AN ECONOMIC ANALYSIS OF LAND PRICES OF MOUNTAINOUS GRAZING LAND IN EASTERN OREGON

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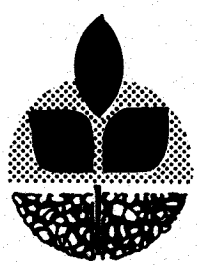

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SUMMARY

This study examines the factors affecting the sale price of privately owned mountainous grazing land in Eastern Oregon between 1970 and 1978. Animal carrying capacity, assessed value of buildings, expected rate of inflation, price of cattle, and price of hay were found to have a significant effect on per acre land prices. Whether the land was purchased for ranch enlargement had a marginally significant effect on sale price per acre. Grazing rights on public land included with the sale, the discount rate, distances to nearest paved road, to county seat, and to other owned property, and the size of the sale have no significant impact on per acre sale price.

AUTHORS

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INTRODUCTION

From 1910 to the early 1950s, variations in farm real estate prices largely could be explained by fluctuations in net farm income per acre [20]. The period of the early 1950s to the early 1970s was characterized by steadily increasing real estate prices despite stable and sometimes decreasing net farm income per acre. From the early 1970s to present, land values have continued to increase steadily, but net farm income per acre has fluctuated widely (Figure 1). An analysis of this discrepancy between farm land prices and net farm income in recent years is the subject of this research. Specifically, this research investigates the factors that have been important in influencing the price of mountainous grazing land in Eastern Oregon.

The fact that land prices have been rising steadily in recent years can be verified easily by studying reports addressing the topic of agricultural land prices, interviewing persons close to the land market, or examining transactions recorded in county assessors' and recorders' offices. However, it is much more difficult to identify the factors responsible for this trend. The determinants of the price of agricultural land have received and continue to receive a great deal of study. This attention is warranted by the interest of various groups including present and prospective land owners, assessors, credit institutions, and local governments largely dependent upon real estate taxes as a base for earning revenue. Land is not a homogeneous factor and the fixity aspect of land serves to effectively separate land markets. The price of land in different land markets is affected by different factors. Barlowe [1] has emphasized the concept of land as location. This concept involves location with respect to markets, geographic features, and other resources. For instance, two parcels of land with the same productive capacity, one near a major metropolitan area and the other in a sparsely populated region likely will command different prices. The prices of different parcels will be affected by different characteristics as determined in each land market.

This research was undertaken to provide some insights into the determinants of the sale prices of mountainous grazing land in two eastern Oregon counties. To separate the sales to be analyzed into transactions of a similar nature, the

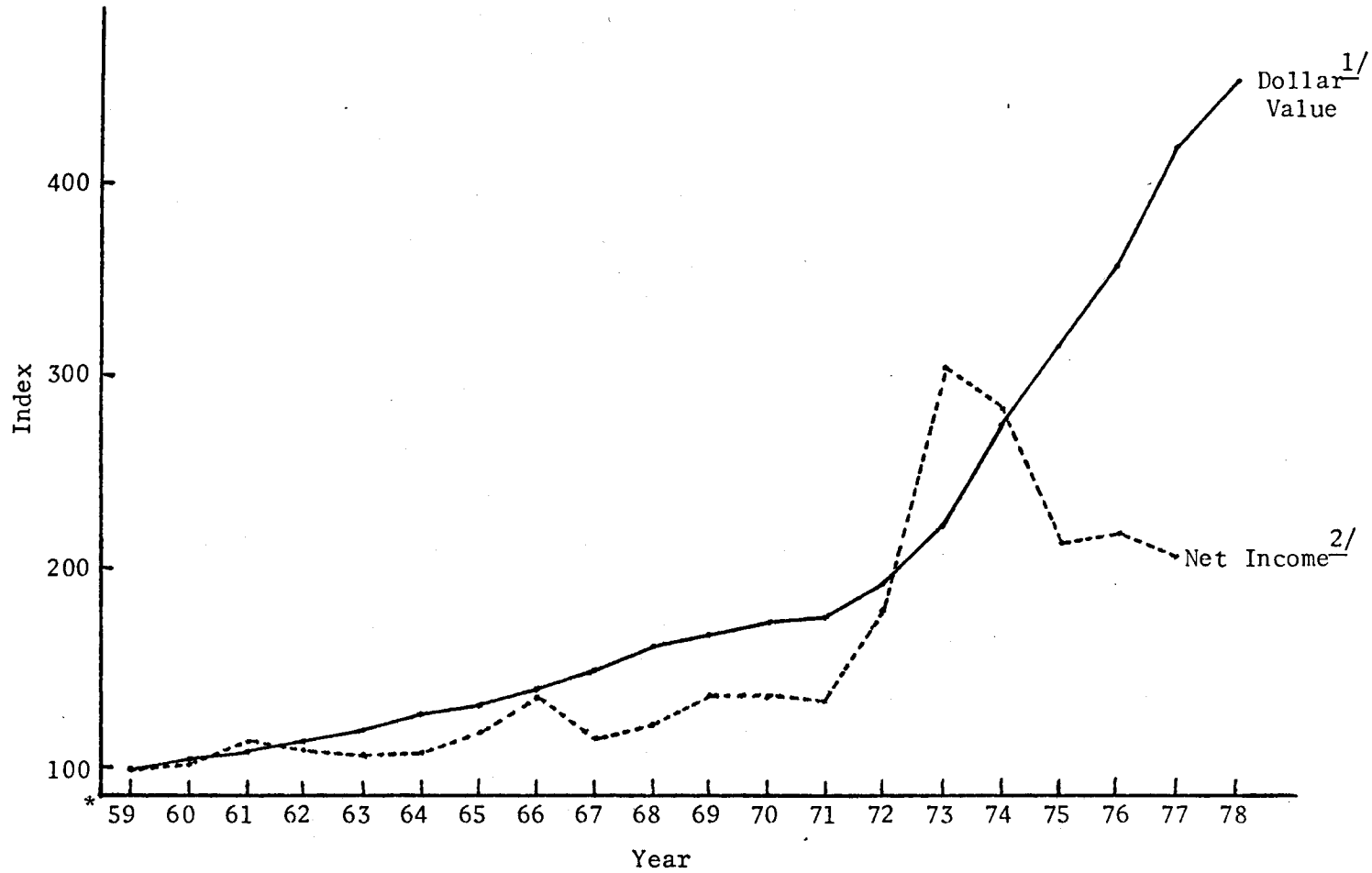

Figure 1.* Relationship Between Index of Real Estate Values Per Acre and Index of Net Income Per Acre, 1959-1977 (U.S.).

*1959 = 100

1/ SOURCE: Farm Real Estate Market Development [43]. 2/ SOURCE: Agricultural Statistics [42].

analyzed land types have been restricted to largely mountainous grazing land (as determined by a preponderance of Class VII land in the sale) and the size of the sale has been restricted to a minimum of 100 acres.[1/] Also, only sales of land in which 100 percent of the acreage has farm use-value assessments are analyzed in this study.[2/] These restrictions are intended to minimize the influence of purchases for subdivision, development, or small mountain acreage retirement homesites. These latter types of land sales are influenced by factors not expected to be important in grazing land sales for agricultural production and the analysis of factors affecting their prices is outside the scope and objectives of this research. It is recognized that the restrictions placed on the types of land sales to be analyzed will limit the applicability of the research results; however, it is believed that there is enough land similar in nature to that analyzed in this study throughout eastern Oregon and surrounding states, notably Idaho, Montana, Wyoming, Utah, Arizona, and Nevada, to warrant the narrowed focus of the study.

