Farmland Prices Determinants

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Abstract

This paper examines determinants of farmland prices in Minnesota. A hedonic price model is used to estimate the implicit value of the land characteristics. Farmland prices are influenced by agricultural production attributes as well as demand factors. The results also suggest that the potential for development of land for higher value non-agricultural activities creates an expectation, that is capitalised into farmland prices.

Introduction

Understanding the roots of farmland price volatility is a concern to agricultural producers, government officials, developers, and investors. These interest groups commonly participate in conflicts surrounding agricultural restructuring, land use planning, property taxes, economic development, and farmland conservation. Clearer insight into how agricultural and other factors influence farmland prices would benefit all concerned as communities wrestle with plans to promote growth in the non-agricultural sector that maintain and sustain opportunities for production agriculture.

Land use conflict throughout rural communities has intensified as development sprawl has increased and farmland has decreased. Despite a weak farm outlook, land values are firm or rising (AgLetter 1998). Bankers speculate that the strong farmland values are associated with residential and commercial development. Total land in farms in the United States has declined 20%, from 1.16 billion acres to 931.8 million acres since 1950 (Census of Agriculture, various issues). During the same period land in crops fell 10% from 478.3 million acres to 431.1 million acres. Understanding the determinants of land prices could provide policy makers with information to guide the development of land use management tools that balance need for agricultural land resources and economic growth and provide a basis for compensating individual land owners caught the two.

Farmland price studies are generally of two types, those that focus on rents derived from agricultural production as farmland's primary price determinant and those assessing the influence of non-farm factors as the primary price determinants (Shi, Phipps, and Colyer, 1997). Studies assessing the influence of returns to agriculture on land prices (Barnard et al. 1997; Burt 1986; Chavas and Shumway 1982; Castle and Hoch 1982; Herdt and Cochrane 1966; Lloyd et al. 1991; Palmquist and

Danielson 1989; Sogaard 1993; Organization for Economic Co-operation and Development 1997) have used agronomic characteristics, land rents, and agricultural structure variables as determinants of farmland prices. These studies found that farm returns, farm size, expected capital gains, capitalized policy benefits, and interest rates influenced farmland prices.

Studies analyzing the impact of non-agricultural factors on farmland prices (Chicoine 1981; Clonts 1970; Colyer 1978; Dunford et al. 1985; Folland and Hough 1991; Husak 1975; Husak and Sadr 1979; Shonkwiler and Reynolds 1986; Shi et al. 1997) considered the influence of location, population density, infrastructure, and urban access on farmland prices. Generally, these studies found that urban proximity and non-agricultural factors leading to greater potential of conversion of agricultural land to non-agricultural use have a positive influence on agricultural land prices.

Conceptual Model

Land is a resource used in various production activities, agricultural production being one. Land's value, or price, is differentiated on the basis of its production attributes for agricultural as well as other activities and can be modeled as a market for differentiated factor of production (Palmquist and Danielson 1990). In rural regions where agricultural production dominates land use, agriculture often has been assumed to be land's highest value use. Therefore, land prices are not influenced by demand for its use in urban activities (Chavas and Shumway 1982). If production agriculture were not the highest value use and we assume farmers are rational decision makers, there would be no agricultural production.

The potential returns from agricultural and non-agricultural activities are capitalized into current farmland prices (Folland and Hough 1991). If the expected future "best and highest" use for farmland is a higher value use like industrial or residential development, its price will be higher than the price for agricultural use (Phipps 1984). Shi, Phipps, and Colyer (1997) suggest agricultural land prices analysis should incorporate measures for net farm returns unless non-agricultural use is currently the most profitable use for the land. Variables reflecting the economic returns to agricultural use can be used to test the influence that returns to agriculture have on prices, especially if it is anticipated that there will be a multi-year transition period for the conversion of land from agricultural use to other uses. Non-agricultural variables can be used to determine if the potential impact of converting agricultural land to a higher value use is influencing land prices (Couglin and Keane 1981).

Hedonic price models (Grilches and Rosen 1971) have been used extensively to impute the

value of agricultural land attributes in farmland prices (Miranowski and Hammes 1984; Palmquist and Danielson 1989; Herriges et al. 1992; Roka and Palmquist 1997). Hedonic indices also have been used to estimate the importance of farmland attributes in production of different products, such as beef and milk (Gillmeister et al. 1996; Richards and Jeffrey 1996). Hedonic pricing suggests prices of heterogeneous goods are determined by the goods' quality characteristics and has been used to estimate implied values of individual farmland characteristics, a multi-attributed good used as a factor of production.

