Estimating the Market Value of Agricultural Land in Kansas Using a Combination of Hedonic and Negative Exponential Techniques

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Abstract

Given the importance of land valuation to the various stakeholders, the objective of this research is to develop a theoretically sound model that robustly estimates the market value of land in Kansas, accounting for urban influence. The market value of land is estimated using a hedonic model that includes factors related to urban sprawl. A semi-log hedonic model that combined site-specific characteristics with negative exponential distance functions was estimated. Results indicated that the upward, urban pressure on price is greater for Kansas City relative to Wichita. Kansas City had a much slower rate of decay than either Wichita or cities with a population of more than 10,000.

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Introduction

Changes in land values are a major concern to agricultural producers, landowners, community businesses, and financial agencies. Farm real estate accounts for more than 80 percent of the value of all farm assets in the United States totaling approximately $1.13 trillion (ERS). Given the magnitude of this investment, agricultural land owners have a significant interest in changes in the value of their land. Large swings in land value have an impact on a landowner's net worth and borrowing ability. These changes spark the interest of financial agencies and may change their position on lending.

Movements in land prices affect sectors outside of agriculture as well. Changes in land prices encourage or discourage the conversion of agricultural land into residential or commercial development. Urban sprawl may drive up land prices near cities, discouraging production agriculture for two reasons. The increased land price makes it difficult for agricultural producers to purchase the land. Secondly, higher land prices may encourage producers to sell to developers who will convert the land out of agricultural production.

Given the importance of land to the various stakeholders, the objective of this research is to develop a theoretical model that estimates the market value of land in Kansas, accounting for urban influence. The market value of land will be estimated using a hedonic model for the state of Kansas that includes factors related to urban sprawl. Using sales data from the Property Valuation Division of the Kansas Department of Revenue (PVD), parameters for productive and location attributes of the acreage sold will be estimated. The sales data used include all open market, arms-length sales of agricultural land in Kansas between 1996 and 2004. The contribution of this research is the development of a hybrid hedonic model that takes into account urban influences. Doing so enables the estimates to incorporate both traditional characteristics of agricultural land and urban pressures specific to agricultural land.

Literature Review

Hedonic models are prominent in the land valuation literature. Rosen (1974) presented a general theoretical framework for using hedonic prices to analyze the demand and supply of attributes of differentiated products. Early applications of Rosen's (1974) theoretical model to agricultural land values include Chicoine (1981), Miranowski and Hammes (1984), and Palmquist (1989).

Shi, Phipps, and Colyer (1997) combine agricultural and urban fringe models into a single equation model for West Virginia farmland prices. They use cross-sectional and time series data from multiple sources for counties in West Virginia. Urban influence is incorporated through a gravity model adapted from marketing research. The gravity model portion of the equation is an explanatory variable calculated by dividing county population by the squared distance of a county from three urban central business districts (CBD). Shi, Phipps, and Colyer point out that West Virginia is surrounded by major metropolitan areas and has many hobby farmers, so including urban factors is essential. They also include explanatory variables that are traditionally used in agricultural rent capitalization models, such as expected net returns, expected capital gains, and real interest rate. Shi, Phipps, and Colyer find that their explanatory variables are significant at the 1% level. The distance ratio has the largest impact on per acre sale price at $132.60.

Shultz and Taff (2004) use a hedonic approach to estimate the implicit price of wetlands in areas of production agriculture. Using Geographic Information Systems (GIS) data, they separate eased and non-eased wetlands to determine whether the wetland was wet throughout the crop year (permanent) or might dry up (temporary). The permanent classifications, wet throughout the year, prove to be statistically and economically significant. Each additional acre of non-eased and eased permanent wetlands decreases sale price by $161 and $321, respectively, implying a 40% and a 79% reduction in average sale price per acre, respectively. This research illustrates the importance of incorporating the production capability of land being sold, which Schultz and Taff do by including wetland information. Shultz and Taff state, “Our estimated implicit prices of eased and non-eased wetlands appear to be consistent with economic theory in that they reflect the relative opportunity costs associated with foregone agricultural production on different types of wetlands” (p. 510).