The Problem and Its Setting

Land prices have a direct effect on farmers' ability to begin, operate, and expand their enterprises. Several studies suggest that agricultural land prices have been increasing at rates and to levels not totally warranted by net farm income [27, 32, 38]. Movements toward various types of farm use-value assessments in many states support this viewpoint.[3/] Factors often cited as important in examining the land price-net income discrepancy include expected capital gains, technological advance, farm enlargement pressures, government farm programs, and pressures from increasing population [4, 28, 32, 35, 46]. Scofield [36] postulates that the belief that land offers safety and protection from inflation has resulted in substantial amounts of non-farm

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[1/] Class VII refers to the land capability rating of the Soil Conservation Service. The ratings are based on all physical features of the land. Class I is the highest rating and Class VIII is the lowest. Class VII land is primarily suited for continuous pasture, recreational use, and timber production.

[2/] The farm use-value assessment assesses the qualifying farm land for tax purposes at its value in agriculture rather than at the land's market value, and farm use-value assessments are considerably below the observed sale prices of the land [25].

[3/] Forty-two states, including Oregon, had adopted some form of use-value assessment as of February 1978 [25].

capital being directed towards farmland markets. Also, the lower tax rate applicable to capital gains (compared to the current income tax rate) contributes to the premium that buyers in high tax brackets are willing to pay for future capital gains from anticipated increases in land prices [39]. Martin and Jeffries [27] argue that it is unrealistic to attempt to explain the price of an asset such as agricultural land on the basis of only its agricultural output. They suggest "ranch fundamentalism" and "conspicuous consumption" as additional outputs that should be considered when addressing the topic of agricultural land prices [27]. These views are supported by Chryst [3] who also emphasizes the importance of location affecting land prices. Murray [29] distinguishes between the sale value and income value of the land. The income value of land is based on expected net income streams from the land discounted at the appropriate interest rate. The sale value includes all value factors; the expected net income stream is only one of them.

Individuals purchasing land are obtaining a consumptive as well as a productive good. However, it is difficult to quantify many of the factors influencing the demand for land as a consumptive good. The analysis of these factors is as much a psychological or sociological problem as an economic problem. However, recognition of the existence of these influences may aid in accounting for the seeming disparity between the farm use-value of agricultural land and the market price of land.

This study is based on land sales in Umatilla and Grant counties, Oregon since 1970. These counties were selected on the basis of availability and completeness of ranch sales data that are not greatly influenced by urbanization pressures. The beginning year, 1970, was determined by the availability of accurate data.

The remainder of this paper consists of four major parts. First, a theoretical model of land prices is developed. A discussion of the empirical variables used to measure each corresponding theoretical variable follows. Empirical results of parameter estimation are contained in the third section. The remainder of the paper is a brief summary and conclusion.

THEORETICAL CONSIDERATIONS RELATING TO THE MARKET PRICE OF CAPITAL ASSETS

The theoretical framework for this study is a modification of the present value approach to capital asset valuation to allow for the various unusual aspects of land as an asset or investment. Scofield [36] has commented on the strong traditional beliefs concerning the intrinsic "goodness" of owning land. These types of social beliefs and traditions have an effect on the land market so that the market value of land may not be determined entirely by its income-producing capacity. Therefore, this study will attempt to incorporate factors other than those that directly affect the net income-producing capacity of the land.

Present Value Approach to Capital Asset Valuation

According to the present value approach of asset valuation, the market value of a capital asset is the discounted value of the net income stream produced by the asset [10]. This relationship is expressed as equation 1.

$$V_0 = \frac{A_1}{(1+r_1)} + \frac{A_2}{(1+r_2)^2} + \ldots + \frac{A_n}{(1+r_n)^n} \qquad (1)$$

where V_0 is the present market value of the capital asset, A_i (i=1, 2, ..., n) is the net income produced during time period i, and r_i (i=1, 2, ..., n) is the relevant discount rate during time period i. If A_i and r_i are assumed to be constant through time, the formula for the present value of a capital asset reduces to equation 2 as n approaches infinity.

$$V_0 = A/r \qquad (2)$$

Modification of the Valuation Theory

Projection of current net income levels using valuation theory leads to market values that have become increasingly inconsistent with observed market prices of agricultural land. Among factors often cited as influences on this inconsistency are pressures from increasing population and urbanization, government program payments, farm enlargement pressures to gain economies of size, technological advance, and expected capital gains [20, 28, 32, 38]. Government

program payments, technological advance, and farm enlargement purchases to obtain economies of size each directly influence the net income relationship of farm land. These factors merely suggest that projecting current net income levels may not accurately reflect expected future net income streams. Appropriately adjusting the level of future expected net incomes should adequately account for the effects of these factors. The other two factors, pressure from increasing population and urbanization and expected capital gains, suggest a structural change in the land market. Expanding urbanization and population change the underlying conditions of the local land market, and these factors affect the potential net income-producing capacity of the land.

The opportunity cost (or highest valued alternative) of keeping the land in agricultural production is increased by expanding urbanization, because the price of land near metropolitan areas reflects expectations of increased net income as a result of non-farmland uses in the future. However, unless the present landowner undertakes the development himself, he will not experience the increased net income stream resulting from non-farm development. Thus, the increased present value as a result of the developer's anticipated future net income possibilities may be considered a windfall gain to the present owner as a consequence of being near a metropolitan area, i.e., the present owner experiences a capital gain if he sells the land to the developer. Sale of the land then leads to the final factor often suggested as an explanatory factor in regard to the apparent disparity between present net income levels and the market price of agricultural land, expected capital gains.

It is not an uncommon error to treat capital gains as income. If capital gains are defined as an increase in the market value of a capital asset, it is clear that capital gains are the result of changes in underlying conditions rather than the cause [8]. Unexpected capital gains are windfall gains to present owners. Furthermore, capital gains do not alter present net income streams, but <u>expected</u> capital gains are capitalized into the present market value of capital assets, thereby increasing the wealth of the owner of the capital asset. However, the capital gains are not realized unless the asset is sold. Past capital gains create expectations that such gains will continue. These expectations contribute to the demand for land, thus compounding the effect of expected capital gains on the market price of the asset [44]. Since expected capital gains do affect land prices, some measure of expected capital

gains should be included in a model explaining the market price of land.

The final factor considered in this section is the discount rate. Changes in the discount rate may cause substantial changes in the present value of a capital asset. The discount rate may be interpreted as the opportunity cost of land investment and, therefore, affects both the supply of farmland and the demand for farmland [16]. An increase in the discount rate as a result of an increase in the rate of return on alternative investments provides incentive for non-farmer investors (landlords) to sell their land and invest in alternative investments, leading to an increase in the quantity of land offered for sale and hence lower farmland prices [20]. An increase in the discount rate also decreases the present value of future net income streams, ceteris paribus, decreasing the demand for land, and again, decreasing the price of land.

APPLICATION OF THEORETICAL CONSIDERATIONS TO MOUNTAINOUS GRAZING LAND

In this section the specific factors deemed to be important in explaining the variations of mountainous grazing land prices will be addressed, and variables used to represent these factors in the subsequent analysis will be presented. The expected relationships between the variables and price of mountainous grazing land will also be presented.