The price for farmland is comprised by a bundle of characteristics. Dunford et al. (1985) classified agricultural characteristics as those that: influence farm income and profitability; external economic and governmental influence; expectations about future conditions; buyer characteristics; seller characteristics; and land characteristics. Attributes signaling potential for converting farmland to a higher value use, such as residential or commercial development also influence farmland prices (Shi et al. 1997).

Similar to Chicoine (1981) farmland prices are modeled as a hedonic function of factors that influence demand to convert farmland to alternative uses along with physical land features. If the demand for land is driven by non-agricultural factors, the lands' agricultural productivity may not significantly affect farmland prices.

Attributes influencing farmland prices are classified as location, agricultural factors, and non-agricultural factors. Location reflects the proximity of the farmland *vis a vis* metropolitan areas. Agricultural factors include characteristics related to the productivity of a specific farmland parcel as well as attributes of the agricultural economy. Non-agricultural factors consist of economic characteristics of the region related to potential demand to convert farmland to a non-agricultural use.

Empirical Model and Data

Factors influencing the value of Minnesota farmland were analyzed using data for 1996 farmland transactions in Minnesota in the following model:

$$\ln P = b_o + \sum_{j=1}^{m} b_j X_j + e$$

where, P is the per acre price of farmland, b_0 is the intercept, X_j represents the farm and non-farm factors that influence farmland prices, and b_j is the coefficient on X_j. Each explanatory variable in the model has an exponential impact on farmland price such that a k change in a variable, X_j, would have

a $100(\exp(k\beta_j)-1)$ percent impact on land price.

Two models were estimated. One model was estimated with data for all farmland transactions in rural counties (non-metropolitan) that reported an agricultural productivity index. The land productivity index was not available for farmland sales in metropolitan counties. Another model was estimated for all farmland transactions.

Data used in the analysis were obtained from a variety of sources. Data related to specific farmland land parcels were obtained from the University of Minnesota. Other data used in the analysis were obtained from the Bureaus of Census and Economic Analysis of U.S. Department of Commerce, the Economic Research Service of the U.S. Department of Agriculture, and the U. S. Department of Transportation. Variable definitions and sources are presented in Table 1.

The dependent variable used in the analysis, similar to Chicoine (1981) and Folland and Hough (1991), was the natural log of the per acre sale price of the farmland parcel in Minnesota for 1996. These data were obtained from Steven J. Taff's web page (http://apecon.agri.umn.edu/faculty/sjtaff/). The data include all arms-length farmland transactions for 1996 of land that was used for agricultural use before and after the sale. Data included sales price, adjusted sales price (reported price less personal property and adjusted for term and time of sale), sale date, parcel size, tillable acres, and an average crop equivalent rating (when recorded). The per acre adjusted sales price was used as the dependent variable.

Two variables were used in each model to measure the influence of urban access on farmland prices. A dummy variable based on BEALE CODES was used to measure the influence of urban access on farmland prices for sales in non-metropolitan counties. ADJACENT took the value of 1 if the county a parcel was located in was adjacent to a metro county and 0 otherwise. It was hypothesized that farmland in counties adjacent to metro counties would have higher prices, *ceteris paribus*, than farmland in non-adjacent counties because of the higher demand for land near areas of population agglomeration.

URBAN, an index developed from urban influence codes development by the Economic Research Service (www.econ.ag.gov/Prodsrvs/dp-rur.htm) was used to test the influence of urban access on farmland prices in the model for all farmland transactions. It was hypothesized that farmland prices would be higher the greater the urban influence, *ceteris paribus*, due to more intensive non-agricultural demand for farmland in urban areas.

INTERSTATE, obtained from the U.S. Department of Transportation, is the number of miles

of interstate highway that pass through a county. This variable measures if urban access as measured by interstate highway miles influences farmland prices. It was hypothesized that better urban access as measured by miles of interstate would have a positive influence on farmland prices, *ceteris paribus.*

Three variables describing attributes of land parcels sold were included in the model to test whether parcel attributes influence price. TILLABLE, the percent of tillable acres in a particular land parcel, was included in the model to test how land's value as an input to production agriculture influenced per acre price. It was hypothesized that the larger the proportion of tillable land in a parcel, the higher the per acre price, *ceteris paribus.*

The size of a particular parcel, DEEDED, was included in the model to test whether a parcel's size influenced per acre price. It was hypothesized, *ceteris paribus,* that larger land tracks would have lower prices per acre because of lower per acre transaction costs.

