Determinants of Oregon Farmland Values: a Pooled Cross-Sectional, Time Series Analysis

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A pooled cross-sectional, time series econometric model is used to examine factors affecting farmland values in Oregon from 1954 to 1978. Value of sales per acre (a proxy used to represent income per acre), average farm size, and the percentage of farmland were found to have a significant effect on farmland values for the entire state during the study period. However, the results also indicate that structural changes in agricultural land markets occurred across time and across subregions. Population density was shown to be a significant factor in the Willamette Valley. A positive intercept shifter for 1969-74 and a negative slope shifter for the value of product sales in the same period may reflect a temporal diminishment in buyers' tendencies to be influenced by potential product sales.

Consistent with the majority of regions in the United States, the average per acre values of farmland in Oregon have shown a considerable increase over the past 20 years. Much of this increase has been attributed to general inflationary trends; however, in recent years land values have risen at a rate outstripping the increase in the Consumer Price Index (CPI). Traditional explanations for accelerating agricultural land values have tended to focus on increases in expected incomes from actual or anticipated productivity increases, anticipated cost savings arising through technological change, or from expected increases in exports to meet global demands. However, when farmland prices continued to rise despite current declines in net farm incomes or rose beyond any increase in net income, additional economic and social influences were postulated and examined empirically. Tax incentives, agrarian fundamentalism, urban pressure, inflation, and capital gains expectations, *inter alia,* have been identified as influencing current farmland prices.

Although recent studies of trends in agricultural land values no longer adhere solely to Ricardian hypotheses of land price determinants, most models retain some productivity or expected income factor and often conclude that expected income has a major effect on land prices. Herdt and Cochrane, Scofield, and Winter and Whittaker concluded that productivity was the primary factor in explaining land prices. Herd and Cochrane emphasized the influence of "technology," as measured by the USDA productivity index. They speculated that technology influences land prices via farmers' efforts to capture resulting (or expected) decreases in per unit production costs by increasing the scale of operations. Tweeten and Nelson

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found that in 1950-63 approximately half the increase in U.S. agricultural land values could be attributed to pressures for farm enlargement [Tweeten and Martin].

Similarly, Crowley found that in the grain growing areas of Oregon land prices were bid up to 20 to 25 times their income-generating potential due to competition for enlargement acreage. However, for those agricultural areas in direct competition with urban expansion, basically the Willamette River Valley, Crowley found that farm size was negatively related to per acre sales price in Eastern Oregon. Morris' cross-sectional model of 1969 U.S. land values replicated this inverse relationship between farm size and price, while Pasour found no statistical relationship. Using such variables as population density, the change in density and property tax values, both Morris and Pasour found that farmland values were primarily influenced by urban encroachment.

Lake and Pope expanded upon the Pasour model using 1974 Census data. They hypothesized a structural contrast between the Standard Metropolitan Statistical Areas (SMSA's) and non-SMSA or non-urban counties within California. In the urban counties, they found that farmland prices were significantly related to changes in population density, property tax rates, and the percentage of county agricultural land in crop production. Non-urban farmland prices were similarly related to population density and the percentage of land in crops, but also to an income factor, gross farm sales per acre. Although the farmland within SMSA counties was the most productive in the State, expected income was not an important factor in determining perceived agricultural land values [Clonts; Morris].[1]

In this study of Oregon farmland values, an attempt is made to verify the general trends found in aggregate models and also to identify trends peculiar to Oregon's agricultural subregions. Average per acre farmland values for all 36 Oregon counties over the time period 1954 to 1978 are regressed against variables representing land productivity, farm incomes, farm size, and urban influence.

The Theoretical Model

Using previous studies as source material for positing causal relationships, the following model for Oregon was hypothesized:

(1) AAV = f (VSA, AFS, IRR, PD, PF)

where:

AAV ≡ average acre values,
VSA ≡ value of sales of agricultural produce,
AFS ≡ average farm size,
IRR ≡ percentage of farmland under irrigation,
PD ≡ population density, and
PF ≡ percentage of the county in farmland.

The rationale for including each explanatory variable is discussed below.

Value of Agricultural Sales per Acre

Traditional economic theory dating back to Adam Smith and David Ricardo suggests that the value of an acre of land is directly related to the discounted sum of its expected future returns. Determination of statewide Oregon land values based on classical capital theory and using the Moody Bond rate as the investment rate are presented in Figure 1.[2] The estimated land values are calculated by first dividing Oregon net farm income by the number of acres in agriculture, then dividing this per acre figure by the interest rate. In this simplistic model, the present net income and interest rates are treated as best estimates for future net income and interest

[1]The urbanization factor could reflect expected incomes due to the enhanced off-farm income opportunities in SMSA counties.

