series data, survey based knowledge of the region's economy, and the underlying assumptions of IO analysis. In developing the basis for price updating an existing transaction table for changes in relative product prices there are two basic considerations: 1) the need to preserve the assumptions of the IO model, 2) the ability to replicate results. This discussion will be presented in four parts, which in their entirety affords others to replicate the results presented here. The first deals with the essential features of a regional transaction table and the fundamental assumptions of IO models. The next part deals with data acquisition, including data sources. In the third portion the relative price updating technique is derived. A procedure to reconcile discrepancies in row and column sums after the transaction table has been modified to reflect current prices is presented in the final section of this discussion.

Input-Output Model Characteristics

The central feature of an IO model is the transaction table (Table 1). This is an accounting device which shows the sales and purchases of endogenous (local) industries to exogenous sectors. The sale and purchases of local industries are the upper left-hand sectors of the transaction table (x_{ij}). Local purchases of non-local products and money transfers, or imports (v_i), appear in the lower left-hand sectors. Local industry sales to exogenous sectors, or exports (y_i), are found in the upper right-hand sectors. The values in the rows represent the sales of each sector, the values in the

Table 1. Generalized Input-Output Model Transaction Table.

Purchasing Sectors Selling Sectors	Intermediate (local) Sectors, $(j = 1,\ldots,n)$			Final Demand (exports)	Total Sales
Intermediate Sectors	X_{11}	X_{1j}	X_{1n}	Y_1	X_1
$(i = 1,\ldots,n)$	X_{i1}	X_{ij}	X_{in}	Y_i	X_i
	X_{n1}	X_{nj}	X_{nn}	Y_n	X_n
Primary Inputs (imports)	V_1	V_j	V_n		ΣV_j
Total Purchases	X_1	X_j	X_n	ΣY_i	Total Output $(\Sigma X_i = \Sigma Xj)$

columns represent purchases. All firms in the region are placed in one of the sectors. These sectors are aggregated groups of similar firms based on similarities in type of output and underlying purchasing patterns.

Let x_{ij} be an entry in the transaction table. The interpretation of this entry is the dollar amount of purchases of input 'i' by sector 'j,' or conversely the dollar amount of sales of output 'i' to sector 'j.'

Necessary Assumptions

There are a number of assumptions necessary in updating the regional transaction table. The first set of assumptions pertain to the IO model, and the second set deals with the price updating procedure. The assumptions used in IO analysis deal with the nature of the production function. According to Chereny and Clark (33-34), there are three basic assumptions incorporated in the IO model.

1) "Each commodity...is supplied by a single...sector" in the economy. There are two corollaries to this assumption:

   i) There is a single method of producing the output. This implies each firm has the same production function, and one production function can be used to describe the production function of the industry.

   ii) Each sector produces one primary output. This requires the researcher to aggregate outputs of firms to represent a homogenous product, effectively eliminating the production of dual outputs by any single sector.

2) "Inputs purchased by each sector are a function only of the level of output of that sector." This assumption is usually further restricted by specifying the production function to be linear (Eppley, p. 44).

3) "The total effect of carrying on several types of production is the [additive] sum of the separate effects." This implies there are no economies or diseconomies of scale.

In addition to the basic IO model assumptions are added three price updating assumptions.

4) From the time of the initial input-output model until the current period there has been no significant changes in the production process. The underlying physical process used to produce the sector's output has remained essentially unchanged.

5) Market conditions are such that there is no difference in the movement of commodity and services prices from the national level compared to the regional level. This assumption allows the use of price series data gathered and aggregated at the national level to be used as prices at the local level.

6) Since each sector is assumed to produce a homogeneous product, the use of a single price series value can be a proxy for the entire sector.

Data Acquisition

The first step in the process of price updating an existing transaction table is the acquisition of price series data. Three publications were used for this, all published by the federal government:

1) "Producer Prices and Price Indexes" (PPI) published by the U.S. Department of Labor, Bureau of Labor Statistics. This publication contains price series data on many different commodities in the U.S. economy.

2) "Consumer Price Index Detailed Report" (CPI), published by the U.S. Department of Labor, Bureau of Labor Statistics.[1]

3) "Economic Report of the President," published by the Council of Economic Advisors. This publication is especially helpful in tracking government expenditures and revenues.

It is necessary to evaluate the composition of economic activity in the region to determine the most applicable price series. This required the gathering of information about the composition of production in the Grant County economy. Both the CPI and the PPI indices are aggregated at various industry and overall levels. For

[1] A note of caution is in order regarding these two sources. The base year of these indexes has changed in the past, and will no doubt be updated in the future as the need arises. It is important that when the prices for a sector are compared and updated that the same base year is used. This may require the adjustment of the final price series by the value of the base year differences.

example, a number represents the price of "hay," another "agricultural commodities," and another "all commodities." The broader aggregations are used if the sector in question is very diverse, (diverse in the sense of numerous and dissimilar subsectors), or if a reasonably appropriate price series in the data cannot be found. If the sector in question consists of large and heterogenous subsectors, a weighted price index for the sector as a whole would be appropriate in the absence of further sectoral disaggregation. The goal of replication of results is hard to attain in this part of the price updating technique. No rigorous procedure on of the most appropriate price series selection exists. The approach used in this research was to gain as much information as practicable in the output mix of the sector in question, then use documented judgement in selecting the most appropriate price index.

Derivation of the Relative Price Updating Procedure

The method of price updating used here is the "Relative Price Updating" procedure reported by Epply (55 ff.). The theoretical basis for this procedure comes from an article written by J.N. Moses. It begins with the derivation of a physical input coefficient, q_{ij}. The x_{ij}s in the transaction table represent the dollar amount of transfers from one sector to another. This value, x_{ij}, is the product of an underlying physical production coefficient and a price ratio. To derive this relationship:

Let $a_{ij} = x_{ij} / X_i$, (1)

where

x_{ij} = dollar amount of input 'i' purchased by sector 'j,' and

X_i = total dollar amount of all sales made by sector 'i.'

(The coefficient 'a_{ij}' is the proportion of sector i's total sales made to sector 'j.')

Now consider a physical production coefficient: Let q_{ij} = the physical amount of input 'i' needed to produce one physical unit of output 'j.' Then x_{ij} can be rewritten as:

$$x_{ij} = q_{ij}\ Q_i\ P_j, \tag{2}$$

where

Q_i = sum of the total physical output of sector 'i.'

P_j = price of input 'j.'

([$q_{ij}\ Q_i$] is the amount of input 'j' purchased by sector 'i.')

And $X_i = Q_i\ P_i$,

where P_i = price of output 'i.'

So:

$$a_{ij} = q_{ij}\ Q_i\ P_j\ /\ Q_i\ P_i \tag{3}$$

$$= q_{ij}\ (P_j/P_i) \tag{4}$$

Therefore each value in the coefficient matrix is a physical production coefficient multiplied by a price ratio.

Now consider this relationship when the prices change,

$$a^0_{ij} = q^0_{ij}\ [P^0_j / P^0_i] \tag{5}$$

$$a^1_{ij} = q^1_{ij}\ [P^1_j / P^1_i] \tag{6}$$

$$q^0_{ij} = q^1_{ij} \qquad \text{(from assumption \#4)}$$

$$q_{ij} = a^0_{ij}\ [P^0_i / P^0_j] = a^1_{ij}\ [P^1_i / P^1_j] \tag{7}$$

$$a^1_{ij} = a^0_{ij}\ [P^0_i / P^0_j]\ [P^1_j / P^1_j] \tag{8}$$

Let

$$P' = [P^0_i P^1_j] / [P^0_j P^1_i], \tag{9}$$

then

$$a^1_{ij} = a^0_{ij}\ P'. \tag{10}$$

The conclusion so far is that the value coefficient after a price change equals the initial value coefficient multiplied by a ratio of product price and input price (Table 2). The next step is to derive the x_{ij} value after the price change.

Let:

$$x^1_{ij} = x^0_{ij}\ [P^1_j / P^0_j] \tag{11}$$

$$X^1_i = X^0_i\ [P^1_i / P^0_i] \tag{12}$$

$$Z_j = [P^1_j / P^0_j] \tag{13}$$

Table 2. (Z_j -- vector of relative price changes for the Grant County transactions table.)

	Price Series			Vector
	1977	1982	1988	Z_j
timber harvesting & hauling	236.5	343.0	116.5	1.69
ranching	173.0	248.0	100.5	1.44
general agriculture	234.2	265.9	195.6	2.22
mining	199.0	296.3	112.1	1.67
lumber & wood products	236.5	343.0	116.5	1.69
food processing	186.1	248.7	115.1	1.54
other manufacturing	206.7	270.5	115.7	1.51
transportation	161.3	262.7	116.1	1.89
communications & utilities	182.7	364.1	106.3	2.12
real estate insurance & finance	127.3	413.4	111.3	3.61
construction	220.9	371.4	118.4	1.99
agricultural serivces	187.8	285.0	108.7	1.65
professional services	173.3	344.3	142.3	2.83
automobile sales & service	165.5	290.4	110.8	1.94
lodging	191.1	343.7	127.0	2.28
cafes & taverns	200.3	312.6	124.1	1.94
wholesale & retail services	171.1	270.0	136.2	2.15
wholesale & retail trade	174.7	293.4	113.5	1.91
households	181.5	292.4	120.3	1.94
local government	273.0	---	652.0	2.39
local agencies of state & fed. govt.	409.2	---	1064	2.60
depreciation & neg. inventory change	194.2	293.4	109	1.65
nonlocal households	181.5	292.4	120.3	1.94
nonlocal government	409.2	---	1064	2.60
nonlocal business	194.2	293.4	109	1.65

Proof:

if (8) and (9) are true then:

$a^1_{ij} = x^1_{ij} \;/\; X^1_i,$ from (1)

$$= x^0_{ij}\ [P^1_j \;/\; P^0_j] \;/\; X^0_i\ [P^1_i \;/\; P^0_i], \tag{14}$$

$$= [x^0_{ij} \;/\; X^0_i]\ [[P^1_j \;/\; P^0_j] \;/\; [P^1_i \;/\; P^0_i]. \tag{15}$$

Recall:

$a^0_{ij} = x^0_{ij} \;/\; X^0_i,$ from (1)

$P' = [P^0_j P^1_j] \;/\; [P^0_i P^1_i],$ from (9)

$$a^1_{ij} = x^1_{ij} \;/\; X^1_i = a^0_{ij}\ P'. \tag{16}$$

Therefore to recover the new x_{ij} coefficient, multiply each row entry in the transaction table by a price change ratio Z_j. This will accurately calculate the new x_{ij} value, and preserve the assumption of no changes in q_{ij}. The new x_{ij} values are the updated values in the new transaction table.

