The Effects of Scenic and Environmental Amenities on Agricultural Land Values

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Submitted for Organized Symposium: "Quantifying the Determinants of Land Values: The Impacts of Irrigation, Recreational Amenities, and off-Farm Income."

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ABSTRACT

Ascribing land value solely to productive capacity does not accurately capture the impact environmental amenities provide on western land prices. Agricultural land prices in Wyoming are estimated using a hedonic price model and Geographic Information Sciences (GIS) data. These GIS measurements include on-parcel wildlife and fish habitat, viewscape attributes and distance to protected federal lands. A feasible generalized least squares (FGLS) approach is used to address both spatial autocorrelation and heteroscedasticity. The estimation is robust and highly significant. Results indicate that amenities as well as productivity are significant in explaining land values for the sample analyzed. Such information is useful for landscape management in the face of amenity threatening parcel fragmentation.

Introduction

Loss of farm and ranchland continues to be a significant public policy concern as evidenced by the many federal, state, local and private protection programs. Historically, farmland protection programs were motivated by a political and public desire to protect domestic food security (USDA, 1975). Increased recognition of the many public good amenities provided by farmland (e.g. biodiversity, climate regulation, rural culture and open space) has broadened public demand for farmland protection. Despite this demand, U.S. farmland continues to be lost at a rapid rate, primarily as a result of conversion to suburban and exurban development (American Farmland Trust, 2009).

Given the relationship between farmland loss and development, it is important to understand what precipitates farmland conversion to development. An understanding of how different factors contribute to conversion can help policymakers predict future growth patterns as well as determine development right values and therein improve the efficiency of protection programs. Numerous empirical studies have been conducted to measure the contribution of farmland characteristics to farmland values, with much of the recent research focused on valuing farmland amenities (see Bergstrom and Ready, 2009, for a review).

Much of the literature on the determinants of farmland values uses the Hedonic Price Method (HPM) to relate property values or land sale prices to specific land attributes. In the context of farmland conversion to development, this literature largely concentrates on farmland surrounding rapidly developing urban centers (Geoghegan, et al. 1997; Cavailhes and Wavresky 2003; Isgin and Forster 2006). Consistent with competitive land market theory (Capozza and Helsley 1989) this HPM literature has generally concluded that agricultural (e.g. crop prices and yields), development (e.g. house characteristics and proximity to urban centers) and amenity (e.g. open space) characteristics are capitalized into observed farmland prices. Agricultural parcels closer to urban centers or with valued amenities will command higher prices, indicating higher development pressure.

Studies of agricultural land price determinants applied at the urban-fringe are unlikely to accurately capture farmland price determinants in more rural settings. The intermountain West provides an excellent example of the potential issues. Farm and ranchland in this region are facing significant pressure to convert to development (Vesterby et al., 1996). Given the few metropolitan areas (e.g. Denver, CO and Salt Lake City, UT), the residential development consuming farmland land in the intermountain West bears little resemblance to the sub-urban sprawl that is prevalent in the literature.

Development in these highly rural land markets is often characterized by large-lot trophy or vacation homes and retirement properties (Gosnell, et al. 2006). In this setting, many of the typical determinants of farmland prices on the urban-fringe (e.g. preservation of prime farmland and concurrent market access; access to employment, health care and education), are likely to be less important than rural and environmental amenities (e.g. protecting ecosystem services; access to recreation and scenic views). HPMs that do not accurately capture the relevant amenities are therefore likely to overestimate the contribution of agricultural characteristics to land prices and underestimate potential development pressure. Plantinga et al. (2002), for example, use aggregate data for the contiguous U.S. to estimate the county-level share of agricultural land values attributable to development potential. Their results imply that development option value accounts for five-percent or less of agricultural land values for most counties in the intermountain West, which is similar to estimates provided by Livanis et al. (2006). These, aggregated data, however, may mute the potential impact of amenities desirable to in-migrants, suggesting that parcel level measurement of amenity values could make a valuable contribution to the literature. The previous discussion suggests that amenity characteristics need to be more precisely measured to disentangle the influence of agricultural productivity from environmental amenities in the amenity rich land markets common in the intermountain West.