Capozza and Helsley (1989) show that there is a positive relationship between the rate of urban growth and the price of housing. In two examples, they show that in rapidly growing cities, the value of expected future rent increases may account for at least half of the average price of land. Making some general assumptions about the values of the variables, they show that the ratio of the price of urban land net of the servicing costs to the value of agricultural land rent changes from 10.2 to 37.7 at growth rates of two and four percent, respectively. This finding implies that the alternative treatment of agricultural land leads to significant loss in property tax revenue to local governments.

Anderson and Griffing’s (2000) research focuses on estimating the lost tax revenues created by preferential treatment of agricultural land. They examine two contiguous urban counties in Nebraska using a negative exponential model of the difference between market value and use-value per acre. They compare market and use-value for a land parcel. For the two counties they examine, they find that the use-value assessments are 63.9 percent and 24.8 percent of market. Moreover, they find that the rates of decay in the difference of value are very similar across these contiguous counties, implying that this rate may be more generalizable beyond their data set. Their results indicate that the expenditure lost due to use-value assessments is significant: 36% of total tax revenue for one county and 75% of total for the other. Anderson and Griffing state that using the integration method may overstate tax expenditures because all land categories are valued at use-value and at market value. This method does not allow for the segregation of agricultural land that would be the only land class affected by a tax policy change.

This research combines hedonic and spatial elements from previous research, using each parcel’s income-generating capability and location. The hedonic variables included are common to most hedonic studies, such as Schultz and Taff. Spatial information is incorporated using the negative exponential function that was used by Anderson and Griffing. The difference between this combined approach and prior gravity model research is that distances are parcel specific, rather than at the county level. The urban influence on each parcel can vary, instead of every parcel in a county being forced to have same distance.

Economic Theory

Capozza and Helsley (1989) develop a theoretical model that assumes capital is durable and landowners have perfect foresight. The price of urban land can be derived by summing four components: the value of agricultural land rent, the cost of development conversion, the value of accessibility, and the value of expected future rent increases. They view the capitalized value of agricultural rent and the value of capital improvements applied to the land as invariant to distance. The other two aspects of price, the value of development conversion and the value of accessibility, are dependent on the location of the land in relation to the Central Business District. Capozza and Helsley represent the price of developed land as:

(1) $$P^d(t,z) = A/r + C + (1/r)(T/\bar{L})[\bar{z}(t) - z] + (1/r)\int_t^{\infty} R_t(\tau, z)e^{-r(\tau - t)}d\tau$$

where A is the value of agricultural rent and r is the discount or capitalization rate. C represents the value of capital improvements applied to the land. The value of accessibility depends on transportation cost, T, mean lot size, $\bar{L}$, and declines with distance, z, to the city boundary, $\bar{z}(t)$.[40] Capozza and Helsley state that urban growth affects the price of land and that in a static context, land price is proportional to land rent. This would make the price of land on the urban fringe equal to the value of agricultural land rent. In a dynamic model, they argue that this is not the case. Specifically, the price of agricultural land is:

(2) $$P^a(t,z) = A/r + (1/r)\int_t^{\infty} R_t(\tau, z)e^{-r(\tau - t)}d\tau.$$

Substituting (2) into (1), the relationship between developed land and agricultural land can be seen as:

(3) $$P^d(t,z) = P^a + C + (1/r)(T/\bar{L})[\bar{z}(t) - z]$$

implying that the price of developed land is equal to the price of agricultural land plus the capital improvements plus the value of accessibility. Using Liebnitz' rule, they find that land is developed when in urban use rent equals the opportunity costs of land and conversion capital. The rent outside the urban area is simply the agricultural rent. Rent at the edge of the urban area increases by the opportunity cost of the capital used to convert land for development. Rents rise inside the urban boundary by transportation costs per unit distance per unit land.

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[40] Models of urban land price theorize that the market value of the land per acre should decline as distance from the Central Business District increases.

According to Anderson and Griffing (2000), little empirical research has evaluated the implications on tax expenditures of favorable treatment of agricultural land. In their 2000 study, Anderson and Griffing discuss more complex models developed by Capozza and show that market value exceeds agricultural value, and this differential decreases with increasing distance from the Central Business District. Anderson and Griffing's (2000) research focuses on estimating the lost tax revenues created by preferential treatment of agricultural land. They use a negative exponential model of the spatial variation in the difference between the two sets of prices and integrate the area between them over the urban area. The negative exponential model implies that the distance to the Central Business District accounts for the difference between market value and use-value. Empirically:

(4) $$\ln(Diff) = \beta_0 - \beta_1 * Distance$$

where *Diff* is the difference between market value and use-value. *Distance* is the distance of the parcel from the Central Business District (CBD). β_0 is the intercept of the function and represents the difference between market value and use-value for a parcel located within the CBD. β_1 is the rate per mile at which market value declines to use-value. A concern when using the negative exponential function with time-series data is the function's reliance on distance as the sole influence on the difference between market value and use value; in essence, the influence that time may have on the land market is disregarded. This concern is addressed in this research modeling time along with the negative exponential function in the model.