[2]The Moody Bond rate is a medium to long-term investment rate that tends to track well with other long-term and low risk interest indicators.

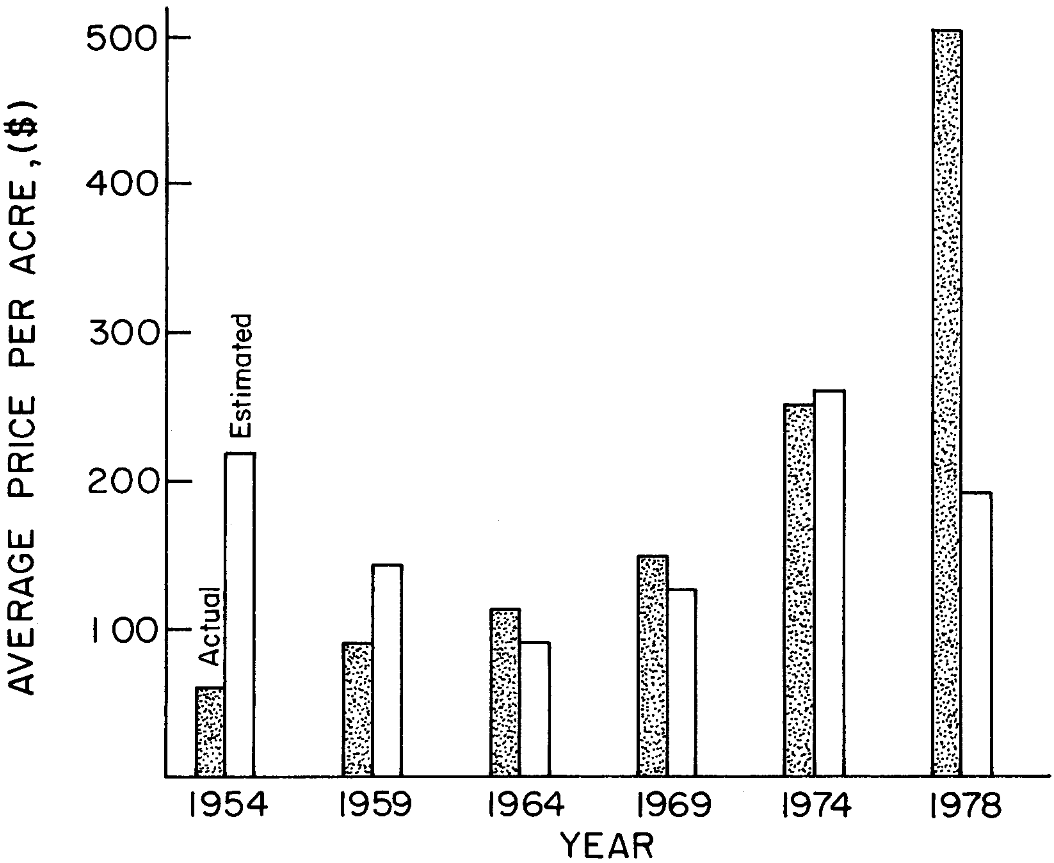

Figure 1. Per Acre Values for Oregon Farmland: Actual and Estimated from Expected Income.

rates. A comparison of these estimates with actual land prices reveals an upward bias before 1964 and an extreme downward bias in 1978, suggesting that, in the aggregate, factors other than income expected based on past trends affected Oregon farmland prices. However, the relative accuracy of the classical estimates between 1969 and 1974 reflects the major influence of income-earning potential on land values during this period. Even following 1974 income expectations and the opportunity cost of capital are expected to influence land prices because most land purchases are financed with borrowed capital [Lee and Rask].

The returns to farming proxy used in this study is average gross sales of agricultural produce, calculated on a per acre basis for each county.[3] This proxy does not reflect perfectly the trend in net farm incomes, but net farm income figures are not available on a county basis. The trend in net farm incomes as a percentage of gross sales for Oregon is illustrated in Figure 2. Although use of the proxy will likely result in some bias — particularly in the highly inflationary period of 1974 to 1978 — the approximation was acceptable due to the identifiable bias. However, an aggregate trend may mask the more critical variation in net to gross income ratios among counties. This limitation, for which meaningful adjustments could not be made, could affect conclusions regarding the statistical significance of the income factor.