Our research objective is to estimate a hedonic model using parcel specific data associated with amenity and agricultural attributes, and thereby provide a more accurate depiction of amenity values and their potential contribution to agricultural lands. We use a unique data set on arms-length sales of agricultural lands in Wyoming and GIS data to accomplish our research objective. We focus on amenity characteristics believed to influence amenity rich land markets, including proxies for access to, and quality of, recreation, and specific measures of the view available on each parcel. Such knowledge should improve policies related to land preservation. Improper measurement of amenity values could create allocation inefficiencies in land markets and exacerbate welfare losses associated with conversion of public good amenities.

Several previous papers have modeled specific amenity values (see Bergstrom and Ready 2009). Many of these studies focus on the spillover effects of amenities to neighboring residential properties (see McConnell and Walls 2005, for a review) as opposed to the onsite contribution of amenities to land values. Others focus to varying degrees on the contributions of specific amenities, including wildlife habitat/recreation (Bastian, et al. 2002; Henderson and Moore 2006), river access/fishing quality (Bastian, et al. 2002; Sengupta and Osgood 2003), scenic views (Bastian, et al. 2002; Paterson and Boyle 2002; Sengupta and Osgood 2003; Cavailhes, et al. 2009) and surrounding land-use/fragmentation (Geoghegan, et al., 1997). Though results vary across applications, there is a general consensus that amenities are significant determinants of farmland prices and that using specific measures of amenity characteristics can improve HPM estimates. Additionally, the more recent literature consistently identifies the importance of addressing econometric issues, such as spatial autocorrelation, to improve the efficiency of parameter estimates (Huang et al., 2007; Kopits, McConnell and Walls, 2006).

Some studies have also taken advantage of GIS and satellite data to improve the specification of amenity characteristics. A simple approach prevalent in the literature uses GIS data to create dummy variables indicating the presence or absence of parcel specific amenities (Johnston, et al., 2001). GIS data is also commonly used to create explanatory variables measuring distance between parcels and amenities (Huang et al., 2006; Sengupta and Osgood, 2003; Johnston, et al., 2001). A few studies, however, use GIS to create spatial measures that more precisely capture amenity characteristics. Examples include using GIS to measure (directly or with indices) the proportion of land surrounding a parcel in various land-uses or land cover (Geoghegan, et al., 1997; Ready and Abdalla, 2005), using GIS to measure characteristics of parcel specific views

(Bastian, et al., 2002; Paterson and Boyle, 2002; Cavailhes, et al., 2009) and using satellite data to create measures of green vegetation (Sengupta and Osgood, 2003; Nivens et al., 2002).

It is clear that accounting for the presence of environmental amenities is important in land valuation as evidenced from the above literature review. The research to date lacks studies that mention, test and correct for both heteroscedasticity and spatial autocorrelation. It is also notable that the preponderance of rural amenity valuation work involves the coastal and densely populated states. The plains, intermountain and public lands states of the West have amenities that are threatened by land conversion; the value of these amenities is policy relevant to the region and beyond. Following Bastian et al. (2002) and Torrell et al. (2005) the HPM offered here can be generalized as follows:

$$y = \sum_{i=1}^{k} \beta_i^{ag} X_i^{ag} + \sum_{i=1}^{j} \beta_i^{amenity} X_i^{amenity} + e \qquad \textbf{(1)}$$

y = \$/acre;

$\beta^{ag} = k$ productive parameter estimates;

$X^{ag} = k$ productive variables;

$\beta^{amenity} = j$ amenity parameter estimates β; and

$X^{amenity} = j$ amenity variables.

e = error term, requires further investigation as per its properties.

An improved model of intermountain West parcel value is offered where the $X^{amenity} = j$ amenity variables are further defined as on-parcel, off-parcel and scenic view amenities. It is expected that alternate segments of market demand value each category of value determinant differently. Agricultural interests may value productivity attributes and on-parcel amenities more so than off-parcel amenities or scenic views due to opportunities to secure rents from the former. Alternatively, exurban home seekers may value off-parcel amenities, scenic views and on-parcel amenities more so than agricultural productivity attributes as rent seeking behavior is secondary to utility maximization. It is the aggregate effect of property development that fragments large ranch parcels such that roads, buildings and fences compromise the on-parcel amenities, agricultural productivity and can affect management of nearby public lands.