Methodology

The objective of this research is to estimate the market value of agricultural parcels in Kansas, taking into account the influence of urban location on the market price of agricultural land. A nonlinear model that combines site-specific explanatory variables that are traditionally included in hedonic models with potential urban influences is estimated. Urban influence is incorporated using the negative exponential function used by Anderson and Griffing. The negative exponential function is used to calculate the difference between market value and use value based on a parcel's distance from the Central Business District. Figure 1 illustrates graphically the premise of the negative exponential function with regard to land sales price. This figure shows the theory behind the negative exponential function in that urban influence declines nonlinearly as the distance of the parcel location increases from the Central Business District.

The hybrid hedonic land price model assumes that the price of land is determined by the summation of the product of the price and quantity of the characteristics of the parcel and the distance the acreage is from metropolitan statistical areas (MSA) in Kansas. Although Kansas is a relatively agricultural state, it is composed of two larger metropolitan areas (Kansas City and Wichita). Urban forces may be stronger in states with more agricultural acres because there are virtually no expansion limitations such as geographic barriers. Thus, it is especially important to include developmental pressures in estimating market value of agricultural land.

A double log functional form was chosen for the model because it is a first order Taylor series approximation to an arbitrary function that is commonly used in the literature and is easily interpreted. Nivens et al. found using Box-Cox estimation that the log form was appropriate for the dependent variable and more likely for the independent variables than the linear form.

The double-log empirical specification of the hedonic model used in this research is:

$$
\begin{aligned}
LSPA = {} & \beta_0 + \beta_1 * Lacres + \beta_2 * Lrain + \beta_3 * PctIrr + \beta_4 * PctImppast + \\
& \beta_5 * PctGrass + \beta_6 * Lprod + \beta_7 * Rolling + \beta_8 * PubUtil + \\
& \beta_9 * NoUtil + \beta_{10} * PavedRoad + \beta_{11} * DirtRoad + \beta_{12} * NoRoad + \\
& \beta_{13} * D1996 + \beta_{14} * D1997 + \beta_{15} * D1998 + \beta_{16} * D1999 + \\
& \beta_{17} * D2000 + \beta_{18} * D2001 + \beta_{19} * D2002 + \\
& \beta_{20} * D2003 + \exp(\beta_{21} - \beta_{22} * KSCity) + \\
& \exp(\beta_{23} - \beta_{24} * Wichita) + \exp(\beta_{25} - \beta_{26} * minGreater10000).
\end{aligned}
\tag{5}
$$

LSPA is the estimate of the logged sale price, or market value, per acre. *Lacres* is the logged total number of acres in the sales transaction. Prior research (Featherstone et al., Roka and Palmquist, and Xu, Mittelhammer, and Barkley) has shown that the expected sign on this coefficient is negative.

The percent of irrigated acreage is designated as *PctIrr*; *PctImppast* is the percent of improved pasture; and *PctGrass* is the percent of native pasture or rangeland. These estimates are relative to non-irrigated acreage, which is the default. Acreage with irrigation should generate more income, so should bring a higher price than dryland. However, both types of pasture should be worth less per acre than the non-irrigated default. Improved pasture should be worth less relative to dryland, but worth more relative to rangeland.

Lprod is the logged value of the weighted average productivity index.[41] Tsoodle, Golden, and Featherstone (2006) show that per acre sale price increases as the productivity of the acreage increases. *Rolling* is the percent of the acres sold for which the topography was not level; the coefficient is interpreted relative to level land so should be negative representing that rolling land is generally less productive than level land.

PubUtil is a binary variable representing the presence of public utilities on the property; *NoUtil* indicates no utilities are present, and private utilities are the default. One would expect that private utilities would be valued more than public or no utilities, so the anticipated signs on those variable coefficients are negative.

