Abstract

Hedonic price modeling of 1,951 non-pasture agricultural land sales across North Dakota indicates that land enrolled in the Conservation Reserve Program (CRP) sold for 14 percent less than otherwise similar cropland over the 2000 to 2004 time period. This price discount is assumed to result from the increasing opportunity costs associated with maintaining agricultural land in conservation, particularly in light of the steadily increasing commodity prices over the study period. Similar findings have recently been reported in the adjacent state of Minnesota. These multi-state results explain why many landowners nationwide are actively lobbying the USDA to allow voluntary opt-outs of remaining CRP contracts. This may also indicate the need to either shorten the length of future CRP contracts and/or to have CRP payment values tied to commodity and/or land price indices. Continued research on this topic would be facilitated and improved with the inclusion of parcel-specific (GIS based) CRP enrollment data.

The Impact of the Conservation Reserve Program on the Sale Price of Agricultural Land

By Nick Schmitz and Steven Shultz

Introduction

The Conservation Reserve Program (CRP) began as a provision of the 1985 Farm Bill and has subsequently been re-authorized under every subsequent Farm Bill. The CRP was designed to meet a number of environmental and economic goals with a particular focus on preventing soil erosion, improving water quality and increasing wildlife habitat. It is administered by the Farm Service Agency (FSA) of the U.S. Department of Agriculture (USDA), and it provides annual payments to landowners who agree to forgo the income associated with production and set aside cropland through the planting of trees, grass or other permanent cover for either five, or more commonly, ten continuous years. Payments are determined through a bid system in which landowners offer a parcel for the annual rate at which they are willing to retire the land. Parcels and bid amounts are then evaluated and accepted based on the potential net benefits of the offer. The program forbids any economic use of the property except under times of drought or other disaster as designated by the Secretary of the USDA (Glaser 1986).

Nick Schmitz raises organic pigeons in Mankato, MN. He has a MS in Economics from the University of Nebraska at Omaha where he was a research assistant in the Real Estate Research Center from 2006 to 2008.

Steven Shultz is the Director of the Real Estate Research Center at the University of Nebraska-Omaha. He was previously an economist at North Dakota State University. He earned his Ph.D. in Renewable Natural Resources and Agricultural Economics from the University of Arizona. His teaching interests include principles of real estate, real estate appraisal, and geographic information system (GIS) technologies.

The CRP has grown to be one of the largest government programs relating to conservation with over 36 million acres earning average annual payments of just under $50/acre for a total annual expenditure of over $1.8 billion dollars (Farm Service Agency 2006). CRP enrollments are most common in areas of the country with marginally productive farmlands and relatively low property values (particularly in Texas and the Northern Great Plains states). In North Dakota, which was the focus of this study, there are approximately 3.3 million enrolled CRP acres or about 9 percent of the nationwide total CRP acreage.

The primary objective of this study was to quantify how CRP enrollments influence the sale price of cropland across North Dakota over the 2000 to 2004 time period. In particular, hedonic price regression modeling is used to quantify the determinants of land values. The hedonic method, which shares similarities with "computerized mass appraisal models," is based on the premise that the value of real property is a function of its characteristics and through the use of multiple regression allows the value of each of these constituent characteristics to be estimated. In particular, this study specified the sale price per acre to be a function of parcel size, land use, soil productivity measures, locational aspects, the year of sale, and whether the land is enrolled in the CRP. However, missing from this analysis are several details regarding the nature of individual CRP contracts, such as the remaining years of CRP enrollments at the time of the sale, which due to FSA policies in place at the time of this study were unavailable for inclusion in this research.

It was hypothesized that the primary factor influencing possible price differentials between CRP and cropland values is the opportunity cost of having land enrolled in the program. If CRP rental payments are less than what could be obtained through cropland production, then CRP land should sell at a discount compared to otherwise identical but non-encumbered cropland. Conversely, if CRP payments exceed potential revenues from production, the land should sell at a premium. The magnitude of these opportunity costs are therefore likely influenced by the CRP payment values (which are fixed at the time contracts are established and intended to equal the productive value of the land if it were not enrolled in CRP), and variable conditions over time (production technologies, weather conditions, government crop support programs), and perhaps most importantly, commodity and land prices. Additional factors that also may be relevant to the opportunity cost of CRP land is the desire for stable and guaranteed income streams over time (which the CRP provides), and the desire of many landowners to enjoy and/or benefit financially from the wildlife and recreation-based products generated by a CRP enrollment.