The existing literature demonstrates a wide array of alternative HPM approaches for valuing farmland amenities. Few of the existing applications, however, consider amenity rich rural areas facing mounting development pressures, such as those typical of the intermountain West. Moreover, while many studies address spatial autocorrelation, none of the existing studies simultaneously address spatial autocorrelation and heteroscedasticity. The data utilized in the study presented here is both cross sectional and place specific. Wide variation in land values associated with amenity and production amenities in regional land markets would suggest the potential for non-constant variance in the error terms as is common with many types of cross sectional data. It is presumed that problems associated with cross sectional data (beyond misspecification and collinearity) and spatially related amenity attributes both require diagnoses and, if present, remediation.

We complement and extend the existing literature by addressing these gaps. The intermountain West possesses habitat for charismatic megafauna such as elk, bison, moose and mule deer in addition to threatened and endangered fauna and flora. World class year round recreation also exists on both private lands as well as on nearby public lands. The basin and range landscapes found in this region also offer unrivaled scenic views. It is this array of environmental amenities, complementing productivity features of agricultural lands, that we seek to account for in intermountain West rural land values.

Study Area

Wyoming is noted for its environmental amenities. There are considerable National Park, Monument and US Forest Service Wilderness areas throughout. Wyoming is among the states with the most rapid growth of vacation or second homes (Taylor and Lieske, 2002). These homes typically are located in areas with high quality environmental amenities.

The Wyoming parcels used here to estimate price are extensively utilized, reflecting a low intensity use (the expected residential development that is competing for the open space and agricultural lands would be low intensity or large lot parcels).

Data Sources

Farm Credit Service appraisals of arm length sales from 1989-95 are used for this estimations. The properties are agricultural lands located in the state of Wyoming. A random state-wide sample was drawn from parcels in every county except Teton (which results in 22 of 23 counties represented). Teton County consists of mostly public lands, has little production agriculture taking place and is a very expensive real estate market. As such it was viewed as an outlier in relation to the other 22 Wyoming counties. Agricultural productive factors and amenity attributes are defined in Tables 1 and 2, respectively with summary statistics provided in Table 3. Spatially precise land attributes have been measured and are incorporated into the model estimation. The extent to which this data set is unique in the GIS construction of the explanatory variables is not replicated in other studies to our knowledge.

The dependent variable for the HPM estimation is nominal price per deeded (privately owned) acre following Xu et al (1994); Spahr and Sunderman (1998); Bastian et al. (2002); and Torrell et al. (2005). The production related parcel traits are thought largely to positively impact price per acre as factors of production. The amenity arguments are GIS measures of explanatory variables. Utilizing GIS measurements provides a 1:1 correspondence between the argument of interest and its measure.

Model specification and variable construction follow Bastian et al. (2002) and Torrell et al. (2005) in order to make productivity and amenity measures explicit. Each parcel is digitized precisely by longitude and latitude for inclusion of spatially precise determinants of land value. Each parcel is analyzed as to what extent wildlife habitat (terrestrial and aquatic) and scenic view layers apply. The ELK variable is calculated by taking the total acre amount of elk habitat on the parcel divided by the total deeded acres. This results in a situation where the amount of elk habitat contained on the parcel is a density function of zero to one. The ELK variable represents elk wildlife viewing/hunting opportunities as well as the propensity for wildlife and livestock competition for forage resources. The FISHW variable is an angling productivity variable calculated by taking the meters of stream on parcel multiplied by the calculated

GIS weighted productivity (population density) divided by deeded acres. This represents aquatic habitat and recreation opportunities.

Germino et al. (2001) provide detailed explanation for the use of GIS techniques in constructing view variables. The digital elevation model (DEM) aspect of view is a measure two meters above the centroid (center of parcel) from which scenic view measures are demarcated. Total view contents (evaluated for a 360 degree view) are divided into 10 possible categories of landscapes. Here three categories (SHRUB, RIPA, ALPINE) and a sub-category (DECI) of landscape are utilized. Each of the three categories, and one sub group, are measured as percent of total view by type. SHRUB relates the sagebrush steppe and scrub landscape thought to be less preferred for visual content. RIPA covers riparian areas expected to offer views of fauna and flora as well as sub-irrigated pasture for hay production and livestock grazing. ALPINE captures views of the snow covered high peaks for which the Rocky Mountain region is noted. DECI is defined as visible tree cover separated from coniferous species. STD10 is a measure of the relief or topography of the view from up to 10 kilometers from the parcel's centroid. The measure is derived as a sum of deviations from a uniform horizon. It is expected that a rugged horizon (within 10 kilometers) is a preferable view to that of a flat prairie

Interaction variables are used in the HPM to represent a hypothesized difference in the way land attributes may be priced in the western region. Four attributes are considered to significantly affect agricultural land price within the western region as follows: AUM productive capacity WIRRPAST, fish habitat quality WFISHW, alpine view WALPINE, and roughness of view WSTD10 It is expected that the more mountainous western region of Wyoming would offer price premiums due to the existence of a greater level of environmental amenities.

