Report for 2005KS44B: Developing an Economic Tool to Predict the Value of Water Rights

Publications

- Conference Proceedings:
  - Golden, B. “The Value of Water in Western Kansas and The Voluntary Water Rights Transition Program.” Presented at the Agricultural Profitability Conference. Ulysses, Kansas. February 1, 2005.
  - Golden, B. “The Economic Value of Water Rights in Kansas.” Presented at the Water and the Future of Kansas Conference. Topeka, Kansas. March, 2006.

- Other Publications:
  - Golden, B., T. Kastens, K. Dhuyvetter, and J. Peterson. “Developing an Economic Tool to Predict the Value of Water Rights.” Research report posted to www.agmanager.info. May, 2006.
  - Golden, B. “Policy Solutions and Economic Impacts: Voluntary Water Retirement Programs.” Presented at The Ogallala Aquifer: What Are We Doing? K-State Meeting With the Stakeholders. Manhattan, Kansas. March 17, 2006.
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Report Follows

FINAL REPORT

Project Title: Developing an Economic Tool to Predict the Value of Water Rights

Project ID: 2005KS44B

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Problem and Research Objective

Governmental policy and economic research are gradually shifting toward a focus on sustainability issues and policy alternatives that achieve an absolute reduction in groundwater consumptive use. A critical water problem in the state of Kansas is developing policy alternatives that yield an absolute reduction in the consumptive use of water from the Ogallala aquifer. One such policy instrument is the voluntary Irrigation Transition Assistance Program. Through this policy, an absolute reduction in consumptive use will be achieved by purchasing and permanently retiring irrigation water rights in the Ogallala region of western Kansas. In order to implement this policy, the state of Kansas needs input from the economic community on both program structure as well as the market value of water rights. The objective of this research was to provide econometric models capable of estimating, on a parcel-specific basis, the fair market value of water rights, for all Kansas counties overlying the Ogallala aquifer. Estimates of the fair market value of water rights, at the county level, were generated. Additionally, a web-based tool was developed so that landowners and other stakeholders can estimate the fair market value of water rights on a parcel specific basis.

Methodology

Hedonic modeling techniques assume that the value of a product, in this case a parcel of land, is equal to the sum of the value of the product's component parts. One of these component parts is the value of the water right. Investigation into the value of water rights, and the role that various hydrological parameters have in determining that value, requires the development and estimation of two basic hedonic models. The first model estimated the value of nonirrigated land and was specified as

$$Y_{NI} = X_1\beta_1 + \varepsilon ,$$

where Y_{NI} is the sales price per acre of nonirrigated land, X_1 is a N x K matrix of explanatory variables associated with land characteristics, β_1 is a K x 1 vector of parameter estimates, and ε is a random disturbance term. The second model is used to estimate the value of irrigated land and was specified as

$$Y_I = X_1\beta_1 + X_2\beta_2 + \varepsilon ,$$

where Y_I is the sales price per acre of irrigated land, X_2 is a N x J matrix of explanatory variables associated with hydrological characteristics, and β_2 is a J x 1 vector of parameter estimates. The difference between the irrigated parcels' estimated sales price and its estimated nonirrigated value represents the implicit value of the water right (VWR) defined as

$$VWR = Y_I - Y_{NI} ,$$

where Y_I and Y_{NI} now represent their model estimated values.

Economists have long been aware that the prices of neighboring parcels of agricultural land are highly correlated. Traditionally, this correlation has been quantified by the inclusion of independent variables that are believed to cause the correlation and residual or unexplained correlation generally has been ignored. While the above mentioned hedonic models will include independent variables to explain spatial correlation, omitted variable bias might lead to residual spatial correlation. Recent advancements in

geographic information systems (GIS), spatial econometric techniques, and computer algorithms allow the estimation of this residual spatial impact without specifying the actual cause of the spatial correlation. Anselin (1988) defines the spatial autoregressive moving average (SARMA) model as

$$Y = X\beta + \rho WY + \varepsilon \quad where \quad \varepsilon = \lambda W\varepsilon + u\,.$$

In this formulation W is an N x N spatial weight matrix, ρ is the coefficient on the spatially lagged dependent variable WY, which quantifies the spatial correlation in the dependent variable, λ is the coefficient on the spatially lagged disturbance term $W\varepsilon$, which quantifies the spatial correlation in the error term, and $X\beta$ represents the basic linear hedonic model for either irrigated or nonirrigated cropland.