This research is considered highly relevant to current policymaking and the appraisal industry. In particular, many landowners and farm operators have been actively lobbying the USDA for early releases from CRP contracts in order to take advantage of historically high commodity prices and demand for corn-based ethanol. So far, such requests have been refused by the USDA. Given unexpected increases in commodity prices, the presence of a contract that forbids the production of commodities is likely to reduce a buyer's willingness to pay for land encumbered by CRP enrollments. Information about the discount or premium associated with land encumbered with a CRP contract is also critical for government officials when designing payment levels for future CRP sign-ups (or closely related conservation security programs that are expected to be a part of the pending Farm Bill), and to landowners making enrollment decisions. Finally, due to the high concentration of CRP enrollments in many parts of the country, appraisers and lenders often need to determine if and how to adjust for CRP encumbrances when valuing agricultural land.

Previous Research

Previous research quantifying the determinants of farmland values is extensive yet limited empirical research exists that has actually measured the implicit value of CRP in areas of production agriculture. Shoemaker (1989) compared market rents and CRP payments during a period of declining values to determine that the CRP had a positive effect on land values. Similarly Kirwin, Lubowski, and Robert (2005) present evidence that CRP payments in many cases exceed reservation rent due to the structure of the CRP bidding process. This implies that the CRP land should sell for higher amounts than otherwise equal but non-CRP encumbered land.

To date, only one known study (Taff & Wesisber, 2007) has looked directly at the effect of the CRP on land prices using a hedonic (or mass appraisal approach). The study focused on

2,937 arms-length agricultural sales across the state of Minnesota from 2003 to 2004. Information on these sales are contained in a State Department of Revenue database which is disseminated by the Minnesota Land Economics Web site (www.apec.umn.edu/landeconomics). This database records characteristics of the sales including whether sold land is encumbered by conservation easements, including CRP enrollments. The analysis excluded sales with other (non-CRP) easements (i.e., various state conservation easement program lands) and was based on a sample of non-CRP sales that closely matched the characteristics of CRP sales (271 sales or 9% of all sales). A series of alternative hedonic regression models were estimated where sale prices were regressed against parcel sizes, improvements, crop coverage (% tillable), relative productivity (on a scale of 1-100), time, and regional control variables. In contrast to the earlier studies, they found that CRP encumbrances reduced land sale prices by between eight and sixteen percent (depending on the model specifications chosen). They note that a major limitation of their research was the inability to account for the portion of sold properties covered by the CRP contract and that they were unable to determine how many years remained on the CRP contract when the sale occurred.

Methods and Procedures

The hedonic price model estimated in this study was based on the assumption that the price for agricultural land is determined by the net present value of an income stream of future rents that can be generated from the property (Freeman 2003). This is consistent with the appraisal theory that the best evidence for the market value of real estate consists of sales and offerings of similar real estate (Derbes et al., 2005). The hedonic technique is well described by Rosen (1974), Palmquist (1989; 1991), and others, and is based on the assumption that producers are able to differentiate factors of production as they relate to profits when purchasing agricultural land. This present study utilizes a hedonic model specified by:

$$(Price/Acre)_i = f(Q, S, Z, C)$$

where the of price per acre is a function of a vector of physical characteristics Q, a time trend matrix of dummy variables S, location dummies Z, a vector representing the presence of a CRP contract C, and a random error term u.

A log-linear functional form was used due its ease of interpretation and since the coefficient of a dummy variable when using this form can be interpreted as the percent change in price caused by the characteristic represented by that variable. However, Halverson and Palmquist (1980) concur that the direct interpretation of these coefficients is misleading and that the adjusted coefficients in the equation put forth by Kennedy (1981) should be used:

$$\hat{g} = \exp(\hat{c} - (1/2)V(\hat{c})) - 1$$

Where V is the predicted variance of the estimated coefficient $\hat{c}$, and $\hat{g}$ is the correct percentage effect of the dummy variable.