[3]This proxy is called an income proxy as it may not relate directly to productivity, due to the inclusion of feedlots, nurseries, and poultry farms.

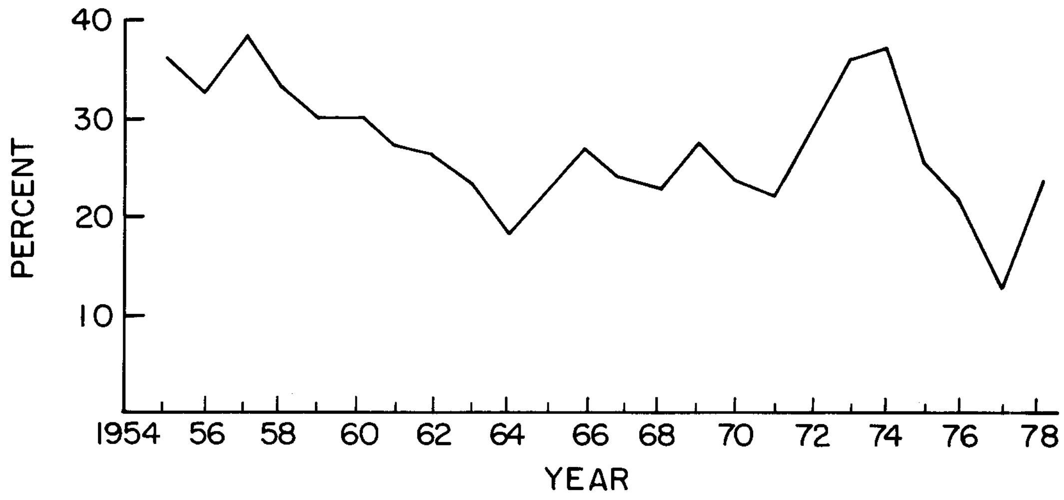

Figure 2. Oregon Net Farm Income Expressed as a Percentage of Gross Sales-Cash Receipts.

Capital Gains

Controversy exists as to whether income measures also include capital gains. Fisher, for example, argued that capital gains are more than the mere capitalization of future incomes; capital gains are symptomatic and not a precipitator of market structural changes. The symptom is manifested as an enhanced present value of the property, based on both the expected income stream and the discounted expected value of the asset at the end of year n, if the property is sold [Plaxico and Kletke].

Although Martin and Jeffries, Raup, Tweeten and Martin, and Winter and Whittaker argue for explicit consideration of a capital gains expectation factor, this study and others have chosen instead to account for probable reasons for enhanced capital gains expectations, such as urban encroachment [Clonts; Crowley; Lake and Pope; Morris] or major changes in expected income streams due to increased exports, new government programs or other structural changes [McConnen; Melichar; Reinsel and Reinsel]. Furthermore, the gross income and land value variables were indexed to remove much of the inflationary factor which is itself sometimes used as a surrogate for expected capital gains [Winter and Whittaker].

Average Farm Size

Based on previous findings [Lake and Pope; Morris; Pasour; Vollink], it is hypothesized that average farm size has a negative effect on land values. This negative relationship may be partially due to the existence of greater numbers of market participants in the bidding for smaller agricultural tracts, particularly as reflected in the increasing demand for "hobby farms." The relationship may be further reinforced by a farm building bias, because Census data do not separate bare land and building values. The value of farm buildings may increase per acre values of small farms (particularly hobby farms) more than large ones.

Irrigation

Irrigation capacity could contribute positively or negatively to land values. If, for example, Oregon farmers are risk averse, irrigated land would command a premium beyond the expected discount return from the agricultural produce of that land. Because land values used in the analysis include improvements, irrigation-fostered asset growth could also have a positive effect on land values. Alternatively, irrigation could introduce greater production costs which would reduce net income if the additional costs are not proportionally offset by increased returns. In Oregon, irrigation may also bring marginal lands which are unsuitable for forestry purposes into agricultural production. These marginal lands may produce the same value of sales as an acre of superior land, but expenses incurred in production may be greater. In addition, the superior, unirrigated soils may have higher residual values.

Population density

The regression coefficient for population density is expected to be positive. Urban population pressure was found to have a significantly positive influence on land prices in the earlier referenced studies of Morris, and Lake and Pope. Crowley showed land in urban-influenced counties appreciated at a faster rate than in the non-urban, grain growing areas.