The procedure for obtaining the price revised transaction table is given below, using matrix notation:

Let

X = the original transaction table with dimensions (n x n).

n = the number of sectors in the transaction table.

Z = the diagonal $\{z_1 \ldots z_n\}$, matrix of price ratios (n x n)

$\{Z_j = [P_j^1 / P_j^0]\}$ from (13)

j = the purchase sector (column number).

R = price revised transaction table (n x n)

Then: $R = X\ Z$[2]

Row and Column Sum Reconciliation

After updating an initially balanced transaction table, row and column sums will be unequal.[3] The transaction table is a double entry device where all the sales in the selling sectors are recorded as purchases in the purchasing sectors. Therefore the sum of intermediate and final sales for a given industry should equal the sum of intermediate purchases, employee compensation, and imports. An unbalanced transaction table no longer shows the total sales of a sector equaling its purchases. This is a violation of the nature of a IO model assumptions and requires the row and column sums to be reconciled.

A cause of unequal row and column sums in the transaction table is different price changes among the various sectors in the economy. Another possible source of discrepancies is unequal growth or development within a sector. Each sector in an IO model is an

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[2] Refer to Appendix A, Table A-2, transaction table after initial price update.

[3] The row and column sums will be equal only if each of the product price indices are the same. This is extremely unlikely, making the assertion of unequal column and row sums reasonable.

aggregation of smaller subsectors. If sectors are experiencing growth, while others aren't, this could cause an error to be introduced when adjusting purchases to reflect new prices. If the sector has fairly large and heterogenous subsectors, a weighted price series value could help eliminate some of the row and column sum discrepancy.

Column and row sum reconciliation is somewhat arbitrary, left up to the discretion and judgment of the researcher. "[Some] have called the procedure unscientific and likened it to '...a meeting over the kitchen table'" (Gerking, p. 33). Given the subjective nature of most approaches to row and column sum reconciliation, replication of results is virtually impossible. Each researcher has different perceptions of the adjustments necessary and each will produce a different transaction table.

A primary goal of the reconciliation procedure presented in this paper is the ability to replicate results. This is accomplished by making some basic assumptions about the price revised transaction table (R), and then applying adjustment procedures equally to all rows and columns. While this may introduce errors into the transaction table, it is assumed the errors will cancel each other out.

The concern of errors in the transaction table introduces the idea of IO accuracy. According to Jensen, accuracy in IO models takes the form of partitive and holistic accuracy. Partitive accuracy refers to the accuracy of the individual cells, or the degree to which the transaction table cell entry accurately represents the true transaction value between the two sectors. Holistic accuracy refers to the "accuracy with which the table represents the main features of the economy in a descriptive sense and preserves the importance of these features in an analytical sense" (Jensen, p. 142). Jensen further concludes that holistic accuracy is guaranteed given partitive accuracy, and that there can be a high degree of holistic accuracy without a high degree of partitive accuracy. In the situation of updating an existing model for current prices, partitive accuracy will never be known for certain. Thus holistic accuracy is a reasonable goal, while partitive accuracy is unpracticable.

The assumption made in price updating is that the existing model is holistically accurate. To preserve that accuracy, the price updating technique needs to preserve the assumptions of the original model. The goal of holistic accuracy allows the adjustment of individual cells so the entire model may better reflect the general structure of the true economy.

Given the goal of holistic accuracy, IO model assumptions guide the reconciliation procedure. An IO model is concerned mostly with the nature of production, and its assumptions relate to the nature of the production function. Recall from assumptions two and three that the production process uses fixed input proportions with no economies or diseconomies of scale. This implies that any price change will cause no substitution of inputs, i.e. q_{ij} (the physical production coefficient) remains unchanged (assumption #4[4]). If no significant change in the production process is assumed, then any discrepancy in sales and purchase sums, are in the sales portion of the transaction table. Thus, the column sums are assumed correct and the row sums are assumed to contain the errors. This will necessitate an adjustment of the row sums to equal the column sums for each endogenous sector.

Adjusting the Row Sums to Equal the Column Sums

The transaction table is separated into two general groups of sectors--endogenous and exogenous. Endogenous sectors are those industries which operate within the local region. These sectors buy and sell from other local sectors, buy imports (goods and services produced outside the region), and sell exports (goods and services to non-local sectors). The exogenous sectors buy exports from and sell imports to the endogenous sectors.

When adjusting the row sums to equal the column sums, adjustments are made in the exogenous sectors' columns. This is because of the previous assumption that the endogenous sectors' production functions remain unchanged, or that the local column sums (total purchases) are correct, and any discrepancies must exist within the exogenous sectors. Therefore, the row adjustment must occur in the exogenous sectors to preserve the assumptions of the IO

[4] The assumption of fixed inputs is a rather naive assumption. It makes the procedure easier than other updating techniques, and more sophisticated methods do not provide "dramatic improvements over the naive [fixed inputs over time] model" (McMenamin 204).

model. In essence, adherence to the assumptions of the IO model leads to the conclusion that any significant changes in the nature of production occurred outside the region (Richardson, p. 9). And the changes in sales, which cause unbalanced purchase and sales sums are caused by forces outside the region.

Depending on the specific model the number of exogenous sectors will vary. These sectors include transfers to (from) nonlocal households, transfers to (from) nonlocal business (exports and imports), transfers to (from) nonlocal governments (taxes and expenditures), depreciation and net investment, and changes in inventory. These sectors are aggregated and disaggregated according to the specific needs of the research. By limiting the survey research done in the region, one cannot always tell in which exogenous sector the adjustments should be made. Since one doesn't know where the adjustment should be made, the best solution is to distribute the row sum-column sum discrepancy proportionally among the exogenous entries. The justification for this allocation is the assumption that there is no correlation of the adjustment error terms. In other words the expected value of the sum of the adjustment error terms is zero.

Let

x_{ij} = the true transaction table entries

x'_{ij}= the price revised transaction table entries

δ_{ij} = adjustment term,

then

$$x'_{ij} = x_{ij} + \delta_{ij} + u_{ij}, \tag{17}$$

where u_{ij} is an adjustment error term, and $E[\Sigma u_{ij}] = 0$; (the expected value of the sum of the error terms equals zero). This assumption may be naive on the part of the researcher, but it is no worse, therefore is just as good or better, than the bias introduced by the researcher in arbitrarily adjusting the exogenous cell values. In the absence of pertinent survey data it is reasonable to distribute the adjustment values proportionally among the exogenous sectors.

To adjust the row sums:

1) Calculate final demand, 'y,' for each sector where

$$y_{ik} = \Sigma x_{ik}$$

i = the endogenous sector

k = exogenous sector.

This vector is the value of final demands for each sector, meaning the amount of sales to exogenous sectors by endogenous industries.

2) Calculate the row error, 'e,' for each sector:

$$e_i = \Sigma x_j - \Sigma x_i \tag{18}$$

Where: Σx_j = column sum for sector j (purchases); Σx_i = row sum for sector i (sales) and i = j.

This vector is the value by which each row and column sum vary. Values will be positive or negative. A positive (negative) value shows that final sales are understated (overstated) and that final sales will have to be increased (decreased).

3) Derive a column vector 'g' where

$$g_i = y_i + e_i \tag{19}$$

Refer to Table 3 (e_i, y_i, and g_i values for the 1988 transaction table.)

Consider each element in the vector 'g.' The value g_i is the sum of final demand and the amount of row adjustment and may be less than or greater than zero. If g_i is greater than zero, the adjustments are made only in sales to exogenous sectors. This is the desired result and is addressed as previously discussed. If g_i is less than zero, it means there is not 'enough room' in the exogenous sectors to make the needed adjustments. The adjustments will have to made proportionally among the endogenous and exogenous sectors, thereby distorting the column sums of the endogenous sectors. The interpretation of a negative g_i value is a violation of the assumption of no change in the underlying production functions for some of the endogenous industries purchasing products of the affected sector. The solution is to distribute the row and column sum discrepancy proportionally among all the sectors for the affected row, implying that the researcher cannot know where the changes have taken place in the economy. This process will distort the column

Table 3. Sales and Purchase Sums After Initial Price Updating

	Total Sales Σx_i	-	Total Purchases Σx_j	=	Adjustment Amount e_i	Final Demand y_i	g_i $(y_i + e_i)$
timber harvesting & hauling	12560		10678		1881	2665	4546
ranching	25067		18282		6784	16626	23410
general agriculture	2361		2798		-438	1177	739
mining	9026		8601		425	8601	9026
lumber & wood products	75525		64589		10936	61130	72066
food processing	2215		1900		315	808	1122
other manufacturing	1118		943		175	262	437
transportation	2201		2324		-123	221	98
communications & utilities	11296		13130		-1834	1907	72
real estate, insurance, & finance	8728		17508		-8780	3177	-5603
construction	5012		5239		-228	2546	2319
agricultural services	3149		2978		172	431	602
professional services	6092		8937		-2844	2793	-51
automobile sales & service	21589		22980		-1392	5638	4246
lodging	2697		2908		-211	2435	2224
cafes & taverns	3154		2925		229	1619	1849
wholesale & retail services	2564		2764		-200	411	211
wholesale & retail trade	28743		31313		-2570	3101	532
households	100861		90356		10505	15427	25932
local government	15622		18158		-2536	6174	3638
local agencies of state & fed. govt.	28191		34908		-6717	7941	1224
depreciation & neg. change	26622		6936		19686	0	19686
nonlocal households	9970		316		9654	0	9654
nonlocal government	22220		44968		-22748	458	-22290
nonlocal business	91133		101276		-10143	4399	-5744

sums, but will minimize the effect of that distortion by spreading it out proportionally among the endogenous and exogenous sectors.

If the researcher has information concerning the state of the sector where g_i is less than zero, it would be appropriate to make selective adjustments. As noted a negative g_i indicates a change in the sector's production function. If the change is known to be due to changes in the labor used relative to other inputs, adjustment to the household sector row would be warranted. If the sector in question is in decline consuming its capital, then an adjustment should be made in the capital account row of the affected sector's column. In the presence of better information, the partitive as well as holistic accuracy of the model will be improved using selective adjustments on the appropriate row(s) of the column.

Row and Column Sum Reconciliation Involving Structural Change

To reconcile the row and column sums, first adjust those rows where g_i is negative. This is adjusted first because it changes the column sums of all the relevant sectors. This procedure produces new transaction table entries, x'_{ij}.

$$x'_{ij} = x_{ij} + (x_{ij} \ / \ X_i) \ g_i \tag{20}$$

X_i = the row totals in the price revised transaction table.