Price of Beef and a Measure of the Productivity of Grazing Land

The major output of mountainous grazing land is beef. The net income potential of an acre of mountainous grazing land then depends on the price of beef, the quantity of beef produced, and the cost of producing the beef.

Measuring the price of beef is quite straightforward, and complete time series data are available from the Livestock Market News Service, USDA. For eastern Oregon mountainous grazing land, the relevant beef price is likely that of feeder steers since the major type of beef production in the area of study is cow-calf ranching, and the major product is feeder calves. Although a composite measure of feeder calves (heifers and steers) is appropriate, the price of feeder steers is highly correlated with a composite measure and, in

addition, the feeder steer price is more readily available. Therefore, the Portland, Oregon, price of feeder steers is used in the subsequent analysis as the relevant measure of the price of beef.

The quantity of beef produced per acre also is directly correlated with the net ranch income per acre. The number of animal-unit-months (AUMs) of forage production per acre per year is used as a variable to quantify the productive capacity of the acreage analyzed in this research. An AUM is defined as the amount of natural or cultivated feed necessary for the sustenance of one cow or its equivalent for one month [11]. Kearl [23] suggested that problems of standardization of AUM's among diverse areas or ranching types exist. Although the general ranching enterprises in the study region are fairly homogeneous, the problems created by differing land classes within sales and differing precipitation patterns in Umatilla land classes must be addressed in deriving a standardized measure of AUMs per acre. The derivation of the AUM measure utilized in this research is based upon information provided by the county assessor's office, Umatilla County, Oregon. In converting acreage to a standardized measure of AUMs per acre, two factors are of particular importance in Umatilla County. First, the land class of the acreage directly reflects the productivity of the land. For the purpose of this research, all acreage was converted to Class VII equivalents using conversion factors that are used by the Umatilla County Assessor's Office for the purpose of tax assessment. Umatilla County was divided into three regions on the basis of average annual precipitation. The weights were assigned to adjust acreages so acreage in Umatilla County, regardless of location, is directly comparable to acreage in Grant County, assuming the same land classification. The same factors used in Umatilla County to adjust for the different land classes were used in Grant County following the adjustments made for differing precipitation patterns in Umatilla County (see Appendix I for greater detail of the process used for acreage standardization). As suggested by the preceding analysis, the measure of land productivity is expected to be positively correlated with the price of land.

Other Factors Affecting the Profitability of Beef Production

Kearl [23] postulates that hay (or winter pasture) is required for livestock maintenance in some fixed proportion to summer pasture, i.e., hay and

summer pasture are complementary inputs in beef production. An increase in the price of hay results in a reduction of the quantity of hay demanded. If hay and grazing land are used in fixed proportion, the demand for grazing land is reduced by an increase in the price of hay. If the assumption of fixed input proportions holds, the price of hay is negatively correlated with the price of grazing land.

The variable used to represent the price of hay in this analysis is the Portland, Oregon, price of alfalfa hay reported by the Oregon Hay Growers Association. The price of alfalfa hay is reported more consistently than prices of other types of hay, and the prices of various types of hay are highly correlated within a relatively small region so that the price of alfalfa hay is a reasonable indicator of conditions in the hay market. In addition, the quality of alfalfa hay is reasonably constant over time so that reported price variations may be considered as the result of supply and demand conditions rather than variations in the quality of the hay.

Another factor often considered important in affecting the price of farm land is the demand for land to enlarge farms [16, 32, 35, 41, 43]. The demand for land for farm enlargement stems from the possibility of spreading fixed overhead costs over more acres thereby reducing per unit costs [32]. Heady and Tweeten [16] concluded that the major source of real estate price increases (between 1953 and 1963) was farm consolidation and associated scale economies from larger acreages. Farm technological advances and increased pressures for farm enlargement are highly related, and the price of land is positively correlated with these effects. However, in the analysis of mountainous grazing land, one would expect that these effects are much less important than they are for tillable cropland because cattle ranching is much less capital intensive than farming. Nevertheless, this research investigates the effect of pressure for farm enlargement on the price of mountainous grazing land. A binary variable is used to represent these sales bought to enlarge a presently owned ranching operation. This variable is expected to be positively related with the sale price of land.

The effects of increasing demand for agricultural land in non-agricultural uses as a result of pressures from an increasing population have been largely eliminated by the restrictions placed on the sales to be analyzed. Each land sale must contain a minimum of 100 acres and only sales with farm-use assessments are analyzed.

Somewhat related to effects of increasing population is the distance of sale tracts from business centers and paved roads [13]. These factors have a direct effect on the profitability of cattle ranching. The closer a ranch is to a marketing center, the lower the costs of operation (predominantly because of lower transportation costs). As this distance increases, it is hypothesized that the sale price per acre will decrease to reflect the effect of higher operating costs. In addition to the effect of location on operating costs, land parcels nearer to business centers would be expected to command a higher price because of population pressures and increased demand of land for non-agricultural uses. As stated by Ely and Wehrwein [7], farm land near cities may sell on the basis of anticipated urban uses rather than on capitalized agricultural net incomes. Although several restrictions were enforced in an attempt to eliminate the influence of non-agricultural land demand, the variable for distance to a business center may account for any influence not eliminated by the restrictions on land sales. The two effects of distance from a business center are complementary, so the hypothesized relationship between distance to a business center and the sale price of land is negative, i.e., as the distance increases, the per acre selling price of land is expected to decrease.

Several researchers have analyzed the effects of various government programs and activities on agricultural land prices [6, 15, 17, 26]. The importance of particular government programs depends on the type of agriculture in the region of study.

The importance of publicly owned lands for supplemental forage of private ranches in the West has long been recognized and the level of user fees for the privilege of private use of public grazing lands has received a great deal of attention in the past [2, 10, 12, 21, 5, 24]. Caton, et al. [2] state that federal range is normally used in conjunction with private pasture, cropland, and water resources. The profit-producing capacity of the entire unit is capitalized into the private part of the ranch. Roberts [33] has outlined the relationship between grazing fees and ranch prices and addressed the processes whereby public grazing privileges may accumulate a sale value (or "permit" value) for private holders. Various researchers have attempted to estimate the value of public grazing privileges to private ranch owners. A 1966 Arizona study by Martin and Jeffries [27] estimated the capitalized value of each AUM of U.S. Forest Service grazing privileges to be about $23 and each AUM of

Federal Bureau of Land Mangement (BLM) grazing privileges to have a capitalized value of approximately $13. Their estimates were based on regression analysis developed to explain total sale prices of ranches. Gardner [11] estimated the market values to be $16 and $10 per AUM of FS and BLM grazing privileges, respectively, in his 1959 study of Colorado sale prices. The values reported by Gardner [11] were estimated directly by a rancher involved in the transfer. This method of analysis seems highly susceptible to biased results since ranchers may wish to conceal or at least distort permit values on the assumption that grazing fees may be increased to eliminate positive permit values. Nonetheless, the results of these studies indicate that a positive relationship may exist between the inclusion of public land grazing privileges and private land sale prices. An investigatien of the relationship between public land grazing privileges and private land sale prices in eastern Oregon is pursued in this research.

The inclusion of public grazing privileges is measured in two alternative methods in this study. The total number of AUM's provided by public grazing lease(s) was supplied by the administering agency (Forest Service or Bureau of Land Management). One formulation of the amount of public grazing relative to private grazing in a sale is the AUM's of public grazing per acre of deeded land. The alternative measure is the percentage of the total AUM's of the sale (private plus public) provided by the public grazing lease(s).