The sample of sales used in the model was generated by collecting all publicly disclosed, arms-length land sales over the 2000 to 2004 time period. Sale data including dates, prices, legal descriptions, and acreage were obtained from individual county tax directors/assessors in all 53 counties of North Dakota. Reported legal descriptions were used to digitize sale polygon boundaries which allowed us to use GIS to quantify land cover and soil productivity within sold parcels as well as to account for locational characteristics and the existence of CRP acreage. Land cover information was obtained from the National Agricultural Statistics Service (NASS) Cropland Data Layer (CDL) annually from 2000 through 2004 to determine the quantity of cropland and pastureland acreage. The National Wetlands Inventory (U.S. Fish and Wildlife Service, 2006) was utilized to determine the percentage of wetlands within parcels. The digital Soil Survey Geographic Database (SSURGO, Soil Survey Staff, 2005) was used to calculate average spring wheat yields across sold parcels, and to identify the land capability class (LCC) ratings of land which was later used to assist in the estimation CRP acreage.

The estimation of CRP enrollment acreage within sold parcels involved the use of GIS-based cropland and pasture land classifications (from NASS), along with land use capability class data and aerial photograph imagery to quantify the characteristics of known CRP parcels (from a database of 33 select properties maintained by the North Dakota Game and Fish Department known to be enrolled in CRP). It was determined that all of these known CRP parcels had LCC ratings of between one and four (indicating that they had cropping potential) but were all denoted as pastureland in the NASS CDL. As well, analyses of these parcels using true manual inspections color aerial imagery (NAIP imagery) indicated that these CRP parcels did not contain fences, cattle trails, watering or feeding infrastructure, or obvious signs of grazing activity. Based on these criteria of LCC classes of between one and four, combined with NASS CDL pasture classifications, an additional 120 possible CRP sales were identified. Interpretation of NAIP imagery determined that 76 of these sales were made up of CRP acreage which resulted in a total of 98 CRP acreage sales available for analysis. Sales that were partially enrolled in CRP were excluded from the analysis.

The remaining non-CRP sales in our database were removed if they contained pasture land and/or if they were known hunting/recreation sales identified in a previous study (Shultz, 2007). This resulted in a sample of 1,853 cropland sales. To account for regional impacts and potential omitted variable bias, it was noted which eco-region each sale was located in (Northwest Glaciated Plains, Northern Glaciated Plains, Lake Agassiz Plain, Northwest Plains). Finally, distance from the sold parcels to the nearest interstate were calculated using GIS operations.

Results

The location of the 1,853 cropland and 98 CRP sales used for the analyses are shown in Figure 1. The analysis is clearly statewide and influenced by the frequency of sales in different regions of the State. Summary characteristics of these sales are provided in Tables 1 and 2. As expected, CRP sales were slightly lower in productivity value than and cropland productivity measures and sale values. Similarly, both distance to interstate and the effect of the 2002 Farm Bill have a positive impact on sale values. It can also be seen that areas in the eastern portion of the state have higher sale values which increased soil productivity and flatter land in these areas.. Finally, larger parcels appear to sell at a discount on a per acre basis and the inclusion of wetlands in a parcel negatively impact sale values.

The estimated coefficients of the hedonic price model are summarized in Table 3. All of the explanatory variables are statistically significant except the dummy variables accounting for sales within the Northwest Unglaciated Plains Eco-region, and the years 2001 and 2002. The F-value for the model is sufficiently high (164), indicating that all variables considered jointly have a statistically significant effect on the dependent variable. The adjusted R^2 value is 0.50 which indicates that the model is likely missing some additional explanatory variables. The coefficient for the variable measuring spring wheat yield shows that a one bushel per acre increase in spring wheat yield will raise the price per acre of agricultural land by 1.8 percent. Conversely the coefficient for percent wetlands (as a decimal i.e., 100% = 1) should be interpreted as the decrease for a parcel that is 100 percent in wetlands. A parcel with 10 percent of its surface area as wetlands would experience a 5.9 percent decrease in value. The parcel size coefficient is negative indicating that larger parcels sell at a lower price on a per acre basis. Among the time-trend variables, only the dummies for years 2003 and 2004 were significant.

The coefficient for the CRP dummy variable is significant at the one percent level and the value of the coefficient is -0.147. However when adjusted using the Kenney (1981) non-linear dummy variable equation, the value of the coefficient becomes -0.138 meaning that CRP land sells for 14 percent less than otherwise similar cropland.