Percentage of Land in Farms

The percentage of county land classified agricultural is used as a proxy for the supply of land available to buyers in that county and is expected to have a negative coefficient. Decreasing percentages indicate a decreasing supply of farmland which, *ceteris paribus*, would increase the market price for the remaining land. Conversely, a larger supply of land would lead to a lower expected price of that land.

Intercept or Constant Term

Conceptually, the constant term can be thought of as a base approximation for the average value of an acre of farmland in Oregon. The accuracy of this measure is attenuated because the dependent variable is inflated arbitrarily by values of a house and buildings. Another factor likely to influence the magnitude of the intercept term is that, in general, only the better quality land is in active agricultural use in Oregon (Census data for 1978 show that 29.3 percent of Oregon land is farmland). The timber industry, a major participant in Oregon's land market, has converted much of the region's marginally productive potential farmland to forestry. Such conversions exert upward pressure on agricultural land values.

The Data Base

Data were obtained from the United States Census of Agriculture, which was published every five years until 1974 and every four years thereafter. Several limitations exist in this data base, but more comprehensive statistics are not readily available. For instance, Census data are collected in the form of a survey and, thus, some response and nonresponse bias may well exist in the published figures, as well as bias stemming from subjective assessments of land values. Second, a minor change in the definition of a Census farm in the 1978 Census may distort those results slightly from results reported in previous Censuses. Other variations within the data base were removed by mathematical adjustments. Third, there are two major aggregation problems: the aggregation to a county level may remove much of the variation in land values, and farm building values are not separated from land values. These latter factors must be recognized in the analysis interpretation. Observations for the econometric model were obtained from six U.S. Census of Agriculture reports published for 1954 to 1978 (time series element) and for

36 Oregon counties (cross-sectional element), yielding 216 pooled observations.

The Empirical Model

Although many of the earlier studies of land values used linear models, model (1) was examined empirically using a double log form. The double log form was used because there was no theoretical basis for using a particular functional form and the double log model performed well relative to linear and transcendental models. The empirical version of model (1) was estimated via a 2-step ordinary least squares (OLS) procedure:

$$(2)\quad LnV = a + b_1 LnVSA + b_2 VSA74 + b_3 VSA78 + b_4 VSAW + b_5 LnAFS + b_6 PF + b_7 IRRH + b_8 LnPDW + b_9 CON74 + u$$

where

LnV ≡ log of indexed (1967 = 100) value per acre of land;

LnVSA ≡ log of indexed (1967 = 100) value of agricultural sales per acre;

VSA74 ≡ LnVSA times a dummy for 1974 (1974 = 1);

VSA78 ≡ LnVSA times a dummy for 1978 (1978 = 1);

VSAW ≡ LnVSA times a dummy for Willamette Valley (WV = 1);

LnAFS ≡ log of size of farm in acres (average);

LnPF ≡ log of percentage of county in farmland;

IRRH ≡ intercept shifter for high percentage in irrigation — equals 1 if percentage >10.5 percent, 0 otherwise;

LnPDW ≡ log of population per acre of farmland times a dummy for Willamette Valley (WV = 1);

CON74 ≡ intercept shifter for 1974 — equals 1 if t = 1974, 0 otherwise;

a ≡ the intercept;

b_i ≡ the regression coefficient (price elasticity) for variable i; and

u ≡ stochastic disturbance term.

The first step consisted of applying OLS to model (2). Examination of the estimated residuals and the Durbin-Watson test statistics for geographically grouped counties revealed the presence of autocorrelation in the model. Step 2 consisted of a Cochrane-Orcutt type procedure, whereby each variable was transformed using an estimated value for the autocorrelation coefficient.[4] Use of this correction procedure results in the loss of observations for 1954, reducing the time series observations from 6 to 5, and thus the total sample size from 216 to 180. However, use of the correction theoretically results in more efficient estimates of the individual coefficients. The dependent variable and average sale per acre were both indexed using the CPI (1967 = 1.00) to attenuate multicollinearity.

Two variables in equation (1) were redefined for the empirical model. Counties were ranked according to percentage of land irrigated and a dummy variable was used to account for only the one-third with the highest percentages. Thus, the binary variable in the final model indicates only twelve counties which had more than 10.5 percent of their farmland irrigated. Similarly, the population per acre of farmland variable was converted to an interaction term to reflect the geographical distribution of Oregon's population centers. Only one city situated outside of the Willamette Valley has a population of over 20,000.