Methods

The HPM follows Bastian et al. (2002) as initially given in (1), and then elaborated upon, as a reduced form hedonic model which lacks direction from the literature as to the appropriate functional form. Previous research suggests an array of different functional forms for a HPM. The Box-Cox model iterations for the estimation here do not converge and as such the transformation will not be used. Semi-log models were considered but not used since the absolute value changes offered by the HPM linear regression results offer the best results in terms of goodness of fit and significant arguments, given the specification. Note too that Bastian et al. (2002) found that the linear and the semilog forms offered similar results and goodness of fit (see specifically Bastian et al. 2002; Table 3, pp 343).

The spatially explicit and cross sectional parcel data may lead to heteroscedasticity and spatial autocorrelation in estimation. A White's test (1980) indicates the presence of heteroscedasticity; however, past literature suggests that tests for heteroscedasticity may be sensitive to the presence of spatial autocorrelation (Anselin 1995; Anselin 1990)

Anselin and Rey (1991) and Anselin (1995) indicate that the normally used Moran's I and Lagrange Multiplier tests for detecting spatial autocorrelation may be sensitive to other issues such as non-normality and heteroscedasticity. In such cases, Anselin (1995) recommends the test proposed by Kelejian and Robinson (1992). The

Kelejian-Robinson (1992) (K-R) test is then utilized for detecting spatial autocorrelation using SpaceStat (Anselin, 1995). The K-R test indicates that spatial errors are the appropriate concern.

A spatial distance band is the boundary within which land parcels are thought to be spatially autocorrelated. The K-R test is used to find a spatial distance band that equaled approximately 54 miles. This band is a functional radius determined by the last statistically significant measure of spatial influence between nearby parcels. This then permits the error terms associated with areas outside the distance band to be independent (Dubin, 1988). Once the model is estimated with the inclusion of the appropriate spatial weights matrix, spatial autocorrelation is not detected but heteroscedasticity is discerned via the previously mentioned Breusch-Pagan test.

Feasible Generalized Least Squares

A two step feasible (estimated) generalized least squares (FGLS) approach is used to correct for both heteroscedasticity and spatially correlated errors. The FGLS model is based on a decomposed error (see equation 2 below) that exhibits random, spatial error, and heteroscedastic components.

Consider the following HPM specification (as modified from equation 1):

$$y = \sum_{i=1}^{k} \beta_i^{ag} X_i^{ag} + \sum_{i=1}^{j} \beta_i^{amenity} X_i^{amenity} + U \qquad \textbf{(2)}$$

where,

y = \$/acre;

β^{ag} = k productive parameter estimates;

X^{ag} = k productive variables;

$\beta^{amenity}$ = j amenity parameter estimates β; and

$X^{amenity}$ = j amenity variables.

Note that $U = \xi + U_h + U_{se}$ with the aggregate error term further decomposed as follows:

U = the aggregated error;

ξ = the random homoscedastic error;

U_h = the decomposed heteroscedastic error term; and

U_{se} = the decomposed spatial error term.

The estimation procedure first addresses heteroscedasticity and then spatial errors.

Step 1: Correcting for Heteroscedasticity

Belsley et al. (1980) suggest transforming the original equation by using the residual values as a possible weighting approach on the heteroscedastic data. Auxilliary regressions utilizing the estimated errors as the dependent variable regressed against the independent variables in the hedonic model are estimated to test various potential weights (see Ramanathan, 1989). It is determined that the most appropriate weight is the absolute value of the OLS residuals ($|e_i|$) (see Wasson, 2005). The absolute values of the residuals are utilized as weights as follows:

$$y^* = \sum_{i=1}^{k} \beta_i^{ag} Z_i^{ag} + \sum_{i=1}^{j} \beta_i^{amenity} Z_i^{amenity} + \varepsilon \qquad \textbf{(3)}$$

Where

$y^* = y(1/|e_i|)$;

Z_i^{ag} = original productive X_i weighted by $1/|e_i|$ and associated β parameter estimates;

$Z_i^{amenity}$ = original amenity X_i weighted by $1/|e_i|$ and associated β parameter

estimates; and

ε = the remaining errors.

