Abstract

In areas where urban development is threatening quality farmland, zoning policies that encourage development on low productivity land have a significant influence on market forces, resulting in upward pressure on the prices of low productivity farmland. This helps identify potential permanent changes of use to a different highest and best use. Identifying the highest and best use of land is fundamental in estimating a vacant land value and identifying comparable sales of vacant land.

Determinants of Farmland Values In the Rapidly Developing Boise, Idaho Metro Area: Applying Mathematical Modeling to Highest and Best Use Analysis

By April Beasley, James Nelson, Ruby Stroschein, and Joel Hamilton

Introduction

From 1990 to 2000 the Boise, Idaho, metropolitan area consisting of Ada and Canyon counties (Figure 1), was the seventh fastest growing metropolitan area in the nation and the fastest growing such city in the Pacific Northwest. During the 1990s, the Boise metro area population increased by 46.1 percent or 136,494 residents (from 295,851 to 432,345) (U.S. Census Bureau, 2001). The growth continues. The 2003 estimated population of the Boise metro area was 476,659 (U.S. Census Bureau, 2005).

The rapid and substantial development that accompanies urban growth and the effects of such development on farmland values are of particular concern to many residents, appraisers, and policy makers in the Boise area. The Ada and Canyon counties have highly diversified crop production on approximately 227,000 acres of the most productive irrigated cropland in Idaho. Only two counties in Idaho have higher cropland receipts per acre than Ada County and Canyon County.

Beasley is a former Graduate Research Assistant; Nelson is a Professor; Stroschein is an instructor of a farmland appraisal course; and Hamilton is a Professor Emeritus, all in the Department of Agricultural Economics and Rural Sociology at the University of Idaho. Stroschein is also a MAI Certified General Appraiser in Moscow, Idaho.

On December 8, 2006, University of Idaho Agricultural Economics and Rural Sociology lost a great friend and Colleague Dr. James R. Nelson. This article is published posthumously and in memory of his dedicated work in rural land use change and valuation modeling.

These are Boise County, which has only about 1,900 acres of cropland, most of which is in nursery production; and Clark County, where almost all of the 31,000 acres of cropland are in high value potato production (U.S. Department of Agriculture, 2004).

Knowledge of the effects of growth and development on farmland values around Boise, Idaho can also be insightful for persons interested in land values and land use in other developing areas. Land owners, appraisers, and decision makers in many areas of urban growth are concerned about such issues as land values, land development, land use planning, open space preservation, and economic base lost as the growth of the metro area results in conversion of high quality agricultural land to residential and commercial development. To effectively address such concerns, they need information about what farmlands are most in demand for development, and why. Since development pressure on farmland is an economic force that exerts upward pressure on land prices, a reasonable method for evaluating such pressure is to examine farmland prices using analytical methods that decompose that value into quantifiable components related to both agricultural value and development value. Once the value of the farmland is established, it can be compared to a value generated from alternative uses. These are mechanisms real estate appraisers can utilize to analyze the market forces in concluding and empirically supporting highest and best use conclusions.

Research Objectives

The overall objective of the research reported in this paper was to identify and evaluate factors that affect farmland values in Ada and Canyon counties in Idaho with the intent that such information will help appraisers identify potential permanent changes in highest and best use of land in developing areas, and will help policy makers better understand how to develop and direct land use policy. Also, study results will hopefully provide other interested individuals with better knowledge and understanding about the dynamics of land values. Specific objectives of this research were to identify land attributes that affect farmland values and to interpret information about these attributes. This will provide information to interested stakeholders about how land values are affected by relative levels of development pressure and other factors.

Land Value Models

Highest and best use analysis as conducted by appraisers involves four implicit criteria: 1) Physically possible; 2) Legally permissible; 3) Financially feasible; and 4) Maximally productive. After considering the applications of what is physically possible and legally permissible (or the reasonable probability of potential zoning changes), financially feasible and maximally productive have traditionally been tested with economic models such as the discounted cash flow model. In theory, the “proper” value of land is the present value of cash flow of the parcel’s future income stream (Elad, et al., 1994). However, application of the discounted cash flow model to explain the present value of land which is likely to have future changes can be quite problematic.

Another option for identifying those uses which will result in the highest land value, (short of completing an in depth fundamental market analysis) is based on the assumption that the value of a differentiated good (such as land) can be identified by a set of attributes. The value of the good is assumed to be the aggregation of the values of its individual attributes. For farmland, individual attributes include agricultural productivity whereas development land value would include proximity to employment centers, schools, and community services, etc. Modeling farmland value in this way is consistent with the concept of decomposition of value into quantifiable components, including development pressure. Models of this sort lend themselves well to estimation using regression techniques. They have been used by numerous researchers including Bastian, et al. (2002); Torell and Bailey (2000); McLeod, et al. (1999); Vasquez, et al. (2002); Elad et al. (1994); and others to explain values of different types of land assets with different types of economically valued attributes.