An average crop equivalent rating per parcel was included in the analysis to test whether land productivity influenced per acre price. It was hypothesized that land with higher average agricultural productivity would have higher value reflecting a higher potential return from agricultural production. CER, a productivity measure obtained by the University of Minnesota for Minnesota land was included to test the influence of soil productivity. This measure was only available for farmland located in adjacent and non-adjacent counties. Consequently two models were estimated. A rural county model (620 transactions) that included the CER measure and a state model (1699 transactions) that did not.

Eight variables were specified to assess the influence of local economic structure on farmland prices. The total area of the county, LAREA, in which a parcel is located was included in the model to assess how the supply of land influenced price, *ceteris paribus*. It was hypothesized that farmland in counties with larger area would have lower prices because of a greater supply of land.

Two measures, CROP92 and LSTK92, were included in the analysis to measure the influence of the size of the local agricultural sector on land prices. CROP92, the value of corps sold in a county in 1992, and LSTK92, the value of livestock sold in a county in 1992, where hypothesized to have a positive relationship to farmland prices. Counties with larger crop or livestock sales were assumed to have larger agricultural sectors, increasing the demand for agricultural land.

The share of non-farm employment in manufacturing, MANUF, was included as a measure of economic structure. A concentration of manufacturing makes a community more attractive to new

manufacturing (Henry and Barkley 1996). Consequently, a higher share of manufacturing employment reflects higher demand for industrial land. This demand increases the potential for converting farmland to industrial land, increasing the price of farmland, *ceteris paribus*.

Minnesota is known for lakes, woodlands, and recreational amenities. Counties possessing an abundance of natural amenities, *ceteris paribus*, are hypothesized to be more attractive locations for retirement home and recreational activity development. Consequently, the value of farmland in counties with high amenities would be higher than in other counties because of high demand for recreational use. AMENITY, a county level natural amenity index developed from climate, topography, and water measures (McGranahan 1999), was included in the model to test whether potential for retirement and recreational activity development influences the price of farmland. It was hypothesized that farmland in counties with more natural amenities would have higher prices.

Three other measures were included in the analysis, SPRAWL, POP90, and POPGR to measure influence of county growth and size. SPRAWL is the percent of farmland lost in a county between 1982 and 1992. Higher loss leads to higher expectations that farmland will be converted to a non-agricultural use as well diminishing the supply of land. If this expectation is capitalized into the price of farmland the price will be higher in counties that have seen larger shares of farmland lost.

POP90 is the county population in thousands of people in 1990. It was hypothesized that demand for land is correlated with population. Larger populations have larger aggregate demand for land for residential and business uses. Therefore, more densely populated counties will have higher farmland prices. POPGR is the change in population over the 1990-1996 period. It was hypothesized that more rapid population growth is associated with increasing demand for land, increasing farmland owners' expectation that farmland will be converted to higher value uses. Thus, we expected a positive relationship between population growth and farmland prices.

Results

Regression results for two estimated farmland price models are presented in table 2. Model 1 is a model for rural farmland prices. It was estimated for 620 land transactions that occurred in non-metro counties. Model 1 included CER, a land productivity index measure, which was not available for farmland transaction in metropolitan counties. Model 2 was estimated for 1699 farmland transactions statewide.

Nine of the 13 independent variables in the Rural Minnesota Land Price Model (Model 1)

were statistically significant at the .01 level and had the hypothesized sign. SPRAWL, POPGR, MANUF, and INTERSTATE were not significant. An f-test for model had a value of 73.8, significant at the .001 level. The adjusted R^2 for the model was .60.

Eleven of the 12 independent variables in the Minnesota Land Price Model (Model 2) were statistically significant at the .01 level and had the hypothesized sign. URBAN was the only variable not significant. The model had an f-test value of 120.1 and was significant at the .001 level. The model's adjusted R^2 was .46.

Condition indices computed for both models were below 30 and no variable had two or more variance proportion values greater than 0.5. Multicollinearity, therefore, was assumed not to be a problem (Judge et al 1985).

