Impact of Rainfall, Sales Method, and Time on Land Prices

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ABSTRACT

Land prices in Western Kansas are analyzed using regression to estimate the influence of rainfall, sales method, and time of sale. The estimates from regression indicate that land prices decreased about $27 for each range that was farther west which can be converted to about $75 per inch of average rainfall. In addition, the influence of method of sale (private sale or auction) is estimated along with the impact of time of sale. Auction sales prices are approximately $100 higher per acre than private sales, and prices have been increasing by about $10 per month. Regression is shown to be a very useful tool to support adjustments in appraisals for several different factors that influence land prices.

Introduction

Many people are concerned about rapid land price changes in recent years. Professionals in farm management, lending, and appraising need the best information possible to make good decisions. When prices are changing rapidly, the need for good information is even greater. Appraisers in particular need to identify variables related to land prices that might influence price differences between parcels. In addition, they need to know how much these variables influence the price of land so proper adjustments can be made to comparable sales. Good techniques are necessary to make these adjustments. Regression is one technique that can be used to estimate the impact of different characteristics on land values.

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Regression has been used in a number of earlier studies. Postier et al. (1992) estimated the impact of a number of variables on land values. Wild (2009) argued that real estate appraisers may need to analyze datasets objectively to confirm value trends and the significance of value determinants. He showed that regression results can be used to support area market trends, to justify the selection of comparable sales, and to support qualitative adjustments in appraisal assignments where a concise quantification of sales pairings is not an option.

Appraisers have traditionally used paired sales analysis to estimate the amount of adjustment necessary to compare sales during an appraisal. Another method of supporting adjustments is to use coefficients from an estimated regression. Regression analysis has the advantage of being an accepted form of analysis in many different fields. Having enough data for regression analysis is an issue in that datasets and sample sizes need to be large enough to yield reliable results. In appraising agricultural properties in southwest Kansas, regression was used to support adjustments in appraisals.

In southwest Kansas, land prices are dependent upon many different variables, but the main ones are time, rainfall, and conditions of sale. In this paper, we examine and quantify these factors using a regression analysis. The dataset consists of 141 sales of dry cropland that occurred in a 16-county area in southwest Kansas over a two-year period, 2010 and 2011.

Factors Influencing Land Values

Farmland prices are expected to increase over time. Wheat, the primary crop grown on dry cropland in western Kansas, has experienced long-term growth in gross revenues due to improved yields and prices (on a nominal basis). Increases in farmland prices include the increases in returns due to changes in purchasing power (inflation) as well as increases in productivity and crop price changes. In a positive inflationary environment, all things being equal, we expect land prices to increase over time. This circumstance is amplified by the increase in productivity and prices, so we expect land prices to increase in this analysis. We measure the increase by looking at the date of sale, with sales dates identified by month of the sale. Figure 1 shows the trend in price over that period.

Southwest Kansas is located on the High Plains, a semi-arid area that receives 16 to 23 inches of rainfall annually. The High Plains are notable for native short grass prairies, low population densities, and windy conditions. The most limiting factor for field crop production is moisture, and most dryland crops are grown in some sort of crop–fallow rotation to manage moisture in the soil profile. We examine the relationship between higher average annual rainfall and land values in this paper. Most of the properties in the area are fairly homogenous, and have similar soils classes; however, one soil type might be Class II on the eastern side of the area and Class III on the western side due to rainfall differences. Southwest Kansas is in the "rain shadow" of the Rocky Mountains located to the west in central Colorado. Prevailing winds in southwest Kansas are from the southwest, so the area is leeward of the Rockies; rainfall decreases closer to the mountains due to the rain shadow. Examining long-term rainfall, we estimate that rainfall decreases an average of one inch for every 16.66 miles one travels west; consequently, we expect land prices to decrease as we travel west. To measure this in our analysis, we used the range in which the property was located (using the Public Land Survey System, or PLSS) as a proxy for rainfall.

The conditions under which properties are sold might affect the price. Anecdotally, we have observed that properties sold at auction receive a higher price than those sold under private contract. This could be due to a number of factors, but we theorize that in a rapidly increasing market, the likelihood of information asymmetries between buyers and sellers increases. A substantial number of landlord owners of farmland are off-farm heirs with little recent knowledge of agriculture, and these landowners may be less aware of current prices when selling their property to a tenant farmer with contemporary knowledge of agricultural conditions and economics. This phenomenon is supported in the literature with auction theory and the "winner's curse." Ashenfelter (1989) suggested that an auction system permits an uninformed seller to receive values nearer market values for wine and art, which suggests that auction values are higher than private treaty sales. Dotzour et al. (1998) explored sales prices for houses sold at auction and sold by private treaty; they found that in some cases auctions can result in premium sales prices, and in no cases did auctions result in lower prices than private-treaty sales. A considerable amount of work has examined issues relating to auctions. Wilson (1977) suggested auctions are preferable to private negotiations for selling high-quality, relatively homogeneous properties. In the dataset we examined, sales were identified as either a private sale or a public auction. Private sales were used as a default and auction sales were identified with a dummy variable. We expected higher sales prices to occur under auction.

Regression Model

To estimate the impact of time, rainfall, and conditions on sale price of farmland, the following function was developed:

(1) $L = f(t, r, a_{dum})$

Where

- L = Land price,
- t = Time expressed as a month/year,
- r = Rainfall using the legal range as a proxy,
- a_{dum} = Auction dummy.

The hypothesis for each independent variable is:

- $t(+)$: As outlined above, land prices should increase over time, so the expected coefficient is positive.
- $r(-)$: In this case, the range increases as rainfall decreases, so the expected coefficient is negative.
- $a_{dum}(+)$: As discussed above, theory suggests an auction sale will be higher than a private treaty sale, so the expected coefficient is positive.