Data

The authors used Farm Credit Services data on 151 farm sales of irrigated cropland in Ada and Canyon counties that transacted from 1994 through 2002. These data included, for each parcel, sale price (total dollars per parcel), acres, year of sale, and township, range, and section. Sale price data were modified to form the adjusted sale price variable, calculated as the sale price minus the value of any improvements. The value of the improvements was estimated by the Farm Credit appraiser who analyzed the sale and is considered to be credible on that merit. Similarly, acres data were adjusted downward by road and waste acreage to form the variable adjusted acres. Adjusted sale price, as defined above, was designated as the dependent variable in this study.

With the help of geographical information system specialists at both the University of Idaho and the Idaho state office of the U. S. Department of Agriculture (2005), Natural Resources Conservation Service (NRCS), more data were gathered. These included distances of parcels from cities greater than 10,000 population, presence of water bodies on or adjoining tracts, average slopes and elevations of sections containing data parcels, and estimated productivity capabilities of soils present in tracts.

Soil capability classes developed by NRCS indicate the presence of soil limitations. The capability classes range from I-VIII, with one defined as land with slight limitations and eight as land unsuitable for farming (Table 1). Since locations of parcels were known only by Government Survey township, range and section identification, the percent of each soil capability class in the transacted parcel was estimated as equal to the percent of each soil capability class in the section (defined by NRCS).

Whether the expected impacts of the independent variables on land values are positive or negative are specified in Table 2. The expected impacts of most of the independent variables on the dependent variable (land value) were readily explainable by economic theory, as follows:

- Parcels located further from cities were expected to be worth less for development than parcels that are nearer to cities.
- Lower numbered soil capability classes are more productive for agriculture, thus were expected to be more valuable than higher numbered classes.
- Since land prices tend to increase over time, and since the base year for analysis was 1997, it was expected that parcels sold before 1997 would be for less dollars than the base year and parcels sold after 1997 would be for more. Departures from the 1997 base year were modeled with dummy variables.

However, for three of the independent variables considered (elevation, slope, and rivers-lakes) economic theory does not clearly suggest whether expected impacts on farmland values should be positive or negative:

- Elevation tends to shorten growing seasons (negative impact on agricultural value), but makes for desirable views (positive impact on development value).
- Slope tends to make a parcel more difficult and costly to farm (negative impact on agricultural value), but it is usually considered to be esthetically interesting (positive impact on development value, but still requires costly excavation).
- Rivers and lakes on or adjoining a parcel add aesthetic value (positive impact on development value), but “break up” land, making it more difficult to farm (negative impact on agricultural value).

Analysis and Results

An ordinary least squares (OLS) regression model was utilized to determine the influence of the independent variables on the dependent variable. Model results indicated that the elevation, slope, and rivers-lakes variables were not significant. So, since their theoretical rationales for inclusion were ambiguous (as mentioned above), they were dropped from the model. Also, the year of sale dummy variables, except for the year 2001, were dropped from the model because they were not significant. Their lack of significance suggests that land value inflation was minimal in the data analyzed.

Technical statistical assumptions were checked, and it was determined that the model should be converted to a weighted least squares (WLS) model.[1] This change does not affect any of the results mentioned above.

Results of the WLS model are shown in Table 3. The regression variables explain 62 percent of the price variation of farmland parcels in Ada and Canyon counties. The independent variables in the model all have the expected signs. The only development pressure variable that is significant is the distance to a city with greater than 10,000 population.

The coefficient for variable I-1 (the number of acres of irrigated soil capability class I in a parcel) is the highest of the soil capability class coefficients. This is consistent with theory, since capability class 1 indicates highest productivity. Coefficients for variables I-2 and I-3 (acres of irrigated soil capability classes II and III, respectively, in a parcel) are not inconsistent with theory, since they are very nearly equal and less than the coefficient for I-1.

The coefficient for low productivity soils (LowPro), however, is almost as large as the coefficient for I-1. This is the result that might be expected if planning and zoning officials in the study area are protecting the agricultural economic base of the area by directing non-agricultural development onto less productive land, or are openly planning to initiate such farmland preservation actions in the future. A conversation with an Extension Educator in the study area (Neufeld, 2005) documented that planning and zoning officials have stated that they see local benefits from protecting the best farmland from development. However, during the time period of the farmland transactions analyzed in this study (1994-2002), almost all farmland in the area was zoned for agriculture. Policy maker decisions related to protection of such land from development could only be documented by a parcel by parcel analysis of whether requests to allow changes of use (from agriculture to non-agriculture) were either approved or denied. Such an analysis was beyond the scope of this study.