Step 2: Correcting for Spatial Errors

The K-R test indicated spatial error dependence, a situation where the error terms for parcels within 54 miles of each other are correlated. The autoregressive process is modeled as follows by (Anselin, 1995, p.208):

$$Y = X\beta + \varepsilon \quad \textbf{(4)}$$

$$\varepsilon = \lambda W_\varepsilon + \xi \quad \textbf{(5)}$$

where

Y = vector of dependent observations;

X = matrix of explanatory variables;

W_ε = the spatially lagged error term;

ε = vector of error terms;

λ = the autoregressive coefficient; and

ξ = the random homoscedastic error term.

For step 2 of the estimation procedure reported here, Y and X are composed of the transformed observations from step 1. The spatial weights matrix, using a 54 mile distance band, is created via procedures outlined in SpaceStat by Anselin (1995) using the x and y coordinates for the centroid of each parcel estimated via GIS.

The spatial error model is estimated using SpaceStat (Anselin, 1995). These two corrections should provide consistent estimates of the error variance matrix and improve parameter efficiency given the presence of heteroscedasticity and spatial autoregression. The estimator via FGLS can be represented as follows (Amemiya, 1985):

$$\beta_{FGLS} = \left[Z' \hat{\Omega}^{-1} Z \right]^{-1} Z' \hat{\Omega}^{-1} y \qquad \textbf{(6)}$$

where

Z = transformed observations (from equation 3);

y = the transformed dependent variable; and

$\hat{\Omega}$ = the estimated error variances that incorporate the spatially corrected errors (from equation 5).

Two separate hedonic models are estimated to test the importance of amenity values relative to agricultural productivity characteristics in explaining agricultural land values given our research objective. First a hedonic model including only the agricultural variables is estimated using the procedure outlined above. Then a model including both agricultural and amenity variables is estimated as outlined above.

Results

Given the above estimation procedures, two models are estimated for comparison. They are an ag only model (i.e., vector of Z^{ag} as independent variables) and a full model including both agricultural and amenity variables (i.e., Z^{ag} and $Z^{amenity}$). The full model is juxtaposed with the productivity only model to demonstrate the significance of the spatially precise amenity variables in determining rural parcel price. See tables 4 and 5 for regression results for these models.

A Lagrangian multiplier (LM) test is used to detect the presence of spatial errors (Anselin, 1995). The LM test statistic indicates that spatial errors are corrected in the Full FGLS model. The LM test in the agricultural only model indicates that spatial errors are not accounted for.[1] When heteroscedasticity is remedied and spatial autocorrelation corrected, the Full FGLS HPM provides a more efficient explanation of land value. The full model is more robust in that it is better specified, reflected by the significant amenity variables. It also yields improved goodness of fit statistics as seen in the pseudo R^2 (Anselin, 1995).

The results indicate that the variable for the weighted average of dry and irrigated AUMs per acre (IRRPAST) across the whole state and the value of improvements per acre (IMPR) reflect increased productivity and as such lead to higher price ceteris paribus. TREND captures increasing land values over the study period.

Most of the amenity measures of land attributes are significant contributors to parcel price. The value of fishing quality across the state (FISHW); the value of fishing quality in the western region (WFISHW); the value of alpine view in the western region (WALPINE); the value of roughness of view in the western region (WSTD10); positively and significantly increased price per acre *ceteris paribus.* Productive lands with on-site fishing and scenic views command a higher price.

FGLS Full HPM results indicate that the variable for the total AUMs representing parcel size (TAUM); weighted average of dry and irrigated AUMs per acre

(WIRRPAST) in the western region; the value of State or BLM leased AUMs per acre (STBLM); the value of deciduous tree view (DECI); the value of shrub view cover (SHRUB); the value of riparian view (RIPA); and the value of increasing distance to federal points of interest (DFEDL) negatively and significantly decreased price per acre *ceteris paribus.* The marginal value of the additional unit of production (AUM) is decreasing as seen in the estimation results. Public lands leased for grazing, though additional productive resources, may incur costs of management and instability of access due to controversy associated with public lands grazing.