Conclusions

Hedonic price modeling demonstrated that CRP enrolled land across North Dakota over the 2000 to 2004 time period sold for 14 percent less than otherwise similar cropland. These results are very similar to those recently reported in the adjacent state of Minnesota. The likely reason for buyers discounting the value of CRP land is that CRP payment values were likely established prior to an expected permanent increase in commodity prices. This has increased the opportunity cost of having land locked into CRP contracts. This explains why so many agricultural landowners have recently been lobbying the USDA to get early releases from their CRP contracts.

It is important to point out that since all known hunting/recreation sales were removed from the analyses these conclusions regarding the impact of CRP enrollments on land values were limited to production agriculture sales only. It is assumed that since the existence of CRP acreage is explicitly noted in advertisements of hunting/recreation land sales, that CRP is likely to have a positive impact on the value of such sales. This fact may help explain why these estimated North Dakota CRP price impacts are slightly higher than those reported for Minnesota (where recreation/hunting sales were not explicitly removed).

From a public policy perspective, these results should not be used to justify increased payments for CRP enrollments since the study period has overlapped with a period of increasing commodity and land prices. In contrast, if commodity and land prices over the 2000 to 2004 time period had been falling, it is hypothesized that CRP land would have sold at a premium to otherwise similar cropland. These study results also indicate that landowners are unlikely to re-enroll land in CRP when their contracts expire in the coming months and years at the same payment level. To encourage re-enrollments or new CRP enrollments, the USDA may want to consider allowing CRP rental payments to increase (or decline) based on pre-established commodity and/or land price indices. Alternatively, shortening the time period of CRP contracts could potentially encourage landowners to accept CRP contracts at fixed payment levels. In the meantime the primary expected use of these research results are that landowners and appraisers can now more accurately make adjustments for existing CRP acreage when appraising agricultural land values. Finally, the increase in commodity prices and land values over the course of a CRP contract manifests itself as a bonus to society which receives the benefits of CRP land at a reduced rate.

The primary limitation of this study was its reliance on estimates for CRP enrollments and the inability to account for the remaining CRP contract years at the time of a sale. If the FSA would release GIS-based parcel-specific CRP enrollment data to researchers, it is likely that the accuracy of the hedonic price estimates reported here would be improved. Another potential limitation with our study is the existence of omitted variable bias. Of particular concern is whether certain CRP and non-CRP land parcels have various deficiencies that make them unsuitable for agricultural production (i.e., rocks, slopes, size configurations, etc.). Future research in this area should attempt to survey buyers to learn about parcel details, conduct more rigorous GIS land use analyses, and/or to or rely more closely on NRCS-FSA records.

In the meantime, it is recommended that this research be replicated in other states and over time (particular as commodity and land prices change) in order to generate timely estimates of how this ubiquitous conservation program influences agricultural land values. Finally, an improved hedonic price model could be estimated through the inclusion of better geo-physical data and/or through surveys of landowners to determine specific farming conditions.

References

110th Congress. (2007). *Openness promotes effectiveness in our National Government Act of 2007*. Retrieved from http://www.govtrack.us/congress/billtext.xpd?bill=s110-849.

Derbes, M.J., MAI, CRE, SIOR, SR/WA. (2005). *The Appraisal of Land*. International Right of Way Association.

Farm Service Agency (FSA). (2006, December). *Conservation Reserve Program: Monthly Summary*. Retrieved from http://www.fsa.usda.gov/Internet/FSA_File/dec2006.pdf.

Freeman, M. (2003). *The measurement of environmental and resource values: Theory and methods*. Washington, D.C.: Resources for the Future.

Glaser, L. K. (1986). Provisions of the Food Security Act of 1985. *U.S. Department of Agriculture, Economic Research Service. Agriculture Information Bulletin No. 498*.

Kennedy. P. (1981, September). Estimation with Correctly Interpreted Dummy Variables in Semi-logarithmic Equations. *The American Economic Review, 71*, 801.

Kirwan, B., Lubowski, R. N., & Roberts, M. J. (2005). How Cost-Effective are Land Retirement Auctions? Estimating the Difference between Payments and Willingness to Accept in the Conservation Reserve Program. *American Journal of Agricultural Economics, 87,* (5), 1239-1247.

North Dakota Agricultural Statistics Service (NASS). (2005). *North Dakota Agricultural Statistics 2005.*

Palmquist, R. (1991). Hedonic Methods. *Measuring the Demand for Environmental Quality*. Elsevier Science Publishers.