Discussion

Coefficients for all of the parcel characteristics were significant with the hypothesized signs and were consistent with other research results. Farmland that offers a higher expected return from agricultural production has a higher price, *ceteris paribus*. Soil quality as measured by CER is capitalized into land prices, consistent with Barnard et al (1997), Burt (1986) and Chavas and Shumway (1982). The share of tillable land in a parcel increased the price (Shonkwiler and Reynolds 1986). The average per acre farmland price was lower the larger the parcel size, reflecting lower transactions costs for both the buyer and the seller (Chicione 1981).

The characteristics of agriculture in a county and the supply of land influence farmland prices. Consistent with Shonkwiler and Reynolds (1986), the larger the supply of land, the lower the price of farmland. Also, farmland in counties with greater agricultural output as measured by crop and livestock sales, had higher land prices. Farmland prices are higher in counties with more intensive agriculture due to greater farmland demand.

The rate of conversion of land from farmland to other uses (SPRAWL) reduces farmland supply. In rural counties, where non-agricultural demand for farmland is less, the conversion of farmland to non-agricultural uses does not influence farmland prices. In the statewide model, however, conversion of farmland to non-agricultural uses was associated with an increase in the per acre price of farmland. Consistent with Folland and Hough (1991), this suggests that high conversion rates increase expectations that farmland will be converted to non-agricultural use and is capitalized into the land price.

Agglomeration of population and population growth increase the demand of land for non-agricultural use. This expectation is reflected in higher land prices (Phipps 1984). Farmland near land converted to a high value use increase in value as the expectation it will be converted increases. Farmland further from the developed land is less likely to be developed but increase in value because of the increasing scarcity of farmland.

An area's natural amenities influence farmland prices. Counties with more natural amenities have higher farmland prices. The presence of natural amenities increases recreational and retirement activity, increasing land owners' perception of the potential demand for land to be used for recreational and retirement activities. The potential in can lead to higher land prices as it is capitalized into land values.

Access and/or proximity to urban areas influences farmland prices. Highway connections to urban areas improve rural-urban access and increase farmland value. As individuals seek land outside of urban areas for recreational or residential purposes, they look to areas that have highway linkages to urban areas. The potential for development demand is capitalized into higher farmland prices.

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Table 1: Variable Description

Variable	**Description**	**Unit of Measure**
Dependent Variable		
SALEACRE	Total reported sale prices/deeded acres	Dollars per acre
INDEPENDENT VARIABLES		
Parcel Characteristics		
TILLABLE	Share of deeded acres that are tillable	Percent
DEEDED	Deeded acres in parcel	Acres
CER	Average crop equivalent rating	Index
County Characteristics		
LARAE	Land area	Square miles
CROP92	Value of crops sold, 1992	Thousand dollars
LSTK92	Value of livestock sold, 1992	Thousand dollars
POP90	County population, 1990	Thousand people
POPGR	County Population growth, 1996-1990	Percent
SPRAWL	Loss of farmland, 1992-1982	Percent
AMINITY	Z-score	Index
MANUF	Share of non-farm employment in manufacturing	Percent
Urban Access		
INTERSTATE	Interstate Highway (1992)	Miles
ADJACENT	Rural County Adjacent to metro county	Dummy Variable
URBAN	Beale Codes	Dummy Variable

Table 2: Multiple Regression Results for Minnesota Land Price Regression Models Using Exponential Functional Form with LN (Land Price per Acre) as the Dependent Variable [1]

Characteristics	Rural Minnesota Land Price (Model 1)	Minnesota Land Price (Model 2)
Constant	5.446	7.096
	(0.190)	(0.135)
Parcel Characteristics		
TILLABLE	0.007	0.003
	(0.001)	(0.001)
DEEDED	-0.001	-0.001
	(0.000)	(0.000)
CER	0.015	------
	(0.001)	
County Characteristics		
LAREA	-0.001	-0.001
	(0.000)	(0.000)
CROP92	0.010	0.008
	(0.001)	(0.001)
LSTK92	0.002	0.001
	(0.001)	(0.000)
POP90	0.007	0.003
	(0.001)	(0.001)
POPGR	1.147	1.178
	(0.873)	(0.455)
SPRAWL	-0.002	0.015
	(0.005)	(0.004)
AMINITY	0.084	0.095
	(0.022)	(0.015)
MANUF	0.001	0.001
	(0.003)	(0.002)
Urban Access		
INTERSTATE	0.000	0.003
	(0.001)	(0.001)
ADJACENT	0.140	------
	(0.069)	
URBAN	------	-0.005
		(0.026)
OBSERVATIONS	620	1699
ADJUSTED R^2	(.60)	(.45)

[1] Standard errors in parentheses.