Other Variables

Other variables may affect the sale price of land without having any effect on agricultural production. One such factor is the existence of a familial relationship between the buyer(s) and seller(s). Sale agreements that occur between relatives may not accurately reflect market conditions as a result of favoritism. To test this factor, a binary variable to identify sales in which the parties are related was included in the analysis.

Another factor which may affect the sale price without any influence on agricultural production is the inclusion of an occupied household on the sale tract. The influence of this factor is also tested through the use of a binary variable.

Somewhat related to the inclusion of an occupied household in a sale is the inclusion of other types of buildings (barns, work shops, etc.) in a land

sale. Oregon law requires that buildings be assessed for tax purposes at 100 percent of their fair market value. On the assumption that assessed values accurately reflect market values, one might merely subtract the assessed value of any buildings included in a sale to compute the bare land sale price. Alternatively, one may wish to test whether the addition of one dollar of assessed building value per acre actually increases the sale price per acre by one dollar. The latter approach is taken in this research. The null hypothesis to be tested in the case of the coefficient for the assessed dollar value of buildings included in the sale is that the estimated coefficient equals one versus the alternative hypothesis that the coefficient is not equal to one. The size of the estimated coefficient provides some indication as to whether assessed values are higher or lower than the true market value.

Data for the assessed value of any buildings included in a sale are available in county courthouses. However, building assessments are not updated each year so the assessed values were updated by the percentage change in the Consumer Price Index in cases where assessments had not occurred during the year of the land sale.

Expected Capital Gains

Expected capital gains reflect the value of land as an investment or hedge against inflation. Increases in capital values contribute to expectations of continued increases in the future and expectations of future capital gains are capitalized into the present value of a capital asset [14]. The importance of capital gains since 1959 relative to net farm income is illustrated in Figure 2. In nearly half of the years from 1959-1970, capital gains were a larger percentage of farm real estate values than realized net farm income.[4/] Scofield [37] suggested that returns to land ownership may be fully as important as returns from production in determining forces behind rising land prices. In the past, farmland has been a relatively effective hedge against inflation and expectations that this relationship will continue to hold have a direct effect on the price of farmland. As the general price level increases, the price of farmland is also expected to increase. This relationship is tested by inclusion of the Consumer Price Index (CPI) as a

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[4/] Capital gains are computed as the percentage change from the previous year of the index of farm real estate values.

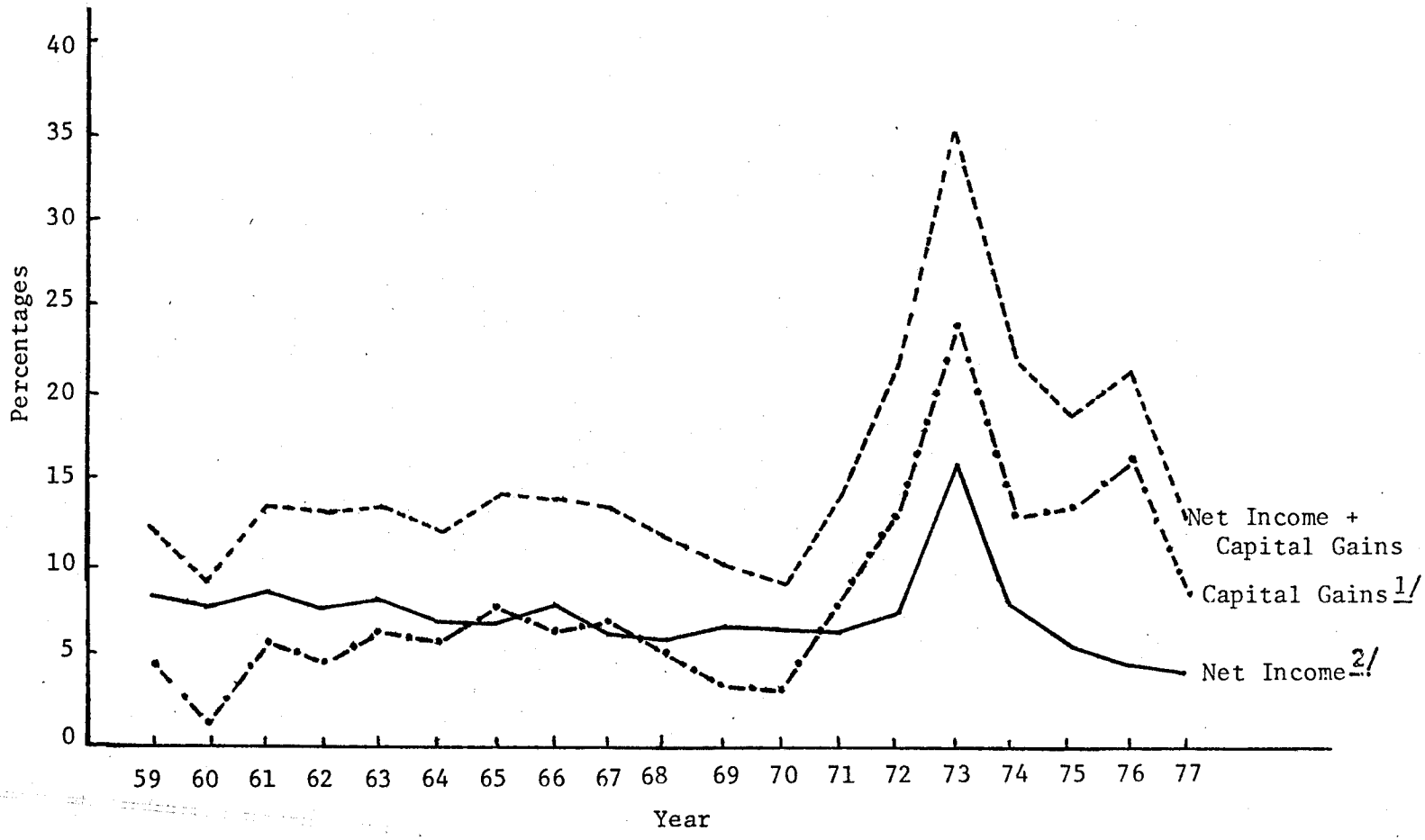

Figure 2. Relative Importance of Capital Gains and Realized Net Income as Percentage of Real Estate Values, 1959-1977 (U.S.).

1/ SOURCE: Farm Real Estate Market Developments [43].

2/ SOURCE: Agricultural Statistics [42].

measure of the general price level. CPI and the price of land are expected to be positively correlated.

The selection of the appropriate discount rate is important because small changes in the rate have large effects on the capitalized value. However, there is no widespread agreement among economists and appraisers on the appropriate discount rate. Scofield [39] says that, ideally, the rate should represent the prevailing opportunity cost of capital as determined by that rate of return that could be realized from other investments having the same liquidity and risk characteristics as farmland. In this regard, he suggests non-farm real estate and common stocks. However, a substantial number of farmland buyers are not likely to consider these as alternative investments. Nonetheless, several studies (notably Herdt and Cochrane [20]; Tweeten and Martin [41]) have used the rate of return on high-grade bonds or common stock as the appropriate discount rate. For many farmland investors, the primary investment alternatives that they might consider are other agricultural inputs (machinery, fertilizer, etc.) Therefore, the internal earning rate is suggested by Reynolds and Timmons [32] as the appropriate discount rate. However, they also indicate that a "subjective discount" may be made from this rate to reflect preferences for farming as an occupation or some other preference attached to owning land. Another common capitalization rate is the average rate of interest on farm mortgages, a measure of the cost of capital to land purchasers. Hurlburt [22] claims that this interest rate serves the purpose for general application, as an indicator of what the average farm operator might be willing to accept as a rate of return on money invested in land. For this reason, the average interest rate on farm mortgages as reported by the Chicago District of the Federal Land Bank is used as the discount rate in this study, and this variable is expected to be negatively correlated with the price of land.