This produces different column sums, each time the adjustment is done, and produces a new set of g_i's. Use the initial column sums for all the adjustments for all the rows where g_i's are initially negative. It is possible that new g_i's will turn up negative, in this case the process must be repeated until all the g_i's are positive.

Once all g_i's are positive, adjust the row sums to equal the column sums by adjusting the values of x'_{ij} in the exogenous sectors. Consider only the exogenous cell entries of the endogenous rows.

$$y''_{ij} = y'_{ij} + (x'_{ij} \,/\, y_i)\; g_i \tag{21}$$

x''_{ij} is the final demand portion of the price updated transaction table. Substitute these values into the exogenous sector of the price revised transaction table. This will produce the price updated transaction table with reconciled row and column sums. (Refer to appendix A, table A-3, the final transaction table with row and column sums reconciled.)

Transaction Table Modifications

After updating the IO model for 1988 prices, other modifications were introduced to accommodate the needs of this research. Modifications to the transaction table included aggregation of the dependent and nondependent[5] ranching sectors in the 1977 Grant County IO model, and the irrigated agriculture portion of ranching transferred to general agriculture.

The separation of irrigation activity from the ranching sector

[5] The distinction between dependent and nondependent ranching is that dependent ranching relies heavily on the availability of Federal land for cattle grazing. For the purposes of this research that distinction was unimportant.

was accomplished by transferring alfalfa production inputs from ranching to general agriculture. In 1988, 85 percent of the alfalfa hay produced in Grant County was not sold. It was produced and consumed in the ranching sector (Miles). The adjustment was based on 1988 alfalfa production levels and a Central Oregon alfalfa enterprise budget (Appendix D).

Impact Analysis

The price updated and structurally modified IO model was used to asses the regional and sectoral impacts of water markets. The impact analysis uses the IO model as an analytic method. The IO model is based on the updated transaction table, 'X' (Appendix A, Table A-3). From the transaction table a matrix of direct coefficients a_{ij}'s is derived, 'A.' (Refer to Appendix A, Table A-4.) The Leontief matrix is derived by inverting the difference between an identity matrix and the matrix of direct coefficients, $(I-A)^{-1}$. (Refer to Appendix A, Table A-6.)

The impact analysis relies on the generation of output multipliers. Output multipliers (Table 4 and Appendix A, Table A-6) are derived by summing the endogenous column entries in the Leontief $[(I-A)^{-1}]$ matrix in each sector (Richardson, p. 32). An output multiplier is the total value of production in all sectors of the economy that is necessary to produce a dollar's worth of final demand for sector in question (Miller, p. 102). An output multiplier of 2.00 is interpreted as two dollars of intermediate and final demand (local economic activity) is stimulated by the initial increase in

Table 4. Output Multipliers

local sector	Output Multiplier
timber harvesting & hauling	2.616
ranching	2.585
general agriculture	1.956
mining	1.691
lumber & wood products	2.606
food processing	1.800
other manufacturing	1.815
transportation	1.718
communications & utilities	1.773
real estate & financial services	1.955
construction	2.159
agricultural services	1.522
professional services	2.518
automobile sales and service	1.883
lodging	2.480
cafes & taverns	2.458
wholesale & retail services	2.763
wholesale & retail trade	1.489
households	2.075
local government	2.901
local agencies of state & fed. govt.	1.878

the sale of one dollars worth of final demand. The product of the final demand change and the multiplier is the regional impact of a change in final demand of a sector.

The specific activity subjected to the impact analysis is a conversion of economic activity within the region. Water is used to irrigate crops, mostly alfalfa, in Grant County. The impact analysis estimated the regional and sectoral impact if water generates cash payments to agricultural households in lieu of income generated from the production of alfalfa hay. To accomplish this analysis any changes in intermediate demand caused by the change from irrigated to nonirrigated land uses are treated as changes in final demand.

Regional Impact

Regional impacts were estimated using output multipliers, changes in agricultural sector purchasing patterns and cash payments to households. The product of the output multiplier and the change in sales for the particular sector in question is the total regional impact caused by the change in sales of the affected sector.

$$R = \Sigma\, m_i \delta_i, \tag{22}$$

where

R = total regional impact

m_i = multiplier for sector 'i,'

δ_i = change in sales of sector 'i,'

i = endogenous sectors, and

($m_i \delta_i$ is the regional impact from a change of sales in sector i). The total regional impact is the sum of the sectoral impacts.

Changes in agricultural purchases were estimated using an alfalfa production budget for Central Oregon obtained from the Oregon State University Extension Service (appendix D). Each productive input from the budget was placed in one of the sectors of the Grant County IO model. According IO model assumptions, the inputs to production were treated as linear functions. The export payments for the water was treated as purchases from households by the agriculture sector, and as an export sale. The tax rate on the water payments was the average household tax rate, and payments to local and nonlocal governments were adjusted accordingly.

Sectoral Impact

Each sector will be affected differently by the actions of the agricultural sector. To derive an impact analysis for each sector consider an individual cell entry in the Leontief matrix $[(I-A)^{-1}]$. It is interpreted as the amount of demand created in the row (selling) sector, given one dollar of change in final demand in the column (purchasing) sector. The output multiplier contains each of the individual sector's responding changes in both intermediate and final demands. The sectoral impacts are the product of the Leontief matrix and the vector of sales changes.

$$S = (I-A)^{-1} \delta, \tag{23}$$

where

S = a vector of sectoral impacts (n x 1)

δ = a vector of sales changes (n x 1)

$(I-A)^{-1}$ = Leontief Matrix (n x n)

The interpretation of 'S,' is a vector of impact values for each sector. An individual entry would be understood as the dollar amount of sales changes due to the sales changes, δ, in the region.

Break-Even Price of Water

The impact analysis produced a vector of sectoral impacts for each water value (Appendix C). Each sector shows a negative impact at low water prices and if the water price was high enough each sector would show a positive impact. Since all the relationships are linear in IO model generated impact values, the application of an OLS regression yields a perfectly correlated model. Treating a series of a particular sector's impacts as the independent variable, and the water price as the dependent variable, an OLS regression calculates the sectoral impact as a function of water price. The model was specified as:

$$Y = \alpha + \beta X$$

where:

Y = sectoral impact values,

X = water prices.

After obtaining the coefficients, the impact (Y) was set equal to zero, and then the water price (X′) at zero sectoral impacting solved for.

$$X' = -\alpha / \beta.$$

Where X′ is the break-even price of water. It is interpreted as the price of water (per acre-foot) where the region or a sector is indifferent regarding the sale of water outside the region.

CHAPTER IV

EMPIRICAL RESULTS

This research produced two categories of empirical results. The first deals with the impact on Grant County if water could be transferred at current market prices. The other set of results deal with the regional and sectoral impacts if water were sold as an export commodity.

Actual Impact

The impact of a water market on Grant County is negligible. This conclusion is based on current prices of water in Grant County and by Oregon's water transfer policy. Water not diverted from the John Day river flows to the Columbia River, and through three dams (John Day, The Dalles, and Bonneville). The only opportunity cost quantified in this study for the water is the value to hydroelectric producers. Hydroelectric production is a function of the head (water depth) at the dam and the flow through the dam. These three dams are very low head dams, therefore the value of each acre-foot of water is rather small. Based on the cumulative head of the three dams and the cost of alternative energy supplies, the opportunity cost of water in the John Day river is $7.38 (Butcher et al., pp. 33-35).

The value of water to the irrigator in Grant County is significantly higher than the value to the hydroelectric producer. A 1985 study of the Upper John Day river area by the Bureau of Reclamation (Planning) estimated the value of additional irrigation water at $10 to $24 per acre-foot; "the lower estimate...appears most appropriate as a measure of the value of an additional acre-foot of water in agricultural production under current cropping patterns" (Johnson and Adams, p. 1844).

This study estimated the average value of water for existing irrigators at $15.26 per acre-foot. This value is based on an alfalfa enterprise budget for central Oregon, 1988 hay and alfalfa prices and production in Grant County, (appendix D) and average water usage for alfalfa (State). This value of $15.26 represents the average productive contribution of water to alfalfa production and is the point where agricultural households are indifferent between using the water to produce alfalfa or selling it for a cash.

Given the difference between water value to hydroelectric producers and irrigators, it is reasonable to conclude no transfers of water from the agricultural sector to hydroelectric producers will occur. Therefore implementing a water market will have no economic impact on Grant County.

Simulated Impact

Water transfers aren't occurring because the value of the water to nonagricultural users is too low. No exogenous entity is willing to pay a higher price for the water than its current value. The following analysis considers the regional impact if the water is sold.

The simulation scenario analyzes the regional impacts if an entity outside the region is willing to buy the water. The analysis has two constraints. First, it assumes the buyer is not a significant supplier of inputs in the region. This assumption simplifies the analysis by not requiring massive adjustments to the transaction table with each price condition. Based on historic patterns of water transfers this assumption is reasonable because many transfers have occurred between agricultural users and municipalities. In these transfers the water price has been very high at times and the economic linkages weak (Saliba and Bush).

The second assumption is the water is not sold permanently. The water is leased on a secure, short term basis. This assumption is imposed because it simplifies the analysis, and an arrangement of this nature will allow long term local control of the water.

Based on these assumptions the impact analysis estimated regional and sectoral impacts of transferring water from the region that had previously been used to produce alfalfa. The specific analysis asses the impact of replacing irrigated alfalfa in Grant County, with nonirrigated hay and households receiving cash payments for the leased water. The analysis was performed under varying price conditions. Appendix C and table 5 show the regional and sectoral impacts under various water prices. Table 6 shows the regional and sectoral impacts as a percentage of initial sales.

If the water transfer occurred at $15 per acre-foot, total sales in the county would decline by 0.51 percent. At a price of $100 per acre-foot, an increase of 0.75 percent in sales is predicted. In general the county's economy is unaffected by selling the water outside the region. Though the overall economy is generally unaffected, the agricultural services sector would loose about 15 percent of sales. Because the agricultural services sector has weak linkages to other sectors, it experiences about the same reduction in sales at low and high water prices. At low water prices the county's economy is slightly hurt, while agricultural households are better off. At higher water prices, the county's economy is mildly improved. The agricultural services sector experiences significant and permanent reduction of sales regardless of water price.