Views of increasing uniform expanses of certain vegetation are less preferable compared to the amenity values of jagged, alpine horizons. The SHRUB, DECI and RIPR may also contribute to land management costs by competing with forage or as riparian areas leading to submerged pasture lands for portions of the on parcel grazing season. Opportunity costs may be associated with the afore-mentioned view components that detract from the aesthetic values. The closer a parcel is to premier amenity public lands (parks, monuments, wildernesses) the higher the price a parcel commands.

The price per acre decreases as the productivity of land increases in the western region of Wyoming. The negative relation on price per acre was not expected. It was assumed that increases in AUM quality increase on-parcel agricultural productivity and therein increase land price per acre in all including the western region counties of Wyoming. A possible explanation of the inverse relationship is that western landowners, and other land market participants, value land productivity less when compared to other attributes, than elsewhere in the state. It could also be that the western section of the state is at a higher elevation with a shorter growing season. Agricultural land as a capital asset in agricultural production may not be seen as a profitable option when compared with the fee generating opportunities of amenities as well as possible option value associated with future development payment..

The quality of fishing in the western section of Wyoming positively affects the parcel price. Increasing fishing quality may provide agricultural landowners supplemental income by affording recreational fishing fee opportunities (Inman et al., 2002). Secondly, a recreational or amenity land buyer may pay a premium for land containing quality-fishing streams.

Alpine view and roughness of view across the state are not significantly found to affect agricultural land price. Alternately, alpine views clearly affect the price per acre when considering the western region of Wyoming. An increase in price per acre is found as the percentage of western region roughness of view or standard deviations WSTD10 increases on a parcel. The roughness of view variable contribution provides a premium to agricultural land price in view of the dramatic relief of pristine mountain peaks.

Conclusions

This research indicates how Wyoming agricultural land's productivity and amenity characteristics both influence land price. The land attributes are deemed important to both consumers and producers. The literature addresses the importance of accounting for productive and amenity attributes in both estimated land price and rent generating abilities. Not including amenity attributes results is not fully accounting for land price variation. Incomplete land model specification fails to give a proper value for agricultural land in areas with high amenity concentration. It can lead to omitted variables problems and model misspecification.

The FGLS Full model provides the most efficient estimators and the most robust estimation of Wyoming agricultural land price. Results also indicate that correcting for heteroscedasticity and spatial autocorrelation provides an improved HPM estimation.

This research documents the role amenities have in determining agricultural parcel price in Wyoming. Amenities that are spatially precisely measured may also be drivers in the market prices of agricultural lands throughout the region. The outcomes offer insights into targeting the location of amenity protection. Moreover, these results suggest that amenities which might be attractive to non-agricultural interests could affect potential development values for in-migrants. Future research should expand the tests of amenity types that may be determinants of agricultural prices. The type, location and quality of various amenities may have key roles as per recreation, ecosystem services, aesthetic values and rural quality of life in local, state and federal as well as private land conservation efforts.

Footnotes

[1] A spatial weights matrix assuming a 54 mile distance band was used for both models. These results indicate the ag only model may not exhibit the same spatial dependence as the full model.

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Table 1 Agricultural Productivity Variable Names, Predicted Signs, and Definition

Variable	***Hypothesized sign***	***Definition***
CDACRE	(Dependent)	The dependent variable is nominal price per acre, in dollars, of the agricultural land sales.
TAUM	Negative	This represents the size and carrying capacity of the land in the sale. It is measured in total animal unit months (AUMs) on the parcel in both deeded acres and assured leases. The expected sign reflects the declining marginal value of additional lands
IRRPAST	Positive	Measures productivity of pastureland in the sale. The variable for IRRPAST is calculated by taking a weighted average of total AUMs on irrigated and pasture and then dividing by deeded acres.
WIRRPAST	Positive	Measures productivity of irrigated and dry pastureland in the Western Wyoming Region sales.
STBLM	Indeterminate	Measures how State or BLM land leases contribute to per acre sales price. STBLM is measured in AUM quality per acre.
IMPR	Positive	The assessed value, in nominal dollars, of agricultural improvements on the property divided by the number of deeded acres.
TREND	Indeterminate	Represents trend in land prices between 1989 (represented by 1) and 1995 (represented by 7).