DISCUSSION OF THE DATA AND EMPIRICAL RESULTS

The data on date of sale, deeded acreage in the sale, total sale price, assessed value of buildings in the sale, and acreage of the sale falling into each land class were obtained from county records. Personal telephone interviews with the buyer or seller (or both) were used to obtain data on location factors, farm expansion sales, existence of occupied households on the sale

tract, and information pertaining to any blood relationship between buyer(s) and seller(s). The district offices of the Federal Bureau of Land Management (Department of the Interior) and the United States Forest Service (Department of Agriculture) verified and quantified the inclusion of public land grazing privileges associated with the private land sales.

Brief Profile of the Data

Fifty-two bona fide ranch sales satisfying the restrictions on sale size and land quality as outlined in the first section of this paper are analyzed in this study. Of these sales, thirty-eight are from Umatilla County and fourteen are from Grant County. Nine of the sales had Federal Bureau of Land Management (BLM) grazing privileges included and eight of the sales had U.S. Forest Service (FS) grazing privileges attached (four of the sales included both BLM and FS grazing privileges).

The average size of the land sales is 769.7 acres with a mean price per acre of $131.24. The average sale included buildings assessed at $8.07 per acre. However, thirty-four of the sales had no buildings. Twenty-eight of the sales were additions to ranch land in the county of the purchase and only five of these sales had buildings included.

Empirical Results

The final models,[5/] estimated in this research, are specified as:

1) Price = f(AUM, AVB, CPI, CATTLE, HAY)

and

2) Price = f(AUM, AVB, CPI, CATTLE, HAY, ADD)

where:

Price = sale price in dollars per acre,

AUM = animal-unit-months of forage provided annually per acre,

AVB = assessed value of buildings per acre in dollars.

CPI = level of the consumers' price index during the month of the land sale,

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[5/] As in most empirical work, several alternative models were studied in an attempt to identify the "best" model. The models presented above were selected on the basis of high statistical significance of the independent variables and goodness of fit. Results of some of the alternative models studied in this research are presented in Appendix II.

CATTLE = Portland, Oregon price of good-choice feeder steers during month of land sale in dollars per hundredweight,

HAY = Portland, Oregon, price of alfalfa hay in dollars per ton,

ADD = binary variable denoting purchases for ranch enlargement (=1 if the purchase was for ranch enlargement; =0 otherwise).

Equations (1) and (2) were estimated in a linear functional form using ordinary least squares (OLS) regression. The results of OLS estimation of the parameters of equation (1) are given in equation (3).

3) $$\begin{aligned} PRICE = &-467.68 + 55.45\ AUM + 4.76\ AVB + 3.53\ CPI + 3.04\ CATTLE - 3.38\ HAY; \\ &(121.89)\quad (20.92)\quad\ (.63)\quad\ (.99)\quad\ (1.41)\quad\ (1.48) \\ &R^2 = .6574 \end{aligned}$$

The numbers in parentheses are the standard errors of the coefficients. Each of the coefficients in equation (3) has the anticipated sign and is significant at the five percent probability level.

One of the assumptions of ordinary least squares regression is homoskedasticity, that is, the variance of the error terms is constant across observations. Violation of this assumption (heteroskedasticity) results in estimated parameters which are inefficient. For this reason, a test of the model for the presence of heteroskedasticity was made.

One method of checking for the presence of heteroskedasticity is through visual examination to ascertain whether the variance of the error terms varies with different levels of the independent variables. The independent variables most likely to be related to the variance of the error terms are AVB, AUM, and CPI. To test for the presence of heteroskedasticity, the residuals from equation (3) were plotted against these variables. No relationship could be detected; it is concluded that the homoskedasticity assumption is not violated so that the parameter estimates are efficient.

The coefficient for AUM (animal-unit-month) implies that an additional AUM per acre adds $55.45 (V) to the per acre sale price. Using this estimate and estimates of private AUM lease rates (A), implied discount rates (r) can be determined from the present value formula, $V = A/r$. Algebraic manipulation of this formula yields $r = A/V$. Assuming perfect competition in the private rental market prevails so that the lease rates accurately reflect the marginal value of an AUM of grazing, private AUM lease rates may be used as an appropriate estimate of A, the annual return from an AUM of forage.

Wood, et al. [48] found the average private AUM rental rate in Malheur County, Oregon, to be $3.46 in 1974. In a 1976 data set for the Malheur National Wildlife Refuge area of Harney County, Oregon, Schmisseur [34] found the average lease rate to be $4.43. The average lease rate for Oregon during 1977 as reported by the Statistical Reporting Service in Farm Real Estate Market Developments [44] was $5.30. These estimates yield implied discount rates of 6.24, 7.99, and 9.56 percent, respectively. The average farm mortgage rate of the Chicago office Federal Land Bank on new loans was 8.44 percent during the 1970-1978 time period. These findings suggest that the average farm mortgage rate is the relevant discount rate considered by prospective purchasers of grazing land (as proposed by Hurlburt [22]).

The estimated coefficient for assessed value of buildings per acre (AVB) implies that an increase in the assessed value of $1 per acre increases the per acre sale price by $4.76. Oregon law requires building assessments to be 100 percent of market value, so one would anticipate an increase in the assessed value of buildings of $1 per acre to cause an increase in the per acre sale price of $1. The size of the coefficient for AVB suggests that the assessed values are not accurately reflecting the value of the buildings to the purchasers. The assessor is faced with considerable difficulty in placing an assessed value on outbuildings (barns, sheds, etc.) of little value in their own right. Purchasers may consider the cost of replacement in determining the value of buildings. In view of escalating construction costs, replacement costs are much greater than the value of buildings. By purchasing existing buildings, ranchers are able to avoid the construction cost for new buildings, and hence, existing buildings as a part of a ranch unit may command prices greater than their assessed value.

Both the estimated coefficients for hay price and cattle price have the anticipated signs. The estimated coefficient in equation (3) implies that a $1 increase in the price of feeder calves induces a $3.04 increase in the price of grazing land. A $1 increase in the price per ton of alfalfa hay results in a $3.38 decrease in the price of an acre of grazing land.

The CPI index is introduced in this study as a measure of inflationary pressures. It is a widely held belief that land has been (and is) a good hedge against inflation. The estimated coefficient for CPI seems to support this belief. An increase on one point in the CPI results in an increase of $3.53

in the price of land. The elasticity of the price with respect to the CPI, calculated at the means is 4.09. Thus, a one percent increase in the CPI is accompanied by a 4.09 percent increase in the price of land. These results suggest that during the 1970-1978 period, increases in the general price level, as measured by the CPI, have been accompanied by even greater increases in the price of grazing land.

The OLS estimates of the parameters of equation (2) are presented below.