Results

The results of estimating equation (2) via the two-step OLS procedure are presented in Table 1. As expected, the coefficient of the

[4]Each of the state's four geographic regions was found to have a different r^{ho} value:

Coastal Region = 0.4376;
Willamette Valley = 0.8989;
Eastern Oregon = 0.7910;
Mountain Region = 0.9238.

TABLE 1. Regression Results for Oregon County Farmland Values, 1954-1978.

Dependent Variable — Natural log of indexed average value per acre of agricultural land

Independent Variable	Est. Coefficient	Standard Errors
1) LnVSA	.228***	.040
2) VSA74	−.080*	.041
3) VSA78	.188***	.013
4) VSAW	.071**	.024
5) LnAFS	−.477***	.039
6) PF	−.048*	.029
7) IRRH	−.025	.016
8) LnPDW	.040*	.019
9) CON74	.641***	.151
CONSTANT	7.537***	.335

R-Squared	.96
Standard Error of the Regression	.15
Number of Observations	180
Mean of Dependent Variable	3.19
F statistic	466.69

*, **, *** = significant at the .05, .01 and .001 levels, respectively.

indexed value of agricultural sales per acre (VSA) is positive and highly significant. However, the interaction of VSA with the slope shifters must be considered in order to interpret the model correctly. The slope shifter for the census period 1969 to 1974 (VSA74) is negative and significant. There are two possible explanations for the negative coefficient. First, Figure 2 shows that Oregon net farm income expressed as a percentage of gross sales increased to 38 percent by 1974, following a relatively stable period from 1959 to 1972 during which the percentage averaged 26 percent. Because agricultural sales are used as a proxy for farm income and do not account for this 1974 rise in net farm income, the relationship between agricultural sales and values of land per acre may be somewhat distorted.

Similarly, the positive and significant slope shifter for sales in 1975 to 1978 may be biased by the use of gross sales figures. While Oregon net farm incomes (not available by county) declined by approximately 20 percent in current dollars between 1974 and 1978, gross sales actually increased by 47 percent over the same period; land prices increased by a record 102 percent. Thus, one might expect a lesser, rather than greater role of 1978 agricultural sales in determining 1978 land values.

The 1974 intercept shifter (CON74) is positive and significant, indicating that all land prices in Oregon increased significantly for the 1968-74 period. Together, the negative coefficient for VSA74 and the positive coefficient for CON74 suggest that in 1969 to 1974 all agricultural land values increased, but the value of agricultural sales became less important in the land valuations. It is hypothesized that participants in the Oregon farmland market began to incorporate capital gains expectations into their estimates of the values of actual and anticipated holdings. Between 1969 and 1974, U.S. net farm incomes peaked, but capital gains showed an even greater increase (Figure 3). Because 45 percent of Oregon farmland is owned by nonresidents of the county [Shirack and Eisgruber], capital gains expectations may be less a function of Oregon urbanization or other local influences than of influences in the general economy [Melichar]. Thus, regional studies may not explicitly identify and account for the source of this capital gains expectation.