Using the model estimated above, it is possible to estimate the expected average price of a parcel of farmland located in the Boise metro area. This can be done by using the coefficients from Table 3 and the average values of the variables (based on the data in the study) to which the coefficients apply. This process is indicated below:

$$\text{Average Adjusted Sale Price} = 123191 - 5.45(13876.43) + 2418.68(9.13) + 1956.47(28.15) + 1974.85(44.70) + 2346.79(17.23) = \$253{,}376.16$$

The estimated adjusted sale price of $253,376.16 applies to an average parcel size of 99.21acres, resulting in an average adjusted sale price of $2,553.94 per acre.

Conclusions and Implications

The von Thunen Factor

Early in the 19th century, Johann von Thunen, a German farmer-economist developed a land use theory that suggested that access to a city matters when deciding to purchase land. The closer the land is to a city, the higher the price. This is because locating at or near the city center minimizes transaction costs. Von Thunen used concentric circles to illustrate the amount each industrial sector is willing to pay for land relative to its distance from the city center (Leahy, et al., 1970). He argued that manufacturers locate in or very near the central city, then as distance from the central city increases, land is used for housing. At greater distances, it is used for agriculture. As these uses bid for land, land prices decline as distance from a city increases.

Several other land use models are commonly used by appraisers. These include the sector model, the multiple nuclei model, and the radial corridor model, along with von Thunen's concentric zone model. Von Thunen's model may be simplistic relative to today's complicated linkages and economies, but it can be used effectively to deal with farmland use change analysis.

Relative to the von Thunen model, research results presented above indicate that, for farmland in the Boise metro area, the value of an average parcel (99.21 acres) decreases $5.45 (or 5.5 cents per acre) for every meter of distance from a city of greater than 10,000 population. This translates to a decline in Boise metro area farmland values of $88.47 per acre for every mile in distance from the nearest town with more than 10,000 residents. The range of the data on which these results are based, and the geographic distribution of study area towns greater than 10,000 population, suggests that this relationship is meaningful in the study area from about three to 17 miles distance from a city of greater than 10,000 population. The expected price per acre for the hypothetical parcel described in the equations above is about $2,554 per acre. This parcel would be located about 8.5 miles from the nearest town with a population greater than 10,000 (Boise, Caldwell, Nampa, Meridian, Garden City, or Eagle). However, if the same parcel were located 16 miles from the nearest town with population greater than 10,000, its expected value would be only about $1,899 per acre. If it were located only three miles from such a city, its expected value would be about $3,041 per acre. As von Thunen's theory suggests, development demand for Ada and Canyon counties' farmland has a substantial effect on land prices. That effect lessens as distance from the nearest city increases.

The Agriculture Factor

The coefficients for the number of acres in a parcel of each of the categories of irrigated land capability (productivity) considered in the study are estimates of the marginal values per acre of agricultural land in each capability class. The fact that the coefficient for the number of acres of low productivity land in a parcel is highly significant, and is almost as large as the coefficient for the number of acres of the highest productivity land; coupled with the fact that local land use policy makers have expressed interest in protecting high quality farmland, suggest that efforts are being made to preserve high quality farmland, and that such efforts are at least somewhat effective.

Application of Results

The information presented in this paper may be interesting, and hopefully useful to many types of people in southwestern Idaho such as buyers and sellers of land, appraisers, land use policy makers, and others with interests in how rural lands around Boise will be used. The effect of distance from large towns (greater than 10,000) on values of farmland parcels in Ada and Canyon counties is quantified. This information may be useful to the sorts of people indicated above as they evaluate land values, investment opportunities and development pressure in the Boise metro area. The distance coefficient presented here can be used directly to evaluate the effects of distance from large towns on farmland values. It may be even more useful to look for situations where the distance coefficient does not seem to reasonably explain land values in the Boise area, then to "figure out why not."

Also quantified in this study are contributions to study area farmland values of land of different levels of productivity. Based on this analysis, the most productive irrigated farmland (capability class I) in Canyon and Ada counties is worth over $400 per acre more than land in capability classes II and II. However, land of lower productive capability than class III is worth almost as much per acre as is class I land. This seems to be because land use policy makers in Ada and Canyon counties are working to protect the best farmland from development. People interested in farmland values in Ada and Canyon counties should be aware of land productivity, land location (distance from large towns), and land use planning policy and how it is applied. In addition, people interested in farmland values in other areas experiencing development pressure should evaluate the effects of farmland values on not only factors which affect agricultural productivity, but also elements which relate to the four influences that affect value, namely government, economic, environment, and social impacts.