4) PRICE = -436.55 + 56.95 AUM + 4.49 AVB + 3.48 CPI + 2.77 CATTLE
(122.19) (20.68) (.65) (.98) (1.40)
-3.31 HAY - 33.47 ADD; R^2 = .6732
(1.46) (22.69)

All the coefficients in equation (4) are significant at one percent except CATTLE, HAY, and ADD. The significance probability for the HAY coefficient is 2.8 percent, 5.5 percent for the CATTLE coefficient, and 14.7 percent for the ADD coefficient.[6/] The estimated coefficients for the variables in equation (3) are of the same magnitude as those for equation (4) and may be interpreted in a similar fashion.

The sign of the coefficient for ADD is negative, contrary to expectations based on the assumption that ranch-enlargement purchases are basically made for the purpose of spreading fixed costs over more units. However, the coefficient is not significant at the ten percent level of probability. Nonetheless, one may wish to consider alternative hypotheses that may explain the negative sign of the ADD coefficient. One factor that may explain the negative coefficient attached to the variable representing farm enlargement purchases is the value of information. Ranchers who own land may have a better idea of the economic value of land than people who do not own ranchland. On the basis of the additional information held by present land owners, they may be willing to pay less for grazing land than those people who do not have the information.

The fact that agricultural grazing land is a consumptive good as well as a productive good may also account for the higher prices begin paid for those purchases that are not ranch enlargements. Additional acreage

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[6/] The significance probability is the minimum level of significance at which the null hypothesis may be rejected. In this case, the null hypothesis is $H_o: \beta_i = 0$.

may not significantly increase the utility obtained for "conspicuous consumption" and "ranch fundamentalism." People who own ranchland may consider the purchase of additional acreage primarily on the basis of its productive capacity since they are already enjoying the consumptive "outputs" from the land they own. Purchasers who do not own any ranchland may attach more importance to the consumptive aspects of owning land and may be willing to pay higher prices for the land because they are obtaining additional outputs when they buy the land.

Grazing Rights on Public Land

Two different procedures were used to incorporate the public grazing privileges into the model. The first method introduces four variables into the model. Two binary variables (DFS, DBLM) determine the effect of inclusion of public grazing privileges without reference to the size of the sale or the number of public AUM's in the sale. The other two variables (FSPACRE, BLMPACRE) provide a measure of the number of AUM's of public grazing privileges of FS and BLM land included in the sale per acre of deeded land.

Because of differences in land productivity, the number of acres is not an accurate measure of the grazing potential of a particular tract of land. For this reason, a second procedure for incorporating public grazing permits was introduced to take account of the relative number of AUM's provided by public grazing privileges. This procedure was accomplished by constructing two variables, PERFS and PERBLM. These variables measure the percent of AUM's in the sale that are provided by FS and BLM grazing privileges and may be an improved measure of the importance of the public grazing privileges to the sale package.

Equations (5) and (6) show the addition of the public grazing formulation to equation (3). In both cases, the standard errors of the added variables are quite large relative to the size of the coefficients, indicating that public grazing privileges do not exert a statistically significant effect on the sale price of mountainous grazing land in the study area during the time period 1970 to 1978. Including the ADD variable in these two equations does not significantly alter the estimates so those results are not presented. All other estimated coefficients are very similar in magnitude to those of equation (3), indicating a relatively stable model.

5) PRICE = -475.28 + 52.73 AUM + 4.74 AVB + 4.74 CPI + 3.19 CATTLE - 3.45 HAY
(132.32) (22.54) (.67) (1.06) (1.53) (1.56)
-9.38 FSPACRE + 74.95 BLMPACRE - 4.65 DFS - 16.42 DBLM R^2 = .6604
(115.18) (210.16) (55.39) (38.45)

6) PRICE = -475.91 + 54.70 AUM + 4.78 AVB + 3.59 CPI + 3.18 CATTLE - 3.47 HAY
(126.52) (21.60) (.65) (1.03) (1.49) (1.53)
-.48 PERFS + .61 PERBLM R^2 = .6586
(1.35) (3.43)

where

PRICE = actual per acre sale prices in dollars,

AUM = standardized measure of animal-unit-months of forage produced per acre per year,

AVB = assessed value of buildings per acre included in the sale in dollars,

CPI = level of consumer price index during month of sale,

CATTLE = price of choice feeder steers at Portland, Oregon, during month of sale, in dollars per hundredweight,

HAY = price of alfalfa hay at Portland, Oregon, during month of sale, in dollars per ton,

FSPACRE = AUM's of Forest Service (FS) grazing privileges per acre of deeded land,

BLMPACRE= AUM's of Bureau of Land Management (BLM) grazing privileges per acre of deeded land,

DFS = binary variable indicating inclusion of FS grazing privileges (=1 if privileges included; =0 otherwise),

DBLM = binary variable indicating inclusion of BLM grazing privileges (=1 if privileges included; =0 otherwise),

PERFS = percentage of total AUM's of sale provided by FS grazing privileges,

PERBLM = percentage of total AUM's of sale provided by BLM grazing privileges.

The most complete publication addressing the issue of public grazing fees is the 1977 joint report of the Secretary of the Interior and the Secretary of Agriculture, Study of Fees for Grazing Livestock on Federal Lands [5]. This publication presents a concise and comprehensive history of the public grazing fee issue from the time user fees were first administered in 1906 to the present. Determination of the "fair" user fee has been a topic of intense controversy since imposition of these fees. Ranchers who had become accustomed

to low-cost and unrestricted use of Federal rangelands became increasingly discontented in the face of increasing user fees demanded by several members of Congress and the public at large who felt that the government should receive renumeration equal to the value of the grazing. The very issue of the "fair market value" of the forage provided by the Federal rangeland has been a topic of much concern. Numerous studies have been conducted to investigate this issue and various suggestions for procedures to determine the "fair market value" have been made as the result of these studies [12, 19, 27, 30, 33].

Prior to 1969, various economic studies were undertaken to investigate the level of user fees and the impact of the level of user fees on the economic stability and structure of ranches affected by the Federal rangeland issue [2, 11, 12, 18, 24, 27, 33]. By and large, these studies concluded that public grazing leases were underpriced relative to private grazing leases and, as a result, the public grazing privileges had accrued substantial capital values.[7/] Purchasers of private grazing land were willing to pay a premium to a seller in cases where the seller had a public grazing permit [12, 27]. The premium was the result of a differential between the fee paid to graze public lands and the true economic value of the grazing use; the capitalized value of this differential is known as the permit value.

Since permit values accrue as a result of underpricing of public grazing leases relative to the true economic value of the grazing, permit values will diminish as the level of user fees is increased to reflect the "fair market value" of the grazing use. Indeed, one of the proclaimed objectives of the agencies administering the Federal rangelands is to escalate the user fees to accurately reflect the "fair market value" of the grazing. When this level of the user fee is achieved, the permit value should be zero. As a result of this stated objective and on the basis of recommendations made in the report, "Review of Public Land Grazing Fees" [40], Forest Service grazing fees have

[7/] When comparing lease rates between public and private grazing leases, more than just the AUM rental charges must be considered. Arguments have been made to the effect that the public grazing lands are lower quality in general than the private grazing lands because homesteaders settled in the choicest locations. The Grazing Fee Technical Committee [40] reported that substantial non-fee costs accompany public grazing leases higher than similar costs for private leases (greater transportation costs, water development, fence repair, and general damage resulting from other users of the public lands). The term "user fees" is used throughout this study and is intended to reflect these differences between public and private grazing leases.

increased from $.51 per AUM in 1966 to $1.60 per AUM in 1977 and BLM grazing fees have increased from $.33 per AUM in 1966 to $1.51 per AUM in 1977. The objective of the fee escalation is to achieve "fair market value" by 1980.