A break-even price of water was calculated for the county and for each sector (Table 7). This price of water is where the region or sector is indifferent about whether to sell the water or to use it to produce alfalfa. The price of $15.26 is the break-even price for the agricultural households (those who make the decision to sell the water or to use it). The break-even price for the region is $49.57. At that price the region is as well off as before the sale of the water, but some of the sectors gain and others lose. The agricultural household sector could be induced to sell at a price adversely impacting the region. There are two sectors not affected at all by the actions of a water market, timber and mining. The specific numerical values in the impact analysis are very rough

Table 5. Regional Impact under various water prices (1000's).

water price per acre-foot	$15.00	$25.00	$50.00	$100.00	Initial Sales
region	-1843	-1310	23	2689	359488
timber harvesting & hauling	-0	-0	0	1	12388
ranching	-3	-0	7	21	24032
general agriculture	-396	-395	-391	-383	4663
mining	0	0	0	0	9023
lumber & wood products	-2	-1	3	11	75297
food processing	-4	-1	7	23	2163
other manufacturing	-3	-1	3	10	1112
transportation	-28	-26	-22	-13	2158
communications & utilities	-52	-30	24	133	11165
real estate, finance & insurance	-83	-66	-23	62	8692
construction	-40	-33	-16	18	4906
agricultural services	-478	-477	-474	-467	3127
professional services	-29	-19	7	59	5991
automobile sales & service	-112	-75	18	204	21329
lodging	-2	-0	3	9	2344
cafes & taverns	-4	-1	9	27	2939
wholesale & retail services	-9	-3	12	43	2498
wholesale & retail trade	-90	-25	138	465	28248
households	-328	-33	704	2177	94307
local government	-130	-85	29	256	15010
local agencies of state & fed. govt.	-49	-40	-16	31	28096

Table 6. Percentage Sales Change From Original Levels (percent)

water price per acre-foot	$15.00	$25.00	$50.00	$100.00
region	-0.513	-0.364	0.006	0.748
timber harvesting & hauling	-0.002	-0.001	0.003	0.009
ranching	-0.013	-0.002	0.028	0.088
general agriculture	-8.501	-8.467	-8.380	-8.207
mining	0.000	0.000	0.000	0.000
lumber & wood products	-0.003	-0.001	0.004	0.015
food processing	-0.170	-0.023	0.345	1.081
other manufacturing	-0.259	-0.120	0.228	0.924
transportation	-1.295	-1.216	-1.019	-0.624
communications & utilities	-0.463	-0.269	0.217	1.189
real estate, finance, & insurance	-0.958	-0.761	-0.269	0.716
construction	-0.811	-0.671	-0.322	0.376
agricultural services	-15.299	-15.256	-15.148	-14.933
professional services	-0.483	-0.311	0.120	0.982
automobile sales & service	-0.524	-0.350	0.086	0.957
lodging	-0.064	-0.012	0.118	0.380
cafes & taverns	-0.148	-0.023	0.290	0.915
wholesale & retail services	-0.368	-0.122	0.494	1.726
wholesale & retail trade	-0.319	-0.088	0.490	1.646
households	-0.347	-0.035	0.746	2.309
local government	-0.868	-0.565	0.192	1.708
local agencies of state & fed. govt.	-0.175	-0.141	-0.057	0.111

Table 7. Break-even Price of Water ($/acre-ft)

households	26.12
ranching	26.31
food processing	26.58
cafes & taverns	26.86
lodging	27.34
wholesale & retail trade	28.79
lumber & wood products	29.37
wholesale & retail services	29.96
other manufacturing	33.61
communications & utilities	38.83
professional services	43.05
local government	43.65
automobile sales & service	45.07
Grant County	**49.57**
real estate, finance & insurance	63.65
local agencies of state & fed. govt.	67.01
construction	73.07
transportation	179.14
general agriculture	2473.71
agricultural services	3568.04

estimates. The utility of these values lies in their relative ranking and magnitude.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Summary of the Problem

Water is currently used to produce alfalfa in Grant County. If the water is not used to produce alfalfa, but to grow dry-land hay and receive cash payments, other regional impacts would result. It is generally agreed that economic methods of resource allocation are most efficient, but third party consequences exist to those actions. These potential costs need understanding and quantification. This paper attempted to address the salient issues of water markets, and present a quantitative estimate of actual and potential impacts of water markets on Grant County.

Conclusions

Water markets have the potential to enhance the efficient allocation of water. By using price as aggregation of the subjective value judgments of individuals, the profit seeking owner of the resource best supplies the needs of the populace. The net affect is the water being put to its best (most profitable) use. An ideal water market as presented in this paper has 1) the characteristics of water being considered separate from the land, 2) unregulated price, 3) uncoerced transactions.

In Oregon most of the conditions for an efficient water market already exist. Given the current legal conditions, and the differences of water value to the agricultural and hydroelectric users, no water transfers will occur in Grant county if the institutional arrangements governing water transfers move toward an efficient market.

If a higher valued use for John Day river water existed, a cost of increasing net efficiency would be the impact on Grant County's economy. The empirical results showed that the owners of the water could be induced to sell at a price above $15.26. The county would not be better off until the water price was $49.62. At the regional break-even price, some sectors benefit, others damaged. Some sectors of the economy will never recover regardless of the water price.[1]

This research produced two general conclusions. Under current conditions, no transfers of water will occur from the agricultural to industrial sectors. Secondly if the water is transferred from the region, the region will suffer at a low water price and prosper at a high water price. The impact of any changes will not be distributed equally among the sectors. Some sectors could benefit, others permanently damaged.

Recommendations For Further Study

The suggestion for further research involve questions regarding the updating and use of the IO model. The scenarios used in the

[1] The agricultural and agricultural service sectors of the economy have a theoretical price of water where they would be as well off as before, however this price is very high and it is unreasonable to extend the IO analysis to that point.

impact analysis could be expanded to address other issues. The updating procedure could be empirically tested to gauge its accuracy and applicability.

The scenario involved in the impact analysis was very simple. Other scenarios could be simulated to gain further insights in the regional impact of water marketing. These scenarios include changing crop or electrical prices to the point where the water is more valuable to other users. This research requires the adjustment of the IO model for each crop or electricity price. Another scenario is the sale of water rights, with a one time cash infusion rather than short term leasing.

The procedure for updating the IO model in this paper is based on nonsurvey methods. An empirical test of the updating method would give an indication of the kind of accuracy involved. This research could aid in evaluating the updating technique and help in assessing appropriate research situations using the procedure.

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APPENDICES

APPENDIX A

1977 Grant County Transaction Table

Appendix A, Table A-1: 1977 Grant County Input-Output Model Transaction Table

	timber harvesting & hauling	ranching	general agriculture	mining	lumber & wood products	food processing	other manufacturing	transportation	communications & utilities	real estate, finance & insurance	construction	agricultural services	professional services	automobile sales & service	lodging	cafes & taverns	wholesale & retail services	wholesale & retail trade	households	local government	local agencies of state & fed. govt.	appreciation & pos. inventory change	non-local households	non-local government	non-local business	Total Sales
timber harvesting & hauling	599	1	0	0	4135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1577	0	0	0	6320
ranching	62	2	0	0	442	21	0	0	0	0	0	0	0	5	0	0	0	0	615	3	0	1400	18	15	10107	12690
general agriculture	0	210	45	0	121	0	0	0	0	0	0	0	2	0	0	35	0	23	128	0	166	21	40	0	469	1260
mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5153	5153
lumber & wood products	0	24	0	26	1684	0	0	0	0	0	40	0	---	1	0	0	---	0	264	4	4	3431	0	0	32749	38227
food processing	0	13	0	0	0	0	0	1	0	0	0	0	0	---	---	0	5	127	564	0	0	6	19	0	500	1235
other manufacturing	0	3	0	39	37	---	0	0	0	0	70	0	0	0	0	0	0	12	232	56	1	8	155	0	0	623
transportation	6	12	16	26	651	3	14	1	61	2	12	29	6	28	0	2	1	110	40	85	7	79	17	0	21	1229
communications & utilities	12	223	16	8	404	19	6	13	57	82	27	18	76	186	294	138	94	190	2930	313	192	153	623	98	26	6198
real estate & finance	75	438	30	0	4	22	1	20	58	62	51	0	43	98	138	85	17	235	2358	230	0	688	63	0	128	4844
construction	0	52	23	0	30	0	0	1	2	0	165	0	6	4	1	27	25	35	569	401	12	945	101	0	233	2632
agricultural services	42	1004	8	0	19	0	0	---	0	0	0	0	---	2	0	0	0	0	146	1	322	261	0	0	0	1805
professional services	36	189	10	0	104	6	3	3	8	12	6	18	47	26	11	20	7	11	1511	107	38	180	253	245	300	3161
automobile sales & service	348	405	7	124	819	32	20	---	11	20	21	103	30	1796	13	5	9	43	4064	914	136	974	1363	156	407	11820
lodging	0	12	---	0	10	0	0	1	1	1	0	0	0	0	0	0	1	12	155	4	10	2	456	462	146	1273
cafes & taverns	6	13	---	0	25	5	0	1	2	11	0	0	---	4	0	4	5	10	579	1	8	349	376	10	101	1510
wholesale & retail services	0	41	0	0	10	8	0	2	6	22	11	0	37	87	23	29	18	10	710	73	8	98	12	62	19	1286
wholesale and retail trade	32	1985	8	1030	215	4	17	55	17	12	13	0	28	394	38	260	43	464	9705	411	69	732	804	0	91	16427
households	2816	3677	253	539	11155	288	138	269	1090	1798	875	221	1892	1770	273	453	783	2086	263	2708	5315	473	199	7110	178	46622
local government	3	630	80	3	463	12	12	15	313	10	28	8	8	67	83	27	22	118	2163	953	---	131	4	2450	0	7603
local agencies of state & federal govt.	779	406	15	69	7562	7	13	10	268	11	78	15	57	371	4	44	60	98	184	318	2	11	261	60	2722	13425
depreciation and neg. inventory change	312	1483	93	26	1115	56	58	33	247	19	61	60	55	130	160	35	19	239	0	7	4	0	0	0	0	4212
non-local households	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	100	0	57	0	0	0	0	163
non-local government	276	255	19	5	776	10	9	13	111	11	147	26	63	215	7	108	27	158	10461	8	4413	176	0	0	0	17294
non-local business	916	1612	637	3258	8446	742	332	791	3946	2771	1027	1307	811	6636	228	238	150	12440	8881	1006	2653	2671	0	0	0	61499
Total Purchases	6320	12690	1260	5153	38227	1235	623	1229	6198	4844	2632	1805	3161	11820	1273	1510	1286	16427	46622	7603	13425	14366	4784	10668	53350	268511