Dataset

As mentioned above, the dataset consisted of 141 sales of dry cropland properties in southwest Kansas during 2010 and 2011. These sales were obtained, verified, and analyzed by Farm Credit of Southwest Kansas appraisers for use in their appraisals and risk management. Four separate data elements were extracted and compiled for each sale. Descriptive statistics for these variables are presented in Table 1 below.

Land values ranged from $401 to $2,031 per acre with an average price of $1,080. The ranges varied from Range 21 to Range 43; 41 percent of the sales were auction sales and the rest were private sales. It should also be noted that these parcels were all 80 acres or larger and were used for agricultural purposes.

Regression Results

The estimated regression yielded the following coefficients:

- t – The estimated coefficient for t is 10.92, implying that land prices increased at a rate of $10.92 per acre per month during 2010 and 2011 for dry cropland in southwest Kansas. The sign on this coefficient is positive, agreeing with the hypothesis above.
- r – The estimated coefficient for r is -27.12, which implies that each additional westerly range in southwest Kansas results in a loss of $27.12 per acre.
- a_{dum} – The estimated coefficient for a_{dum} is 104.01, implying that land prices under auction are $104.01 higher than private sales. The sign on this coefficient is positive, which agrees with the hypothesis above.

The value of R^2 for the estimated regression is 0.24, so the in-sample overall fit of the regression analysis is only fair. We believe that the data contains a lot of variability simply due to randomness in market prices.

The F value in the regression estimate is 15.76, which exceeds the critical value of 2.60 at the 95 percent confidence level. As evident in Table 2, the t-statistics for each of the independent variables exceeds the critical value of 1.980 at the 95 percent confidence level.

The results of the impact of range on land price can be converted into an estimate of the impact of an inch of rainfall on the price. On average, rainfall decreases one inch for each 16.66 miles west in Southwest Kansas. Each range by definition consists of approximately six miles east to west, so we can calculate the value of an inch of rainfall as (16.66 miles per inch rainfall/6 miles per range) × $27.12 per range = $75.30 per inch of rainfall.

We can use the results of the regression to make adjustments to comparable sales parcels. The time adjustment of $10.92 can be used to adjust the comparable to the subject property. The range information can be used to make adjustments based on a grid. For example, in appraising a subject property located in Range 42 and a comparable sale located in Range 40, we would need to adjust the comparable sale -54.24 (2×27.12) to make the comparable sale equal to the subject.

Finally, if the comparable sale were sold as a private sale, as a part of the conditions of sale adjustment, $104.01/acre would be added to the comparable sale to make it comparable to the subject. Our assumption is that a rational actor would prefer a higher sales price and would select the higher value method of selling. This approach does not adjust for the selling costs of an auction, which a seller would have to take into consideration.

Additional analysis was undertaken to further investigate the impact of selling larger parcels of land at an auction. All the parcels were relatively large, 80 acres or larger and used for agricultural purposes. Size of parcel was not significant in impacting the price when it was a private treaty sale, so only size and auction sales were considered. New dummy variables were created to capture, the impact of a large parcel at auction (greater than 160 acres) and a small parcel at auction (80-160 acres). The results showed that large parcels at auction in particular showed an even larger increase in price than small parcels at auction when compared to sales by private treaty, so it may be important also to consider the size of the parcel in the analysis.

Summary

We used regression to estimate the impact of time; location, which can be translated into average annual rainfall; and method of sale. The signs on the estimated coefficients matched what we expected, and testing indicates the independent variables are statistically significant at the 95 percent confidence level. Land values increased $10.92 per month, decreased $27.12 for each range that was farther west, and were $104.01 higher for auctions than for private sales. The range value of $27.12 can be converted to $75.30 per inch of average rainfall because average rainfall decreases fairly uniformly across Western Kansas.

The overall fit of the estimate was not as robust as we would have liked, but it reflects the overall randomness in market prices and the difficulty in capturing all the variables that might influence price. Land is not a homogeneous commodity, and as such prices and conditions of the sale can vary considerably which results in randomness that is difficult to model. Local neighbors who bid up the price considerably above the average, or private treaty sales that are not arms length can influence the price substantially, and are responsible for some of the randomness in market prices that are not explained by the model.

This two year period is one in which land prices are changing fairly rapidly, and it may be important to estimate equations like this fairly frequently particularly when prices are changing as fast as they are now. The premium in price due to an auction in particular may change, possibly being less when land prices are more stable and being potentially greater when land prices are changing rapidly in which case some people may be less aware of the current level of prices when negotiating a private treaty sale.

This paper shows that appraisers can use information generated by regression to adjust comparable sales to the subject property. Regression techniques provide appraisers with an excellent tool to evaluate the influence of many factors on the price of land objectively.

References

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Table 1. Data from 141 sales in southwest Kansas during 2010 and 2011

	$/Acre	*t*	*r*	a_{dum}
Mean	1,080	12.7	35.24	0.41
Maximum	2,031	24.0	43.0	1.0
Minimum	401	1	21	-
Standard Deviation	337	6	6	0
Coefficient of Variation	31%	51%	16%	120%

Table 2. Regression Results

Variable	Estimated Coefficient	Standard Error	t-Statistic	P-Value
Intercept	1854.48	167.23	11.09	<.001
Date (Time)	10.92	3.84	2.84	0.005
Range (Rainfall)	-27.12	4.49	-6.03	<.001
Auction Dummy	104.01	52.05	2.00	0.05

Figure 1. Prices for dry cropland in 2010-2011 in southwest Kansas