While it is possible that permit values have occurred because of underpricing of grazing fees on public lands relative to the true value of the forage, the results of this study indicate that purchasers of private grazing lands have not been paying a premium for the public grazing permits in the form of higher private land sales (equations 5 and 6).

Public grazing leases would be expected to carry a permit value until the user fee accurately reflects the fair market value of the grazing. Therefore, the permit value should decrease as the user fees are increased to reflect the diminishing differential between user fees and the fair market value of the grazing. However, Schmisseur [34] found that very few ranchers had a thorough understanding of the policies and procedures regulating and determining the level of user fees. If ranchers are generally unaware of the policies and goals of the grazing fee system, observed increases in user fees may have a greater effect on the ranchers' reactions than is warranted from an economic viewpoint. That is, limited knowledge about future fee increases may result in overly cautious behavior as a result of past fee increases.

Another factor that may have caused an accelerated reaction to fee increases is the psychological and/or sociological effects of grazing public lands. There are several non-monetary costs associated with grazing the public range. Among these is some loss of choice in the ranching operation as various regulations and policies must be upheld while grazing public ranges. Costs of this nature may compound the effect of increased user fees and expedite the reduction of permit values.

Discussion of Omitted Variables

Our theory suggests that several variables not found in equations (3) or (4) should affect the price of agricultural grazing land. The theory underlying the impact of these variables was outlined earlier.

Possible reasons why these variables were not important in their effect on the sale price in the region of analysis are presented below.

Discount Rate

The importance of the discount rate is evident from the present valuation formula, since small changes in the discount rate result in large changes in the present value of an asset. The discount rate is not linearly related to the present value of a capital asset but rather enters into the model in a multiplicative form. However, when the discount rate is included in the model in a manner consistent with economic theory, the statistical significance of the independent variables declines markedly (see Appendix II).

This result is likely caused by a high degree of multicollinearity. The simple correlation coefficient between R (the discount rate) and CPI (the Consumer Price Index) is .944 which is not too surprising since R is a nominal interest rate which is expected to be influenced by expected inflation. The high degree of multicollinearity results in imprecise estimates of the regression coefficients, i.e., the least squares estimators have large variances [48]. Because of the problem of multicollinearity, the discount rate is omitted from the final model. While omitting the discount rate from the model results in the introduction of specification error into the model, efficiency is gained through increasing the statistical significance of the remaining variables.

Distance Variables

Several distance variables were used in an attempt to identify the importance of the location factor in affecting sale prices of agricultural grazing land. Variables tested included distance to nearest county seat (assumed to be the major marketing center in the area), distance to the nearest paved road, and distance to other owned property in the county. None of the distances proved to have a significant effect on the price of grazing land. Possible reasons for this result are that transportation costs are a minor factor in ranching and that the towns in the region are not large enough to exert a significant influence on sale prices from increasing urbanization.

Size of Sale

Several researchers [4, 45] have estimated a negative relationship between the size of a sale and the sale price per acre. Presumably this relationship exists as a result of spreading relatively fixed transactions cost over more units. In this study, the size of the sale as measured by total number of deeded acres did not have a significant effect on the per acre sale price.

Perhaps the restriction limiting sales to be analyzed to 100 acres or more results in the transactions cost becoming a relatively minor factor in the total sale price and nullifies the effect of sale size on per acre sale price.

Another aspect that may be related to the influence of the size of the sale and the sale price per acre is the existence of different land markets for different size sale tracts. Again, the restriction on sale size has eliminated the influence of the demand for small tracts of land for second homes, etc.

SUMMARY AND CONCLUSIONS

The major objective of this study was to identify the factors that exert a significant influence on the price of mountainous grazing land in eastern Oregon. Linear regression analysis was utilized to investigate the impact and importance of the independent variables on the per acre sale price of private grazing land in Umatilla and Grant counties.

The variables determined to have a substantial effect on the price of grazing land include the quality of the land (AUM), the assessed value of buildings per acre included in the sale (AVB), the price of feeder steers (CATTLE), the price of alfalfa hay (HAY), expected capital gains (CPI), and farm enlargement pressures (ADD). As hypothesized, the estimated coefficients for AUM, AVB, CATTLE, and CPI were positive and the coefficient for HAY was negative. Contrary to expectations, the coefficient for ADD was negative, but the coefficient for this variable was not statistically significant at the ten percent level.

The coefficient for AUM was used to determine implied discount rates in the range of 6.24 to 9.56 percent on the basis of various estimates of private AUM lease rates. The average Federal Land Bank mortgage rate is included in this range of values and it is concluded that the farm mortgage rate is an appropriate measure of the discount rate considered by purchasers of mountainous grazing land.

The inclusion of public grazing privileges was found to have no significant impact on the level of private grazing land sale prices. This result does not support earlier studies done by Martin and Jeffries [27] (in Arizona) and Gardner [11] (in Colorado). Both of these studies found that substantial permit values had accrued as a result of user fees plus nonfee user costs for grazing

federal rangelands being substantially below the fair market value of the forage. However, these two studies were undertaken before 1969 when a new policy was enacted with the explicit objective of escalating user fees to reflect the fair market value of the forage grazed while the present study analyzes only sales that have occurred after 1969. The results of this study support the conclusion that permit values did not exert a significant effect on private sale prices within the time period and region analyzed.

Limitations of the Study

Throughout this paper, the problem of standardizing the AUM measure has been recognized. This problem is the main obstacle to direct application of the model to other areas since the AUM measure in this study has been converted to a quite specific measure. Generalization of the estimate of the AUM coefficient to regions outside the study area could give misleading results since the estimated coefficient relates to the standardized AUM measure in this study. However, the general procedures used in this study should be easily adaptable to other regions that are similar in nature to the study region of this research.

Implications of the Study and Suggestions for Further Research

This study provides some insights into the determination of agricultural grazing land prices. As much as two-thirds of the variation in sale prices was explained by the variables in the land price model. The model's explanatory power compares quite favorably with other studies of a similar nature. Crowley [4] obtained R^2 ranging from a low of .1140 in an urban-influenced land market to .6284 in an agricultural land market. Vollink [45] obtained R^2's ranging from .50 to .62 in four regions in North Carolina.

The estimated model is not suitable for the purpose of determining property assessment since approximately one-third of the price variation is unexplained. However, the model may be useful for determining whether assessed values reasonably reflect market values (i.e., is the estimated assessed value of buildings coefficient close to one) and further development of the model may be able to account for more of the price variations in grazing land sales.

The results of this study indicate that the inclusion of public grazing privileges does not have a significant effect on the sale price of private grazing land, contrary to results of earlier studies in Arizona and Colorado.

Further research is needed in these areas to determine the effect of the fee escalation on the permit values. Economic theory suggests that the permit values should decrease as the user fees are increased to reflect the true market value of the forage. Changes in user fee policies affect both operating costs of ranching and the wealth position of permit holders and the effects of these policy changes on the structure and nature of the ranching industry merit further research.