Palmquist, R. (1989, February). Land as a Differentiated Factor of Production: A Hedonic Model and its Implications for Welfare Measurement. *Land Economics, 65*, 23-28.

Palmquist, R., & Danielson, L. E. (1989). A Hedonic Study of the Effects of Erosion Control and Drainage on Farmland Values. *American Journal of Agricultural Economics, 71*, (1), 55-62.

Rosen, S. (1974) Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy, 82*, 34-55.

Shoemaker, R. (1989, May). Agricultural Land Values and Rents under the Conservation Reserve Program. *Land Economics, 65,* 131-137.

Shultz, S. (2007). Non-Local Purchases of Agricultural Land for Hunting Purposes. *Journal of the American Society of Farm Managers and Rural Appraisers*, 126-131.

Soil Survey Staff. (2005). Soil Survey Geographic Database (SSURGO). Digital Spatial Data. Natural Resource Conservation Service, United States Department of Agriculture. http://www.nrcs.usda.gov.

Taff, S. J. & Weisberg, S. (2007). Compensated Short-Term Conservation Restrictions May Reduce Sale Prices. *The Appraisal Journal, 75*, 45-53.

United States Fish and Wildlife Service. National Wetlands Inventory. (2006). Digital Spatial Data. Retrieved from http://www.fws.gov/nwi.

Table 1. Land sale characteristics by eco-region (2000-2004)

EPA eco-region of the sale	Cropland	CRP	*Statistic*
Northwest Glaciated Plains	234	32	*n*
	365	290	*Mean Price/Acre*
	341	300	*Median Price/Acre*
	93	87	*Mean % LCC<5**
	32	28	*Mean SWY*
Northern Glaciated Plains	874	51	*n*
	478	393	*Mean Price/Acre*
	449	400	*Median Price/Acre*
	95	95	*Mean % LCC<5*
	37	31	*Mean SWY*
Lake Agassiz Plain	627	2	*n*
	890	231	*Mean Price/Acre*
	866	231	*Median Price/Acre*
	96	100	*Mean % LCC<5*
	44	34	*Mean SWY*
Northwest Plains	123	8	*n*
	330	318	*Mean Price/Acre*
	325	300	*Median Price/Acre*
	90	83	*Mean % LCC<5*
	24	22	*Mean SWY*

* Percent of soil map units in the parcel with a land capability class less than 5 (tillable)

Table 2. Summary statistic of the explanatory variables

Variable	Mean	Standard Deviation	Expected Sign
Dummy CRP	0.05	0.21	-
Spring Wheat Yield	37.36	8.10	+
Distance to Interstate [miles]	62.54	58.45	-
Dummy 2001	0.17	0.38	-
Dummy 2002	0.18	0.38	-
Dummy 2003	0.23	0.42	+
Dummy 2004*	0.26	0.44	+
Dummy Northern Glaciated Plains**	0.47	0.50	+
Dummy Lake Agassiz Plain	0.32	0.47	+
Dummy Northwest Plains (not Glaciated)	0.07	0.25	-
Ln Parcel Size	5.23	0.54	-
% Wetlands [NWI]	0.04	0.07	-

* Year 2000 excluded and accounted for in the intercept; **Northwest Glaciated Plains excluded and accounted for in the intercept

Table 3. Hedonic model results

Variable	Coef.	Std. Err.	P>t
D CRP	-0.147	0.042	0.000
Spring Wheat Yield	0.018	0.001	0.000
Distance to Interstate [miles]	-0.001	0.000	0.000
D 2001	0.014	0.029	0.622
D 2002	-0.022	0.029	0.451
D 2003	0.122	0.027	0.000
D 2004	0.144	0.027	0.000
D Northern Glaciated Plains	0.164	0.027	0.000
D Lake Agassiz Plain	0.496	0.035	0.000
D Northwest Plains (not Glaciated)	-0.029	0.043	0.502
Ln Parcel Size	-0.047	0.016	0.003
% Wetlands [NWI]	-0.593	0.136	0.000
Constant	5.613	0.105	0.000
Obs		1951	
F-value		163.68	
Prob > F		0.000	
R2		0.5033	
Adj, R2		0.5003	
Root MSE		0.37401	

Figure 1. Crop and CRP sale locations in North Dakota (2000-2004)