Appendix A, Table A-2: 1988 Grant County Input-Output Model Transaction Table After Initial Updating (row and column sums not reconciled)

	timber harvesting & hauling	ranching	general agriculture	mining	lumber & wood products	food processing	other manufacturing	transportation	communications & utilities	real estate, finance & insurance	construction	agricultural services	professional services	automobile sales & service	lodging	cafes & taverns	wholesale & retail services	wholesale & retail trade	households	local government	local agencies of state & fed. govt.	appreciation & pos. inventory change	non-local households	non-local government	non-local business	Total Sales
timber harvesting & hauling	1012	2	0	0	6987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	2665	0	0	0	10678
ranching	89	3	0	0	637	30	0	0	0	0	0	0	0	7	0	0	0	0	886	4	0	2017	26	22	14561	18282
general agriculture	0	466	100	0	269	0	0	0	0	0	0	0	4	0	0	78	0	51	284	0	369	47	89	0	1042	2798
mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8601	8601
lumber & wood products	0	41	0	44	2845	0	0	0	0	0	68	0	0	2	0	0	0	0	446	7	7	5797	0	0	55333	64589
food processing	0	20	0	0	0	0	0	2	0	0	0	0	0	0	0	0	8	195	868	0	0	9	29	0	769	1900
other manufacturing	0	5	0	59	56	0	0	0	0	0	106	0	0	0	0	0	0	18	351	85	2	12	250	0	0	943
transportation	11	23	30	49	1231	6	26	2	115	4	23	55	11	53	0	4	2	208	76	161	13	149	32	0	40	2324
communications & utilities	25	472	34	17	856	40	13	28	121	174	57	38	161	394	623	292	199	403	6207	663	407	324	1320	208	55	13130
real estate, finance & insurance	271	1583	108	0	14	80	4	72	210	224	184	0	155	354	499	307	61	849	8523	831	0	2487	228	0	463	17508
construction	0	104	46	0	60	0	0	2	4	0	328	0	12	8	2	54	50	70	1133	798	24	1881	201	0	464	5239
agricultural services	69	1656	13	0	31	0	0	0	0	0	0	0	0	3	0	0	0	0	241	2	531	431	0	0	0	2978
professional services	102	534	28	0	294	17	8	8	23	34	17	51	133	74	31	57	20	31	4272	303	107	509	744	693	848	8937
automobile sales & service	677	787	14	241	1592	62	39	0	21	39	41	200	58	3492	25	10	17	84	7901	1777	264	1894	2650	303	791	22980
lodging	0	27	0	0	23	0	0	2	2	2	0	0	0	0	0	0	2	27	354	9	23	5	1042	1055	333	2908
cafes & taverns	12	25	0	0	48	10	0	2	4	21	0	0	0	8	0	8	10	19	1121	2	15	676	728	19	196	2925
wholesale & retail services	0	88	0	0	21	17	0	4	13	47	24	0	80	187	49	62	39	21	1526	157	17	211	26	133	41	2764
wholesale & retail trade	61	3784	15	1963	410	8	32	105	32	23	25	0	53	751	72	496	82	884	18499	783	132	1395	1533	0	173	31313
households	5458	7126	490	1045	21619	558	267	521	2112	3485	1696	428	3667	3430	529	878	1517	4043	510	5248	10301	917	386	13780	345	90356
local government	7	1505	191	7	1106	29	29	36	748	24	67	19	19	160	198	64	53	282	5166	2276	0	313	10	5851	0	18158
local agencies of state & fed. govt.	2026	1056	39	179	19663	18	34	26	697	29	203	39	148	965	10	114	156	255	478	827	5	29	679	156	7078	34908
depreciation & neg. inventory change	514	2442	153	43	1836	92	96	54	407	31	100	99	91	214	263	58	31	394	0	12	7	0	0	0	0	6936
non-local households	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	194	0	110	0	0	0	0	316
non-local government	718	663	49	13	2018	26	23	34	289	29	382	68	164	559	18	281	70	411	27201	21	11475	458	0	0	0	44968
non-local business	1508	2655	1049	5365	13909	1222	547	1303	6498	4563	1691	2152	1336	10928	375	392	247	20486	14625	1657	4369	4399	0	0	0	101276
Total Purchases	12560	25067	2361	9026	75525	2215	1118	2201	11296	8728	5012	3149	6092	21589	2697	3154	2564	28743	100861	15622	28191	26622	9970	22220	91133	517714

Appendix A, Table A-3: 1988 Grant County Input-Output Model Modified Transaction Table

	timber harvesting & hauling	ranching	general agriculture	mining	lumber & wood products	food processing	other manufacturing	transportation	communications & utilities	real estate, finance & insurance	construction	agricultural services	professional services	automobile sales & service	lodging	cafes & taverns	wholesale & retail services	wholesale & retail trade	households	local government	local agencies of state & fed. govt.	appreciation & pos. inventory change	non-local households	non-local government	non-local business	Total Sales
timber harvesting & hauling	1012	2	0	0	6987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	4374	0	0	0	12388
ranching	89	3	0	0	637	30	0	0	0	0	0	0	0	7	0	0	0	0	886	4	0	2723	35	29	19590	24032
general agriculture	0	2837	100	0	269	0	0	0	0	0	0	0	4	0	0	78	0	51	284	0	369	27	51	0	594	4663
mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9023	9023
lumber & wood products	0	41	0	44	2845	0	0	0	0	0	68	0	0	2	0	0	0	0	446	7	7	6813	0	0	65026	75297
food processing	0	20	0	0	0	0	0	2	0	0	0	0	0	0	0	0	8	195	868	0	0	12	39	0	1020	2163
other manufacturing	0	5	0	59	56	0	0	0	0	0	106	0	0	0	0	0	0	18	351	85	2	20	410	0	0	1112
transportation	11	23	30	49	1231	6	26	2	115	4	23	55	11	53	0	4	2	208	76	161	13	37	8	0	10	2158
communications & utilities	22	402	29	14	729	34	11	23	103	148	49	32	137	336	530	249	170	343	5287	565	346	273	1112	175	46	11165
real estate finance & insurance	135	732	111	0	7	40	2	36	105	224	92	0	77	177	249	153	31	423	4249	414	0	1100	111	0	225	8692
construction	0	101	48	0	60	0	0	2	4	0	328	0	12	8	2	54	50	70	1133	798	24	1635	175	0	403	4906
agricultural services	69	767	903	0	31	0	0	0	0	0	0	0	0	3	0	0	0	0	241	2	531	580	0	0	0	3127
professional services	69	364	19	0	200	12	6	6	15	23	12	35	133	50	21	39	13	21	2912	206	73	288	479	446	547	5991
automobile sales & service	677	768	33	241	1592	62	39	0	21	39	41	200	58	3492	25	10	17	84	7901	1777	264	1339	1874	214	560	21329
lodging	0	27	0	0	23	0	0	2	2	2	0	0	0	0	0	0	2	27	354	9	23	4	801	811	256	2344
cafes & taverns	12	25	0	0	48	10	0	2	4	21	0	0	0	8	0	8	10	19	1121	2	15	682	735	20	197	2939
wholesale & retail services	0	88	0	0	21	17	0	4	13	47	24	0	80	187	49	62	39	21	1526	157	17	74	9	47	14	2498
wholesale & retail trade	61	3784	15	1963	410	8	32	105	32	23	25	0	53	751	72	496	82	884	18499	783	132	16	18	0	2	28248
households	5458	6824	792	1045	21619	558	267	521	2112	3485	1696	428	3667	3430	529	878	1517	4043	510	5248	10301	1151	484	17309	433	94307
local government	7	1485	211	7	1106	29	29	36	748	24	67	19	19	160	198	64	53	282	5166	2276	0	153	5	2868	0	15010
local agencies of state & fed. govt.	2026	1056	39	179	19663	18	34	26	697	29	203	39	148	965	10	114	156	255	478	827	5	4	97	22	1007	28096
depreciation & neg. inventory change	514	1363	1233	43	1836	92	96	54	407	31	100	99	91	214	263	58	31	394	0	12	7	0	0	0	0	6936
non-local households	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	194	0	110	0	0	0	0	316
non-local government	718	663	49	13	2018	26	23	34	289	29	382	68	164	559	18	281	70	411	27201	21	11475	458	0	0	0	44968
non-local business	1508	2655	1049	5365	13909	1222	547	1303	6498	4563	1691	2152	1336	10928	375	392	247	20486	14625	1657	4369	4399	0	0	0	101276
Total Purchases	12388	24032	4663	9023	75297	2163	1112	2158	11165	8692	4906	312	5991	21329	2344	2939	2498	28248	94307	15010	28096	26161	6440	21941	98953	512984

Appendix A, Table A-4: 1988 Grant County Input-Output Model Coeficient Matrix (A)