This study indicates that the assessed value of buildings in the study area is not accurately reflecting the prices land purchasers are paying for the buildings. Whether this situation should be altered by increasing assessed values is a normative, policy question. Nonetheless, the economic impact of increasing building assessments on the social welfare of the region is another area of possible research that could provide useful information to state and county officials.

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Appendix I

Procedure for Standardizing Acreage

An earlier section explained the need for standardizing acreages of land sales from different areas of the region of analysis. The purpose of this appendix is to demonstrate the methods used in this study to standardize the acreages.

The study area was divided into three distinct regions on the basis of productivity differences arising from variations in precipitation patterns. The divisions of Umatilla County were based upon guidelines suggested by the Umatilla County data analyst in a personal interview. Region 1 consisted of Townships 4N, 5N, and 6N, all in Umatilla County. Region 2 consisted of Townships 1N, 2N, and 3N, all in Umatilla County. Region 3 consisted of Townships 1S through 6S in Umatilla County and all of Grant County.

All acreages were converted to Region 3 equivalent acreages. To accomplish this, acreages of each land class in Region 1 were multiplied by 2.266 and acreages in Region 2 were multiplied by 1.185. These conversion factors were based on the number of acres required to support one animal unit for a month as suggested by the Umatilla County Assessor's office.

These transformed acreages were next converted to AUM's produced per month of grazing. To convert to AUM's, the transformed acreages of each land class were multiplied by the factors in Table 1. This transformation accounts for differences in productivity among the various land classes.

Finally, differences in the grazing seasons in the different regions were taken into account. Region 1 has a six-month grazing season, but Regions 2 and 3 have seven-month grazing seasons. As a consequence, the AUM's per month were multiplied by six for sales in Region 1 and by seven for sales in Regions 2 and 3.

TABLE I. FACTORS FOR CONVERTING LAND CLASSES TO AUM'S PER MONTH

Land Class	Factor
I	.394
II	.335
III	.292
IV	.247
V	.216
VI	.199
VII	.175
VIII	.140

The result of this multiplication is a standardized measure of AUM's of grazing provided per year by the entire sale acreage. This measure is divided by the actual number of acres in the sale to achieve a standardized measure of AUM per acre per year.

Numerical Example

For simplicity, assume a sale that occurred in Region 1 consisted of one acre in each of the eight land classes. Since the sale occurs in Region 1, each of the acreages is multiplied by 2.266 to convert to Region 3 equivalent acreages. We now have 2.266 (transformed) acres in each land class. The number of (transformed) acres of each land class are now multiplied by the factors in Table 1 and summed to derive the number of AUM's provided per month of grazing.

$$\begin{aligned} \text{AUM/Month} &= 2.266(.394+.335+.292+.247+.216+.199+.175+.140) \\ &= 2.266(1.998) \\ &= 4.527 \end{aligned}$$

The number of AUM's per month (4.543) is multiplied by six to account for the length of the grazing season in Region 1 to yield 27.162 (= 4.527 x 6) total AUM's in the sale. This is divided by the total acreage of the sale, eight acres, to find 3.39525 (= 27.162/8) AUM's per acre per year for this particular example.

Appendix II

Selected Regression Results

In an earlier section, the final estimated models of this research were presented and the variables that did not significantly affect mountainous grazing land prices were discussed. This appendix provides a brief presentation of some of the regression results not presented earlier.

The results are contained in Table A-II. The variable definitions and discussion are presented below.

Variable Definitions

PRICE = actual per acre sale prices in dollars,

AUM = standardized measure of animal-unit-months of forage produced per acre per year,

AVB = assessed value of buildings per acre included in the sale, in dollars,

CPI = level of consumer price index during month of sale,

CATTLE = price of choice feeder steers at Portland, Oregon, during month of sale, in dollars per hundredweight,

HAY = price of alfalfa hay at Portland, Oregon, during month of sale, in dollars per ton,

ADD = binary variable indicating purchases for ranch enlargement (= 1 if purchaser owned other ranch property in county at time of sale; = 0 otherwise),

R = average farm mortgage rate on new loans of Chicago District Federal Land Bank,

TACRES = size of sale, in acres,

TOWN = distance from sale tract to nearest county seat, in miles,

ROAD = distance from sale tract to nearest paved road, in miles,

C = binary variable for county of sale (= 1 if Grant County, = 0 if Umatilla County),

HH = binary variable for occupied household included in sale (= 1 if house included; = 0 otherwise),

REL = binary variable to indicate if buyer and seller were related (= 1 if related; = 0 otherwise).

TABLE II. SELECTED REGRESSIONS RESULTS[1/,2/]

Variable	Equation Numbers		
	1.1	1.2	1.3
AUM	55.45 (20.92)	56.95 (20.68)	45.88 (23.37)
AVB	4.76 (.63)	4.49 (.65)	4.70 (.84)
CPI	3.53 (.99)	3.48 (.98)	3.76 (1.06)
CATTLE	3.04 (1.41)	2.77 (1.40)	2.32 (1.67)
HAY	-3.38 (1.48)	-3.31 (1.46)	-3.79 (1.57)
ADD		-33.47 (22.69)	-40.85 (29.74)
TACRES			-.012 (.015)
TOWN			-.17 (1.12)
ROAD			-5.13 (4.49)
C			4.21 (37.92)
HH			-37.03 (40.74)
REL			12.88 (38.38)
R^2	.6574	.6732	.6976

1/ Dependent variable is PRICE.

2/ Numbers in parentheses are standard errors.

Discussion of the Variables

The expected signs of most of the estimated coefficients follow from the discussion in the text.

Equation 1.1 and 1.2 are identical to the final models presented as equations 3 and 4 in the text. Equation 1.3 has the population-distance variables included as well as total sale acreage and the binary variables for county of sale (C), occupied household in sale (HH), and relationship between buyer and seller (REL). None of the added variables are significant at the ten percent level of significance. TACRES, TOWN, and ROAD each had the expected negative coefficients, but the signs of the coefficients for HH, REL, and PAST did not agree with a priori expectations. There was no a priori expectation for the C coefficient.

The coefficients of the variables in equation 1.1 remain fairly stable when other variables are added which indicates that equation 1.1 (or 1.2) may be a fairly accurate specification of the land price model. The R^2 is also quite stable (which is to be expected since the added variables are not significant) and indicates that about two-thirds of the variation in sale prices is explained by the model.

The present value formula, V = A/r, demonstrates that the discount rate, r, is not expected to affect the present value of a capital asset in a simple linear fashion. For this reason, CATTLE, HAY, CPI, and interaction term CATTLE x AUM were discounted by R and these variables were used in formulating a linear land price model. The results of estimation are presented in equation 1.

$$\begin{aligned} \text{PRICE} = {} & -735.40 + 4.61\ \text{AVB} + 162.74\ \text{AUM} - .24\ (\text{CATTLExAUM})/R \qquad (1) \\ & \quad (207.45) \quad (.65) \qquad\quad (85.50) \qquad (.18) \\ & +.54\ \text{CATTLE}/R - .20\ \text{HAY}/R + .35\ \text{CPI}/R \qquad R^2 = .6460 \\ & \quad (.33) \qquad\quad (.13) \qquad\quad (.11) \end{aligned}$$

As before, the numbers in parentheses are standard errors. None of the discounted variables are significant at five percent. All of the variables have the expected signs except for the interaction variable. Although the R^2 is comparable to those of the other models, this model is rejected on the basis of insignificant explanatory variables.