On a county basis, both conventional hedonic models as well as spatial adjustment models were developed. Statistical measures such as Moran's I, log-likelihood ratio tests, levels of statistical significance, R^2, maximum log likelihood values, and out of sample predictive ability were used to select the most appropriate model.

Data from the Kansas Society of Farm Managers and Rural Appraisers, the Property Valuation Division of the Kansas Department of Revenue, the Kansas Division of Water Resources, the Kansas Geological Service, and the United Stated Department of Agriculture Farm Service Agency were combined, on a parcel specific basis, to create a time series data set of observed land sales transactions.

This 'quasi-appraisal' technique allowed for the unbiased estimate of the value of water rights based both on the conventional site-specific characteristics as well as the hydrological characteristics of the associated water well.

Significant Findings

1) Previous research estimated irrigated and nonirrigated values in a single model. Based on statistical tests, this research suggests that the markets for irrigated and nonirrigated land are separate and distinct and require separate model estimation.
2) This research suggests that the average annual acre-foot per acre usage (AFU) of irrigation water may combine the positive impact associated with well capacity and the negative impact associated with diminishing saturated thickness.
3) The literature suggests that the seniority level of the water right is a significant determinant of value. This research found no difference between the perceived value of junior and senior water rights. The lack of significance on this variable probably is due to the fact that rarely have junior water rights been restricted. If the market, based on past experience, does not see a difference between junior and senior rights, it is unlikely that seniority will be a significant determinant of the market price.
4) There is significant variation in the value of water rights within a given county, even at a constant water usage.
5) Low quality land receives a substantial discount if it is used for nonirrigated production while there is little discount associated if it used for irrigated production.
6) The distance to the nearest town is important for nonirrigated land but usually has a statistically insignificant impact on irrigated land value.

7) Contrary to previous research that suggests sales price per acre decreases with farm size for nonirrigated land, these models suggest that it actually increases for irrigated land.
8) The possible existence of market arbitrage in the irrigated land market was observed in the data. Arbitrage is the nearly simultaneous purchase and sale (pure exchange) of a good in order to profit from the price differential. The presence of arbitrage raises concerns that the number of willing buyers and sellers may be too limited for the market for irrigated land to be classified as competitive.
9) The results suggest that spatial adjustment models in the presence of unavoidable model misspecification may not lead to unbiased parameter estimates.
10) Contrary to conventional wisdom and published literature, the value of water appears to be increasing in both nominal and real terms. One possible explanation is that the rate of technological advancement in water use efficiency and crop production is increasing the value of the remaining stocks of water faster than the aquifer is being depleted.

Publications and Presentations

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Information Transfer

1) The results and understanding acquired through this research were conveyed through seminars (as listed above) delivered by the investigators directly to all interested policy decision makers, irrigated producers and agribusinesses, in public meetings conducted in key irrigated areas of Kansas.
2) A final report that documented the research methods and what was learned from the study was written and delivered to the Kansas Water Resource Institute, Kansas

Division of Water Resources, Kansas Water Office, and the State Conservation Commission.

3) The final report and Excel tool were posted to a web-site that has been designed to promote learning related to groundwater management issues in Kansas (http://www.agmanager.info/).
4) The data set, methods, and results will be made available, through peer review publications, to other researchers focusing on policies needed to achieve an absolute reduction in groundwater use.

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