Special Implications for Farmland Appraisal

Results of this research can provide intellectual rigor to real estate professionals based on use of mathematical models to conclude market forces to establish the most profitable, competitive use to which a property can be put. Implications of the model can assist in evaluating whether there are development pressures that affect the market values of particular farmland parcels. Development pressure can be thought of as demand for a parcel that is associated with its potential conversion to some non-agricultural use in the near or distant future.

A way to "check for development pressure" is to calculate an agricultural income multiplier for the parcel under consideration. This multiplier is the ratio between the market value of the parcel and its average annual gross income in agriculture (Boykin and Gray, 1994). Compare this ratio to agricultural income multipliers for other parcels (in the same general area) for which the highest and best uses are unambiguously agriculture. A multiplier for the parcel under consideration that is substantially greater than those for the purely agricultural parcels is strong evidence of development pressure on the considered parcel.

In cases where market evidence strongly suggests that zoning change is imminent, it may be appropriate for an appraiser to conclude a highest and best use other than that which is presently legally permissible. In such cases, results of mathematical models such as presented herein can address concerns about subjective speculation. This is achieved by comparing the results of the model for farmland valuation to the value of the tract as development land using traditional valuation methodologies. In such situations it is important for an appraiser to check for verifiable value adjustments associated with nonagricultural attributes of the parcel.

Appraising farmland that is impacted by development pressure is not conceptually different than appraising farmland for which the highest and best use is definitively agriculture. However, such appraisals involve different variables and more complications and complexities than do appraisals of farmland unaffected by development pressure.

The work of appraisers is to interpret real world market forces and their impacts on the assets of society so that others in society can better understand and react to these forces. Increasing (sometimes rapidly increasing) development pressure on rural lands is a common reality in the United States today, so it is a market force about which rural appraisers must have or develop high level expertise.

End Note

[1] The OLS assumptions were checked and multicolinearity was not found to be a problem. However using a Glejser test (Glejser, 1969), heteroskedasticity was found to be a problem. The problem was addressed with weighted least squares (WLS) techniques.

References

Appraisal Institute. *The Appraisal of Real Estate* (2nd Edition), pp. 307-311. Chicago, 2001.

Appraisal Institute and American Society of Farm Managers and Rural Appraisers. *The Appraisal of Rural Property* (2nd Edition), p. 147. Chicago, 2000.

Boykin, J.H. and M.T. Gray. "The Relevance and Application of the Gross Income Multiplier." *The Appraisal Journal*. April 1994:203- 208

Economagic.com: Economic Time Series Page, April 2005. Series Title: Unemployment Rate: Boise City, ID MSA; Percent; NSA. http://www.economagic.com/em-cgi/data.exe/blsla/lausm10800003

Elad, R. L., et al., 1994. "Hedonic Estimation Applied to the Farmland Market." *Journal of Agriculture and Applied Economics*, 26, 2, 351-366.

Glejser, H., 1969. "A New Test for Heteroskedasticity." *Journal of the American Statistical Association*, 64, 316-323.

Leahy, et al., 1970. *Urban Economics: Theory, Development and Planning*. New York, New York: The Free Press.

McLeod, D.M., et al., July, 1999. "The Contribution of Environmental Amenities to Agricultural Land Values: Hedonic Modeling Using Geographic Information Systems Data." Paper presented at the Western Agricultural Economic Association Meeting.

Neufeld, Jerold, January 2005. Canyon County, Idaho Extension Educator. Telephone conversation about farmland protection policies and practices in Ada and Canyon counties, Idaho.

Torell, L.A. and S.A. Bailey, July 2000. "Is the profit motive an Important Determinant of Grazing Land Use and Rancher Motive?" Paper presented at the annual meeting of the Western Agricultural Economic Association.

U.S. Census Bureau, April 2001. Ranking Tables for Metropolitan Areas: 1990 and 2000. http://www.census.gov/population/www/cen2000/phc-t3.html

U.S. Census Bureau, February 2005. Idaho QuickFacts. http://quickfacts.census.gov/qfd/states/16000.html

U.S. Department of Agriculture, April 2005. Natural Resource Conservation Service. http://soils.usda.gov/technical/handbook/contents/part622.html#02

U.S. Department of Agriculture , June 2004. 2002 Census of Agriculture, Vol. 1, Chp. 2: Idaho County Level Data. http://www.nass.usda.gov/census/census02/volume1/id/index2.htm

Vasquez, Orestes, et al., July 2002. "Determining the Effects of Land Characteristics on Farmland Values in South-central Idaho," Paper presented in Land Value Economics Session at the Annual Meeting of the Western Agricultural Economics Association.