Table 2 Amenity Variable Names, Predicted Signs, and Definition

Variable	***Hypothesized sign***	***Definition***
ELK	Indeterminate	Percent elk habitat of entire parcel.
FISHW	Positive	Composite of stream length weighted by trout population density and then divided by parcel size. This variable is a parcel specific measure of angling quality.
WFISHW	Positive	Represents the fishing quality contribution the western Wyoming region counties have on predicted agricultural land price per acre.
DECI	Indeterminate	Represent the area of visible deciduous trees as a percentage of total view..
SHRUB	Negative	Represents the area of visible shrub land as a percentage of total view.
RIPA	Indeterminate	Represents the area, of visible riparian as a percentage of total view.
ALPINE	Positive	Represents the area of visible high mountain, above-tree line, alpine environment as a percentage of total view.
WALPINE	Positive	Represents the contribution the western Wyoming region counties have on predicted agricultural land price per acre.
STD10	Positive	This variable measures roughness of the topography visible between 0 and 10 kilometers distance as seen from 2 meters above vegetation height at the parcel's centroid. It is measured in standard deviations from the average visible height between visible landforms' lowest and highest elevations.
WSTD10	Positive	Represents western Wyoming region county's view roughness contribution to predicted agricultural land price per acre.
DFEDL	Negative	Shortest direct distance from a parcel, in linear miles, to the nearest national park, monument or wilderness area. This represents the distance to the nearest recreation opportunity for a high value amenity area.

Table 3 Variable Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
CDACRE	461.88	475.94	28.54	2875.00
TAUM	1447.77	1919.17	12.00	12480.00
IRRPAST	2.74	3.66	0.12	17.50
WIRRPAST	1.20	2.33	0.00	10.42
STBLM	0.05	0.13	0.00	1822.50
IMPR	58.81	170.15	0.00	1822.50
ELK	0.09	0.26	0.00	1.00
FISHW	2.34	4.74	0.00	43.84
WFISHW	1.07	4.19	0.00	43.84
DECI	0.92	5.90	0.00	53.07
SHRUB	7.57	14.41	0.00	60.16
RIPA	1.59	5.86	0.00	52.15
ALPINE	0.42	3.25	0.00	35.97
WALPINE	0.06	0.16	0.00	1.47
STD10	85.48	164.25	1.95	2238.11
WSTD10	36.66	67.79	.00	355.86
DFEDL	57.43	41.00	5.7	138.75
TREND	5.18	1.56	1	7

n = 220

Table 4 FGLS Agricultural Only Regression

Variable	Parameter Estimate	Standard Error	Asymptotic t-value
CONSTANT	282.67	33	8.57 ***
TAUM	-.014	.005	-2.67 ***
IRRPAST	54.05	2.96	18.23 ***
STBLM	-105.29	71.5	-1.47 *
IMPR	1.27	.08	16.59 **
TREND	-12.52	5.86	-2.14 ***
	Statistic		**Probability**
LM (ERROR) DF=1	73.05		.0000000
Goodness-of-fit	Pseudo R^2 = .45		

n = 220

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10%

Table 5 Fully Specified FGLS HPM

Variable	Parameter Estimate	Standard Error	Asymptotic t-value
CONSTANT	191.26	16.53	11.57 ***
TAUM	-0.02	0.00	-13.62 ***
IRRPAST	52.71	1.02	51.31 ***
WIRRPAST	-24.67	1.32	-18.58 ***
STBLM	-243.6	23.7	-10.28 ***
IMPR	1.20	0.03	38.29 ***
ELK	-172.53	18.73	-9.20 ***
FISHW	10.64	1.66	6.39 ***
WFISHW	16.44	3.28	5.01 ***
DECI	-2.49	0.14	-17.41 ***
SHRUB	-3.21	0.19	-17.01 ***
RIPA	-6.50	1.65	-3.93 ***
ALPINE	0.17	0.79	0.21
WALPINE	582.01	11.87	49.00 ***
STD10	0.08	0.06	1.40
WSTD10	1.85	0.07	25.44 ***
DFEDL	-1.39	0.08	-16.37 ***
TREND	19.54	2.21	8.84 ***
	Statistic		**Probability**
LM (ERROR) DF=1	0.0006		0.980
Goodness-of-fit	Pseudo R^2 = .68		

n = 220

*** Significant at the 1% level