A cross-sectional slope shifter accounts for

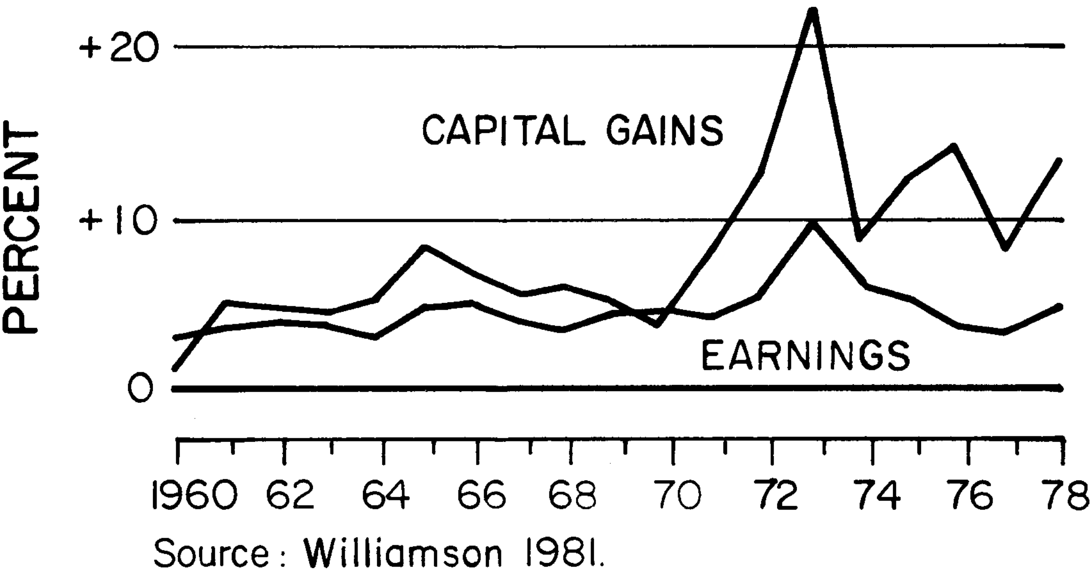

Figure 3. Percentage Return to Farming Attributable to Capital Gains and Income in the U.S.

a potentially different agricultural sales (VSA) effect in the Willamette Valley (VSAW). The VSAW coefficient is positive and significant. One economic interpretation is that, *ceteris paribus*, land in the Willamette Valley commands a premium based on the value of agricultural sales from that land. If one accepts the Von Thuenen hypothesis that higher value goods and those demanding greater transportation costs (e.g., vegetables and dairy products) are produced at close geographical proximity to market centers, then the premium on Willamette Valley farmland is the product of rational producers responding to both the potential sales volume in the populated Valley (as reflected in the high correlation of VSAW and PDW) and to cost minimization criteria. In addition, land use assessment taxes may well have a distorting effect upon land value in the Valley.

The estimated coefficients for both average farm size (AFS) and percentage farmland (PF) are negative and significant. As noted above, the negative farm size coefficient is likely due to the spreading of building values over larger acreages (hobby farms are prevalent in Oregon), and the negative elasticity for percentage farmland in a county may reflect the price effects of competition for farmland. Other researchers [Lake and Pope, Morris, Pasour] also have found negative coefficients for these variables.

The coefficient of the dummy variable for counties with 10.5 percent or more of the farmland irrigated (IRRH) is negative but not statistically significant at the 5 percent level. Perhaps the major benefit from irrigation consists of the increased value of agricultural sales; that is, the VSA variables account for many of the benefits. Alternatively, irrigation may be used primarily to bring marginal (i.e., lower valued) lands into production and thereby into the agricultural census data base. This expansion of the extensive margin via irrigation could have a negative effect on average farmland prices. Another possibility is that irrigation related investment is adopted as a risk-reducing strategy and is capitalized into land values. Each of these benefits — increased sales, introduction of marginal lands, and decreased risk — likely accrue in different degrees to various producers across Oregon. The diversity of Oregon's agricultural land base limits the interpretation of aggregate trends, but time-series data are not available for more disaggregate analyses.

Finally, the coefficient of population density in the Willamette Valley (PDW) is positive and significant. Although this variable does not explain as much of the variance in land prices as in other studies cited above, it helps account for some of the influences of urbanization on land prices other than through an increase in the value of agricultural sales (e.g., via greater volumes and higher valued products).

Summary and Conclusions

The major objective of this paper was to identify the variables that have had an influence on the price of agricultural land in the State of Oregon. A pooled time-series, cross-sectional econometric model was used to investigate the importance of selected influences on farmland values in Oregon's thirty-six counties.

The empirical model revealed that the value of agricultural product sales had a positive effect on land values while average farm size and percentage farmland had negative effects. In addition, intercept and slope shifters indicated that for the period ending in 1974, agricultural sales increased dramatically but Oregon farmland values tended to be influenced less by product sales trends than in earlier periods. This structural change suggests a need for further research on the impacts of capital gains expectations or dramatic changes in agricultural sales expectations on land prices and the further economic implications of this change in land price determinants.

The findings suggest that the model should be disaggregated to several subregional models. In the Willamette Valley urban encroachment may explain many of the changes in agricultural land values, while in northeastern counties increasing land values may be related to anticipated growth in wheat exports. Similarly, census periods following 1969 to 1974 should be examined separately because the pooled model suggests a structural change occurred during the 1969 to 1978 periods. Although theory suggests a lagged structure model would likely be most appropriate, the current data base will not accommodate such a model. Given data constraints, the pooled model is particularly useful in that it highlights the regional and temporal diversities in structure while revealing the importance of farm product sales potential across counties and time.

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