Figure 1. Boise, Idaho, metropolitan area (Ada and Canyon Counties)

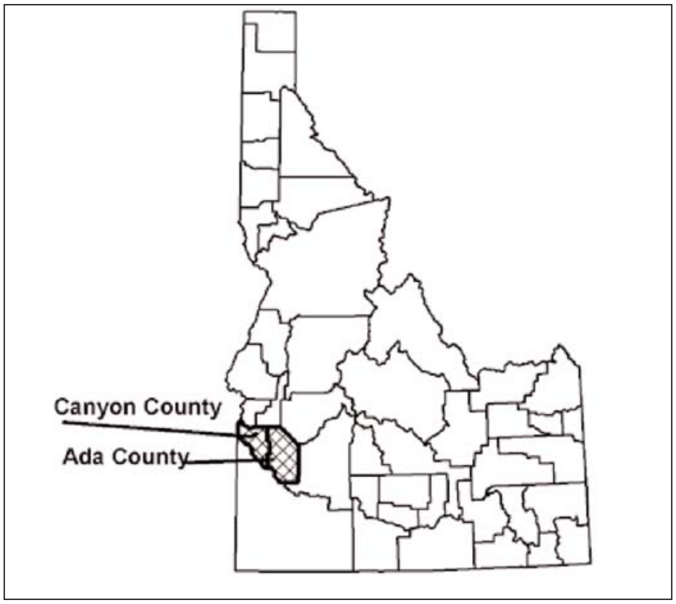

Table 1. Soil capability class definitions provided by the USDA natural

Resource Conservation Service (NRCS)*

CLASS	DEFINITION
CLASS I	Soils have slight limitations that restrict their use.
CLASS II	Soils have moderate limitations that reduce the choice of plants or Require moderate conservation practices.
CLASS III	Soils have severe limitations that restrict the choice of plants or require very careful management, or both.
CLASS IV	Soils have very severe limitations that restrict the choice of plants or require very careful management, or both.
CLASS V	Soils have little or no hazard of erosion but have other limitations, impractical to remove, that limit their use mainly to pasture, range, forestland, or wildlife food and cover.
CLASS VI	Soils have severe limitations that make them generally unsuited to cultivation and that limit their use mainly to pasture, range, forestland, or wildlife food and cover.
CLASS VII	Soils have very severe limitations that make them unsuited to cultivation and that restrict their use mainly to grazing, forestland, or wildlife.
CLASS VIII	Soils and miscellaneous areas have limitations that preclude their use for commercial plant production and limit their use to recreation, wildlife, or water supply or for esthetic purposes.

* U.S. Department of Agriculture (2005).

Table 2. List of variables and their expected ipacts on farmland values

Variable Name	Variable Description	Expected Sign
Dependent Variable		
Adjusted Sale Price	Total dollars per parcel	-------
Independent Variables		
Continuous Variables		
More10000	Meter distance to a city greater than 10,000	(-)
Elevation	Section average elevation (meters)	(?)
Slope	Section average slope (degrees)	(?)
I-1	Acres of irrigated soil capability 1	(+)
I-2	Acres of irrigated soil capability 2	(+)
I-3	Acres of irrigated soil capability 3	(+)
LowPro	Acres of irrigated soil capability 4, 5, 6, 7	(+)
Discrete Variables		
Y1994	Parcel was sold in the year 1994*	(-)
Y1995	Parcel was sold in the year 1995*	(-)
Y1996	Parcel was sold in the year 1996*	(-)
Y1998	Parcel was sold in the year 1998*	(+)
Y1999	Parcel was sold in the year 1999*	(+)
Y2000	Parcel was sold in the year 2000*	(+)
Y2001	Parcel was sold in the year 2001*	(+)
Y2002	Parcel was sold in the year 2002*	(+)
Rivers-lakes	River or lake located in or borders section	(?)

*Base year is 1997

Table 3. Weighted Least Squares (WLS) model results

Variables	Parameter Estimate	T-Value
Int	123191	4.81***
Y2001	66398	1.95*
More10,000	-5.45	-3.46***
I1	2418.68	3.01***
I2	1956.47	5.10***
I3	1974.85	6.54***
LowPro	2346.79	3.49***
Computed R-Squared	0.6218	
F-Value	64.11	

* (0.1) Significance Level ** (0.05) Significance Level ***(0.01) Significance Level