	timber harvesting & hauling	ranching	general agriculture	mining	lumber & wood products	food processing	other manufacturing	transportation	communications & utilities	real estate, finance & insurance	construction	agricultural services	professional services	automobile sales & service	lodging	cafes & taverns	wholesale & retail services	wholesale & retail trade	households	local government	local agencies of state & fed. govt.
timber harvesting & hauling	0.082	0.000	0.000	0.000	0.093	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ranching	0.007	0.000	0.000	0.000	0.008	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.000
general agriculture	0.000	0.118	0.021	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.026	0.000	0.002	0.003	0.000	0.013
mining	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
lumber & wood products	0.000	0.002	0.000	0.005	0.038	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000
food processing	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.007	0.009	0.000	0.000
other manufacturing	0.000	0.000	0.000	0.007	0.001	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.006	0.000
transportation	0.001	0.001	0.006	0.005	0.016	0.003	0.024	0.001	0.010	0.000	0.005	0.018	0.002	0.002	0.000	0.001	0.001	0.007	0.001	0.011	0.000
communications & utilities	0.002	0.017	0.006	0.002	0.010	0.016	0.010	0.011	0.009	0.017	0.010	0.010	0.023	0.016	0.226	0.085	0.068	0.012	0.056	0.038	0.012
real estate finance & inrurance	0.011	0.030	0.024	0.000	0.000	0.018	0.002	0.017	0.009	0.026	0.019	0.000	0.013	0.008	0.106	0.052	0.012	0.015	0.045	0.028	0.000
construction	0.000	0.004	0.010	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.067	0.000	0.002	0.000	0.001	0.018	0.020	0.002	0.012	0.053	0.001
agricultural services	0.006	0.032	0.194	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.019
professional services	0.006	0.015	0.004	0.000	0.003	0.005	0.005	0.003	0.001	0.003	0.002	0.011	0.022	0.002	0.009	0.013	0.005	0.001	0.031	0.014	0.003
automobile sales & service	0.055	0.032	0.007	0.027	0.021	0.029	0.035	0.000	0.002	0.004	0.008	0.064	0.010	0.164	0.011	0.003	0.007	0.003	0.084	0.118	0.009
lodging	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.004	0.001	0.001
cafes & taverns	0.001	0.001	0.000	0.000	0.001	0.004	0.000	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.003	0.004	0.001	0.012	0.000	0.001
wholesale & retail services	0.000	0.004	0.000	0.000	0.000	0.008	0.000	0.002	0.001	0.005	0.005	0.000	0.013	0.009	0.021	0.021	0.015	0.001	0.016	0.010	0.001
wholesale & retail trade	0.005	0.157	0.003	0.218	0.005	0.004	0.029	0.049	0.003	0.003	0.005	0.000	0.009	0.035	0.031	0.169	0.033	0.031	0.196	0.052	0.005
households	0.441	0.284	0.170	0.116	0.287	0.258	0.241	0.242	0.189	0.401	0.346	0.137	0.612	0.161	0.226	0.299	0.608	0.143	0.005	0.350	0.367
local government	0.001	0.062	0.045	0.001	0.015	0.013	0.026	0.017	0.067	0.003	0.014	0.006	0.003	0.008	0.085	0.022	0.021	0.010	0.055	0.152	0.000
local agencies of state & fed. govt.	0.164	0.044	0.008	0.020	0.261	0.008	0.030	0.012	0.062	0.003	0.041	0.012	0.025	0.045	0.004	0.039	0.062	0.009	0.005	0.055	0.000
depreciation & neg. inventory change	0.041	0.057	0.264	0.005	0.024	0.043	0.086	0.025	0.036	0.004	0.020	0.032	0.015	0.010	0.112	0.020	0.013	0.014	0.000	0.001	0.000
non-local households	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.004
non-local government	0.058	0.028	0.011	0.001	0.027	0.012	0.021	0.016	0.026	0.003	0.078	0.022	0.027	0.026	0.008	0.096	0.028	0.015	0.288	0.001	0.408
non-local business	0.122	0.110	0.225	0.595	0.185	0.565	0.492	0.604	0.582	0.525	0.345	0.688	0.223	0.512	0.160	0.133	0.099	0.725	0.155	0.110	0.155
	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix A, Table A-5: 1988 Grant County Input-Output Model Technology Matrix (I-A)

	timber harvesting & hauling	ranching	general agriculture	mining	lumber & wood products	food processing	other manufacturing	transportation	communications & utilities	real estate, finance & insurance	construction	agricultural services	professional services	automobile sales & service	lodging	cafes & taverns	wholesale & retail services	wholesale & retail trade	households	local government	local agencies of state & fed. govt.
timber harvesting & hauling	0.918	-0.000	0.000	0.000	-0.093	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.000
ranching	-0.007	1.000	0.000	0.000	-0.008	-0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.000	0.000	0.000	0.000	0.000	-0.009	-0.000	0.000
general agriculture	0.000	-0.118	0.979	0.000	-0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	-0.026	0.000	-0.002	-0.003	0.000	-0.013
mining	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
lumber & wood products	0.000	-0.002	0.000	-0.005	0.962	0.000	0.000	0.000	0.000	0.000	-0.014	0.000	0.000	-0.000	0.000	0.000	0.000	0.000	-0.005	-0.000	-0.000
food processing	0.000	-0.001	0.000	0.000	0.000	1.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003	-0.007	-0.009	0.000	0.000
other manufacturing	0.000	-0.000	0.000	-0.007	-0.001	0.000	1.000	0.000	0.000	0.000	-0.022	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	-0.004	-0.006	-0.000
transportation	-0.001	-0.001	-0.006	-0.005	-0.016	-0.003	-0.024	0.999	-0.010	-0.000	-0.005	-0.018	-0.002	-0.002	0.000	-0.001	-0.001	-0.007	-0.001	-0.011	-0.000
communications & utilities	-0.002	-0.017	-0.006	-0.002	-0.010	-0.016	-0.010	-0.011	0.991	-0.017	-0.010	-0.010	-0.023	-0.016	-0.226	-0.085	-0.068	-0.012	-0.056	-0.038	-0.012
real estate & financial services	-0.011	-0.030	-0.024	0.000	-0.000	-0.018	-0.002	-0.017	-0.009	0.974	-0.019	0.000	-0.013	-0.008	-0.106	-0.052	-0.012	-0.015	-0.045	-0.028	0.000
construction	0.000	-0.004	-0.010	0.000	-0.001	0.000	0.000	-0.001	-0.000	0.000	0.933	0.000	-0.002	-0.000	-0.001	-0.018	-0.020	-0.002	-0.012	-0.053	-0.001
agricultural services	-0.006	-0.032	-0.194	0.000	-0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	-0.000	0.000	0.000	0.000	0.000	-0.003	-0.000	-0.019
professional services	-0.006	-0.015	-0.004	0.000	-0.003	-0.005	-0.005	-0.003	-0.001	-0.003	-0.002	-0.011	0.978	-0.002	-0.009	-0.013	-0.005	-0.001	-0.031	-0.014	-0.003
automobile sales & service	-0.055	-0.032	-0.007	-0.027	-0.021	-0.029	-0.035	0.000	-0.002	-0.004	-0.008	-0.064	-0.010	0.836	-0.011	-0.003	-0.007	-0.003	-0.084	-0.118	-0.009
lodging	0.000	-0.001	0.000	0.000	-0.000	0.000	0.000	-0.001	-0.000	-0.000	0.000	0.000	0.000	0.000	1.000	0.000	-0.001	-0.001	-0.004	-0.001	-0.001
cafes & taverns	-0.001	-0.001	0.000	0.000	-0.001	-0.004	0.000	-0.001	-0.000	-0.002	0.000	0.000	0.000	-0.000	0.000	0.997	-0.004	-0.001	-0.012	-0.000	-0.001
wholesale & retail services	0.000	-0.004	0.000	0.000	-0.000	-0.008	0.000	-0.002	-0.001	-0.005	-0.005	0.000	-0.013	-0.009	-0.021	-0.021	0.985	-0.001	-0.016	-0.010	-0.001
wholesale & retail trade	-0.005	-0.157	-0.003	-0.218	-0.005	-0.004	-0.029	-0.049	-0.003	-0.003	-0.005	0.000	-0.009	-0.035	-0.031	-0.169	-0.033	0.969	-0.196	-0.052	-0.005
households	-0.441	-0.284	-0.170	-0.116	-0.287	-0.258	-0.240	-0.241	-0.189	-0.401	-0.346	-0.137	-0.612	-0.161	-0.226	-0.299	-0.607	-0.143	0.995	-0.350	-0.367
local government	-0.001	-0.062	-0.045	-0.001	-0.015	-0.013	-0.026	-0.017	-0.067	-0.003	-0.014	-0.006	-0.003	-0.008	-0.085	-0.022	-0.021	-0.010	-0.055	0.848	0.000
local agencies of state & fed. govt.	-0.164	-0.044	-0.008	-0.020	-0.261	-0.008	-0.030	-0.012	-0.062	-0.003	-0.041	-0.012	-0.025	-0.045	-0.004	-0.039	-0.062	-0.009	-0.005	-0.055	1.000
depreciation & neg. inv. change	-0.041	-0.057	-0.264	-0.005	-0.024	-0.043	-0.086	-0.025	-0.036	-0.004	-0.020	-0.032	-0.015	-0.010	-0.112	-0.020	-0.013	-0.014	0.000	-0.001	-0.000
non-local households	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.000	-0.002	0.000	-0.004
non-local govermnet	-0.058	-0.028	-0.011	-0.001	-0.027	-0.012	-0.021	-0.016	-0.026	-0.003	-0.078	-0.022	-0.027	-0.026	-0.008	-0.096	-0.028	-0.015	-0.288	-0.001	-0.408
non-local business	-0.122	-0.110	-0.225	-0.595	-0.185	-0.565	-0.491	-0.603	-0.582	-0.525	-0.345	-0.688	-0.223	-0.512	-0.160	-0.133	-0.099	-0.725	-0.155	-0.110	-0.155

Appendix A, Table A-6: 1988 Grant County Input-Output Model Leontief Matrix $(I-A)^{-1}$

	timber harvesting & hauling	ranching	general agriculture	mining	lumber & wood products	food processing	other manufacturing	transportation	communications & utilities	real estate, finance & insurance	construction	agricultural services	professional services	automobile sales & service	lodging	cafes & taverns	wholesale & retail services	wholesale & retail trade	households	local government	local agencies of state & fed. govt.
timber harvesting & hauling	1.089	0.001	0.000	0.001	0.106	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.001
ranching	0.015	1.005	0.003	0.002	0.015	0.018	0.003	0.003	0.003	0.005	0.005	0.002	0.008	0.003	0.005	0.005	0.008	0.002	0.012	0.007	0.005
general agriculture	0.007	0.125	1.024	0.002	0.012	0.004	0.002	0.002	0.003	0.003	0.004	0.001	0.006	0.003	0.003	0.031	0.006	0.003	0.007	0.005	0.016
mining	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
lumber & wood products	0.004	0.005	0.002	0.006	1.043	0.002	0.002	0.002	0.002	0.003	0.018	0.001	0.004	0.002	0.003	0.003	0.005	0.001	0.006	0.005	0.003
food processing	0.008	0.008	0.004	0.004	0.007	1.004	0.004	0.005	0.004	0.006	0.006	0.002	0.009	0.004	0.006	0.007	0.013	0.009	0.013	0.008	0.005
other manufacturing	0.003	0.004	0.002	0.008	0.004	0.002	1.002	0.002	0.002	0.003	0.026	0.001	0.004	0.002	0.003	0.003	0.005	0.002	0.006	0.011	0.002
transportation	0.005	0.008	0.013	0.009	0.021	0.005	0.026	1.003	0.013	0.003	0.009	0.019	0.006	0.005	0.007	0.007	0.007	0.009	0.006	0.018	0.003
communications & utilities	0.056	0.065	0.035	0.021	0.059	0.046	0.039	0.038	1.037	0.056	0.051	0.028	0.083	0.043	0.274	0.132	0.134	0.030	0.086	0.101	0.047
real estate, finance & insurance	0.054	0.071	0.046	0.016	0.037	0.042	0.024	0.038	0.031	1.057	0.052	0.014	0.060	0.029	0.144	0.091	0.064	0.029	0.069	0.078	0.027
construction	0.014	0.022	0.021	0.005	0.014	0.009	0.009	0.009	0.011	0.010	1.083	0.005	0.018	0.007	0.018	0.033	0.040	0.008	0.023	0.081	0.010
agricultural services	0.014	0.059	0.200	0.002	0.011	0.003	0.002	0.002	0.003	0.002	0.004	1.001	0.004	0.003	0.003	0.009	0.005	0.002	0.005	0.005	0.024
professional services	0.031	0.037	0.019	0.008	0.025	0.019	0.018	0.015	0.014	0.021	0.021	0.019	1.051	0.014	0.029	0.033	0.036	0.009	0.042	0.041	0.019
automobile sales & service	0.156	0.120	0.070	0.059	0.110	0.081	0.088	0.043	0.052	0.067	0.077	0.103	0.107	1.233	0.090	0.075	0.113	0.031	0.141	0.250	0.067
lodging	0.003	0.004	0.001	0.001	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.001	0.003	0.001	1.002	0.003	0.005	0.002	0.005	0.004	0.003
cafes & taverns	0.010	0.008	0.004	0.003	0.008	0.009	0.005	0.005	0.004	0.009	0.007	0.003	0.010	0.004	0.007	1.010	0.015	0.003	0.015	0.009	0.006
wholesale & retail services	0.015	0.017	0.008	0.005	0.013	0.016	0.008	0.009	0.009	0.016	0.016	0.005	0.030	0.017	0.034	0.034	1.034	0.006	0.024	0.029	0.010
wholesale & retail trade	0.165	0.288	0.078	0.273	0.143	0.091	0.113	0.126	0.079	0.118	0.123	0.051	0.187	0.111	0.150	0.296	0.224	1.081	0.265	0.222	0.107
households	0.708	0.540	0.320	0.214	0.598	0.375	0.359	0.341	0.322	0.523	0.527	0.215	0.813	0.300	0.500	0.539	0.856	0.215	1.223	0.685	0.469
local government	0.058	0.127	0.082	0.021	0.068	0.048	0.061	0.048	0.106	0.046	0.061	0.026	0.069	0.037	0.159	0.080	0.098	0.031	0.094	1.241	0.038
local agencies of state & fed. govt.	0.202	0.073	0.026	0.032	0.310	0.024	0.046	0.024	0.078	0.020	0.067	0.024	0.051	0.066	0.044	0.067	0.095	0.018	0.033	0.101	1.015
depreciation & neg. inventory change	0.057	0.103	0.282	0.012	0.042	0.050	0.093	0.031	0.042	0.011	0.032	0.036	0.027	0.018	0.130	0.041	0.028	0.019	0.015	0.018	0.011
non-local households	0.002	0.002	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.003	0.002	0.005
non-local government	0.363	0.230	0.125	0.084	0.344	0.138	0.151	0.130	0.157	0.171	0.272	0.099	0.296	0.151	0.187	0.295	0.331	0.088	0.383	0.264	0.558
non-local business	0.578	0.666	0.591	0.903	0.611	0.810	0.754	0.837	0.800	0.817	0.694	0.863	0.675	0.830	0.682	0.662	0.638	0.892	0.600	0.717	0.426
Output Multipliers	2.617	2.586	1.957	1.691	2.606	1.800	1.814	1.718	1.774	1.969	2.159	1.522	2.526	1.883	2.481	2.459	2.764	1.490	2.076	2.902	1.879

APPENDIX B

Price Series Scalers

Appendix B

Price Series Scalers

Sources for price update vector:

CPI: Consumer Price Index Detailed Report. United States Department of Labor, Bureau of Labor Statistics.

ERP: Economic Report of the President. Council of Economic Advisors.

PPI: Producer Prices and Price Indexes. United States Department of Labor, Bureau of Labor Statistics.

Sector	Source
timber harvesting hauling	PPI Table 4B "lumber & wood products-& other softwood"
ranching	PPI Table 4B "livestock"
general agriculture	PPI Table 4B "hay"
mining	PPI Table 4B "concrete ingredients"
lumber & products	PPI Table 4B "lumber & wood products-wood -other softwood"
food processing	PPI Table 4B "processed foods and feed"
other manufacturing & processing	PPI Table 4B "misc. metal products"
transportation	PPI Table 4B "transportation equipment"
communications & utilities	CPI Table 4A "fuel & utilities"
real estate, finance insurance	CPI Table 4A "bank services"
construction	PPI Table 5 "construction materials"

agricultural services	PPI Table 4B "agricultural chemicals"
professional services	CPI Table 4A "medical care"
automobile sales & service	CPI Table 4A "private transportation"
lodging	CPI Table 4A "shelter"
cafes & taverns	CPI Table 3A "food away from home"
wholesale & retail services	CPI Table 1A "other services"
wholesale & retail trade	CPI Table 1A "commodities"
households	CPI "all items"
local government	CPI Table 4a "property taxes"
local agencies of state & fed. govt.	ERP Table B-76 "outlays"
Depreciation/Negative Inventory Change	CPI "all items"
Nonlocal households	CPI "all items"
Nonlocal government	ERP Table B-76 "expenditures"
Nonlocal business	PPI "all commodities"

APPENDIX C

Impact Analysis Results

Appendix C. Impact Analysis Results (1000's), (changes sector's sales under various water prices)

Water Price ($/acre-foot)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
Total Regional Impact	-2642	-2376	-2109	-1843	-1576	-1310	-1043	-777	-510	-243	23	290	556	823	1089	1356	1622	1889	2155
timber harvesting & hauling	-1	-0	-0	-0	-0	-0	-0	0	0	0	0	0	0	1	1	1	1	1	1
ranching	-8	-6	-5	-3	-2	-0	1	2	4	5	7	8	10	11	12	14	15	17	18
general agriculture	-399	-398	-397	-396	-396	-395	-394	-393	-392	-392	-391	-390	-389	-388	-388	-387	-386	-385	-384
mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lumber & wood products	-5	-4	-3	-2	-1	-1	0	1	2	2	3	4	5	6	6	7	8	9	10
food processiong	-8	-7	-5	-4	-2	-1	1	3	4	6	7	9	11	12	14	15	17	19	20
other manufacturing	-5	-4	-4	-3	-2	-1	-1	0	1	2	3	3	4	5	6	6	7	8	9
transportation	-31	-30	-29	-28	-27	-26	-25	-25	-24	-23	-22	-21	-20	-19	-19	-18	-17	-16	-15
communications & utilities	-84	-73	-63	-52	-41	-30	-19	-8	3	13	24	35	46	57	68	79	89	100	111
insurance, finance & real estate	-109	-100	-92	-83	-75	-66	-58	-49	-40	-32	-23	-15	-6	2	11	19	28	37	45
construction	-50	-47	-43	-40	-36	-33	-30	-26	-23	-19	-16	-12	-9	-6	-2	1	5	8	12
agricultural services	-480	-480	-479	-478	-478	-477	-476	-476	-475	-474	-474	-473	-472	-472	-471	-470	-470	-469	-468
professional services	-44	-39	-34	-29	-24	-19	-13	-8	-3	2	7	12	18	23	28	33	38	43	48
automobile sales & servise	-168	-149	-130	-112	-93	-75	-56	-37	-19	-0	18	37	55	74	93	111	130	148	167
lodging	-3	-3	-2	-2	-1	-0	0	1	2	2	3	3	4	5	5	6	6	7	8
cafes & taverns	-10	-8	-6	-4	-3	-1	1	3	5	7	9	10	12	14	16	18	20	21	23
wholesale & retail services	-18	-15	-12	-9	-6	-3	0	3	6	9	12	15	18	22	25	28	31	34	37
wholesale & retail trade	-188	-155	-123	-90	-57	-25	8	41	73	106	138	171	204	236	269	302	334	367	400
households	-770	-622	-475	-328	-180	-33	114	262	409	556	704	851	998	1146	1293	1440	1588	1735	1882
local government	-199	-176	-153	-130	-108	-85	-62	-39	-17	6	29	52	74	97	120	143	165	188	211
local agencies of state & federal govt.	-63	-59	-54	-49	-44	-40	-35	-30	-26	-21	-16	-11	-7	-2	3	8	12	17	22

Appendix C. Impact Analysis Results (1000's), (changes sector's sales under various water prices)

Water price ($/acre-foot)	85	90	95	100	125	150	175	200	225	250	275	300	325	350	375	375	400	425	450
Total Regional Impact	1889	2155	2422	2689	4021	5354	6687	8020	9352	10685	12018	13351	14683	16016	17349	17349	18681	20014	21347
timber harvesting & hauling	1	1	1	1	2	2	2	3	3	4	4	4	5	5	6	6	6	6	7
ranching	17	18	20	21	28	35	42	50	57	64	71	78	85	92	100	100	107	114	121
general agriculture	-385	-384	-383	-383	-379	-375	-371	-367	-363	-358	-354	-350	-346	-342	-338	-338	-334	-330	-326
mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lumber & wood products	9	10	10	11	15	19	23	27	31	35	39	43	47	51	55	55	58	62	66
food processing	19	20	22	23	31	39	47	55	63	71	79	87	95	103	111	111	119	127	135
other manufacturing	8	9	9	10	14	18	22	26	30	33	37	41	45	49	53	53	57	61	64
transportation	-16	-15	-14	-13	-9	-5	-1	4	8	12	16	21	25	29	33	33	38	42	46
communications & utilities	100	111	122	133	187	241	296	350	404	458	513	567	621	675	730	730	784	838	892
insurance, finance & real estate	37	45	54	62	105	148	191	233	276	319	362	405	447	490	533	533	576	619	661
construction	8	12	15	18	36	53	70	87	104	121	138	155	173	190	207	207	224	241	258
agricultural services	-469	-468	-468	-467	-464	-460	-457	-454	-450	-447	-443	-440	-437	-433	-430	-430	-427	-423	-420
professional services	43	48	54	59	85	110	136	162	188	214	240	265	291	317	343	343	369	394	420
automobile sales & service	148	167	186	204	297	390	483	576	669	762	854	947	1040	1133	1226	1226	1319	1412	1505
lodging	7	8	8	9	12	15	18	21	24	27	30	33	36	40	43	43	46	49	52
cafes & tarverns	21	23	25	27	36	45	54	64	73	82	91	100	110	119	128	128	137	146	156
wholesale & retail services	34	37	40	43	58	74	89	105	120	135	151	166	182	197	212	212	228	243	259
wholesale & retail trade	367	400	432	465	628	791	954	1118	1281	1444	1607	1770	1933	2097	2260	2260	2423	2586	2749
households	1735	1882	2030	2177	2914	3651	4387	5124	5861	6597	7334	8071	8807	9544	10281	10281	1017	11754	12491
local government	188	211	234	256	370	484	598	711	825	939	1052	1166	1280	1394	1507	1507	1621	1735	1848
local agencies of state & federal govt.	17	22	26	31	55	78	102	126	149	173	196	220	244	267	291	291	315	338	362

Appendix C. Impact Analysis Results (1000's), (changes sector's sales under various water prices)

Water price ($/acre-foot)	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800
Total Regional Impact	20014	21347	22680	24012	25345	26678	28011	29343	30676	32009	33342	34674	36007	37340	38673	40005
timber harvesting & hauling	6	7	7	8	8	9	9	9	10	10	11	11	11	12	12	13
ranching	114	121	128	135	142	149	157	164	171	178	185	192	199	207	214	221
general agriculture	-330	-326	-322	-318	-314	-310	-306	-302	-298	-294	-290	-286	-282	-278	-274	-270
mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lumber & wood processing	62	66	70	74	78	82	86	90	94	98	102	106	110	114	118	122
food processing	127	135	143	151	159	167	175	183	191	199	206	214	222	230	238	246
other manufacturing	61	64	68	72	76	80	84	88	91	95	99	103	107	111	115	119
transportation	42	46	50	55	59	63	67	72	76	80	84	89	93	97	101	106
communications & utilities	838	892	947	1001	1055	1109	1164	1218	1272	1326	1381	1435	1489	1543	1598	1652
insurance, finance & real estate	619	661	704	747	790	833	875	918	961	1004	1047	1089	1132	1175	1218	1261
construction	241	258	275	292	310	327	344	361	378	395	412	430	447	464	481	498
agricultural services	-423	-420	-417	-413	-410	-406	-403	-400	-396	-393	-390	-386	-383	-379	-376	-373
professional services	394	420	446	472	498	524	549	575	601	627	653	678	704	730	756	782
automobile sales & service	1412	1505	1598	1691	1784	1876	1969	2062	2155	2248	2341	2434	2527	2620	2713	2805
lodging	49	52	55	58	61	64	67	70	73	76	79	82	85	89	92	95
cafes & taverns	146	156	165	174	183	192	202	211	220	229	238	248	257	266	275	284
wholesale & retail services	243	259	274	289	305	320	335	351	366	382	397	412	428	443	459	474
wholesale & retail trade	2586	2749	2913	3076	3239	3402	3565	3729	3892	4055	4218	4381	4544	4708	4871	5034
households	11754	12491	13228	13964	14701	15438	16174	16911	17648	18384	19121	19858	20594	21331	22068	22805
local governmnet	1735	1848	1962	2076	2190	2303	2417	2531	2645	2758	2872	2986	3099	3213	3327	3441
local agencies of state & federal govt.	338	362	385	409	433	456	480	503	527	551	574	598	622	645	669	692

APPENDIX D

Impact Analysis Worksheets

Water value worksheet, Appendix D

Agricultural sales:	$4,277	(Ag Sector after water transfers)
Agricultural purchases:	$2,598	(Initial Ag sector)
Water price:	$49.57	(per Acre-ft)
Gross water sales:	$1,737	(Thousands)
Household transfer payment:	$1,679	"
Household opportunity cost:	$351	"
Net household income:	$790	"
Value per acre-ft of water:	$49.57	
Avgerage Application rate (inches):	36.56	
Acre-ft of water used / ton produced:	0.9520	
Acres of alfalfa in Grant County:	11500	
Water transfered (Ac-ft):	35031.875	
Value of water transfered:	$1,736,530	
Alfalfa price per ton:	$75.49	
Alfalfa production (tons):	36800	
Alfalfa production / acre:	3.2	
Value of alfalfa produced	$2,778,032	
Value lost from water transfer:	$2,065,032	
Value gained from water transfer:	$1,736,530	
Acres of other hay:	35000	
Other hay Price per ton:	$62.00	

Other hay production:	35000
Other hay production per acre:	1
Value of crop	$2,170,000

Net value of sales forgone from general agriculture to ranching:

2.2	differance in tonage/acre
11500	Acres of alfalfa
$13	Difference in price
$341,297	Total difference in sales

Appendix D, Table 2, Impact Analysis Worksheet.

Water Sale   Net Ag. Sector Hsehld Impact: $790

price: $49.57   Gross Regional Impact: $0

Sector	I-O Multipler	Adjusted Sales	Initial Sales	Changed Sales	Regional Impact	Sector Impact
timber harvesting & hauling	2.6165	12388	12388	0	0	0
ranching	2.5853	24033	24033	0	0	7
general agriculrure	1.9561	4277	4663	-386	-754	-391
mining	1.6909	9023	9023	0	0	0
lumber & wood products	2.6058	75297	75297	0	0	3
food processing	1.8000	2163	2163	0	0	7
other manufacturing	1.8148	1112	1112	0	0	2
transportation	1.7182	2145	2158	-13	-23	-22
communications & utilities	1.7731	11153	11165	-13	-23	23
finance, insurance & real estate	1.9552	8530	8579	-49	-96	-24
construction	2.1588	4884	4906	-21	-46	-16
agricultural services	1.5223	2728	3127	-400	-609	-474
professional services	2.5178	5940	5948	-9	-21	7
automobile sales & service	1.8826	21314	21329	-15	-28	17
lodging	2.4797	2344	2344	0	0	3
cafes & taverns	2.4578	2939	2939	0	0	8
wholesale & retail services	2.7635	2498	2498	0	0	12
wholesale & retail trade	1.4891	28241	28248	-7	-10	136
households	2.0750	95097	94308	789	1638	691
local government	2.9010	15012	15010	2	5	27
local agencies of state & fed. govt.	1.8783	28079	28096	-17	-32	-16

OREGON STATE UNIVERSITY EXTENSION SERVICE

ALFALFA HAY
Central Oregon

,ed on:

1. 160 acres
2. 5-ton yield per acre
3. Assumes 2 cuttings per year
4. 6-year life of stand
5. Wheel roll sprinkler irrigation
6. Machinery operator labor @ $6/hour
7. Irrigation labor @ $4/hour
8. 65 H.P. tractor @ $13.60 hour

INPUTS PER ACRE

PRODUCING YEARS	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total Cost	Your Cost
Cultural Operations[1/]							
Fertilize[2/]				Fert.	31.00		
				Custom	4.00	35.00	____
Sprinkler irrigate (12X)	6.0	24.00	31.20	Elec.[6/]	20.00		
				Water[5/]	15.50	90.70	____
Alfalfa weevil control				Custom	8.00	8.00	____
Weed control				Custom	12.00	12.00	____
Harvest Costs							
Swath SP 12' (2X)	.5	3.00	20.00			23.00	____
Rake (2X)	.4	2.40	6.00			8.40	____
'e ($12/T)				Custom	60.00	60.00	____
,ing ($7/ton)				Custom	35.00	35.00	____
Other Charges							
Land charge (cash rent basis, assumes land value at $1700/ ac.)					90.00	90.00	____
Taxes on land					10.00	10.00	____
Operating Capital Interest (15%)					8.70	8.70	____
General overhead					12.00	12.00	____
Amortized establishment cost					87.00	87.00	____
Total Cash Costs		24.00	22.90		216.20	263.10	____
Total Noncash Costs		5.40	34.30		177.00	216.70	____
Total Costs		29.40	57.20		393.20	479.80	____
Cost per ton @ 3 ton yield						147.20	____
Cost per ton @ 4 ton yield						115.20	____
Cost per ton @ 5 ton yield						96.00	____
Cost per ton @ 6 ton yield						83.10	____

(Footnotes on back)

These data were obtained and computed by County Agents, Marvin M. Young, Martin Zimmerman, Bob Henderso. d farm management specialists in cooperation with Deschutes, Jefferson Crook Counties hay producers.

Department of Agricultural and Resource Economics, February 1983

INPUTS PER ACRE

ESTABLISHMENT YEAR	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total Cost	Your Cost
Cultural Operations [3/]							
Rototill (2X) [4/]	3.0	18.00	47.00			65.00	______
Plow	.5	3.00	10.00			13.00	______
Disc or harrow	.25	1.50	6.50			8.00	______
Roll	.25	1.50	6.00			7.50	______
Spray	.2	1.20	4.00	Mtl.	5.00	10.20	______
Drill	.5	3.00	6.00	Seed	30.00	39.00	______
Fertilize				Fert. 5/	35.60		
				Cust.	4.00	39.60	______
Irrigate (9X)	5.0	20.00	23.40	Elec.	15.00		
				Water 6/	15.50	73.90	______
Harvest Costs (1 ton yield)							
Swath	.25	1.50	10.00			11.50	______
Rake	.2	1.20	3.00			4.20	______
Bale ($12/T)				Custom	12.00	12.00	______
Hauling ($7/T)				Custom	7.00	7.00	______
Other Charges							
Land charge [3/] (cash rent basis, assumes land value @ $1700/ac.)					90.00	90.00	______
Taxes on land					10.00	10.00	______
rating capital interest (15%)					4.70	4.70	______
eral overhead					12.00	12.00	______
Total Cash Costs		20.00	49.40		152.50	221.90	______
Total Noncash Costs		30.90	66.50		90.00	187.40	______
Total Costs (for establishment)		50.90	115.90		240.85	407.65	______
Credit for 1st year crop (1 ton @ $80)						80.00	______
Net cost of establishment/acre						327.65	______
Annual amortized establishment cost (6 years @ 15%)						87.00	______

1/ Consult your county agent for recommendations on specific practices.

2/ Fertilizer varies by soil type in the region. Phosphorus amounts are determined by Soil Test. Gypsum is applied at the rate of 40 lbs. actual sulfur annual per acre on the heavier soil. The sulfur amount is increased to 60-80 lbs. actual sulfur per acre on the sandy soils in the southern part of the region.

3/ Assumes land was in grain production previous year. Rototilling charged off to alfalfa establishment rather than preparation for grain and assumes a spring seeding.

4/ Rototilling is becoming the common operation. Sometimes followed by a plowing. Both operations may not be necessary. Land preparation may vary if alfalfa is drilled into stubble of grain hay in August.

Single super P_2O_5, applied at the rate of 90 lbs. actual phosphorus as a preplant plowdown.

6/ Crook-Deschutes $15.50/acre. Jefferson County $27.00/acre.