PavedRoad is a binary variable for access from a paved road; *DirtRoad* indicates dirt road access; *NoRoad* indicates there is no road access; and semi-improved (gravel) roads are the default. Paved roads should bring a premium relative to gravel roads. Dirt roads and no road access should discount the per acre sale price of land.

The *DYear* variables are binary variables representing the year of the sale and are included to capture the annual trend in land sales price. *DYear* is equal to 1 for the year in which the acreage sold; for example, if the sales year was 1996 then *D1996* was equal to 1 and zero for all other

[41] County average rainfall was not included in the model because productivity and rainfall are highly correlated.

years 1997 through 2004. The coefficients for the year binaries are interpreted relative to 2004 sales, so these coefficients are expected to be negative.

Components included in the exponential portion of the model explain urban influences on land price. The β_{21} parameter is the intercept term for the distance in miles to Kansas City (*KSCity*), and β_{22} is the rate of change in *LSPA* per additional mile of distance from *KSCity*. The β_{23} parameter is the intercept term for the distance in miles to Wichita (*Wichita*), and β_{24} is the rate of change in *LSPA* per additional mile of distance from *Wichita*. The β_{25} parameter is the intercept term for the minimum distance in miles between each parcel and any community with a population of more than 10,000 people. The β_{26} parameter estimate represents the rate of change in *LSPA* per additional mile of distance from communities with a population of over 10,000. The intercept terms represent the difference between the sale price and the use-value when distance is zero, or the parcel is located in the Central Business District. The intercept represents the largest difference between use-value and market value of the acreage sold. The distance variables are calculated using GIS data that measures the distance between a parcel and the two primary metropolitan areas in Kansas and the minimum distance between a parcel and a *greater than 10,000* community.

Interpretation of parameter estimates in this model, in most cases, is relatively straight forward. The parameter estimates for the logged independent variables can be interpreted directly as elasticities. Those variables that are in percentage form can also be interpreted as elasticities. For the case of binary variables, the elasticity of the binary variable equals the exponential of the variable's parameter estimate minus one (Halvorsen and Palmquist).

Data

The Property Valuation Division (PVD) of the Kansas Department of Revenue (KDOR) is the main source of data. The sales data consist of actual arms-length, open market agricultural land sales in Kansas between 1996 and 2004 and has over 23,000 complete observations. It contains the sales price and consists of all agricultural parcels in Kansas sold in the specified years. The sales data contain information on parcel identification number, county number, sales class, certificate of value, month, year, sale type, sales price, sales validity code, agriculture use type, soil mapping unit, agriculture size, acres, building value, topographical codes, utility codes, and access codes. Definitions and descriptions of these codes are contained in KSCAMA Residential/Agricultural Data Collection Course 1-104-2 (KDOR).

Agricultural use type, soil mapping units, and *agricultural size* are variables that together describe a sub-unit of the parcel. Soil mapping units define a particular soil type. The agricultural size data define the acreage associated with the soil mapping unit, while the agricultural use type provides information on how the sub-parcel is used. In these data, land is classified as non-irrigated and irrigated crop acreage, improved pasture acreage, and/or rangeland acreage. When aggregated, these sub-parcel components define each parcel's characteristics. These characteristics were used to create the acreage and productivity variables, *Acres* and *Lprod*, respectively. *Acres* is the calculated sum of all sub-parcel agricultural size components as discussed above.

The construction of *Lprod* is more complicated. In 2001, the Natural Resource Conservation Service (NRCS) developed the General Crop Productivity Index, known as the KS_SRPG in Kansas, as the land classification system that is incorporated into PVD's agricultural valuations. The NRCS developed the first version of the KS_SRPG model in 1992. This model arrays soil mapping units relative to their potential to produce crop growth assuming average management.[42] In 2001, Powers, Ransom, and Vanderlip modified the KS_SRPG for irrigated cropland. The resulting Kansas Irrigated Productivity Index (KIPI) arrays soil mapping units relative to their potential to produce crop growth under full irrigation. Both the KS_SRPG and KIPI models account for six groupings of soil properties including surface characteristics, water features, soil chemistry, soil climatic factors, physical profile, and landscape features. The Rangeland and Improved Pasture Productivity Index (RIPPI) was developed at Kansas State University and encompasses both rangeland and improved pasture (KDOR). The scale for rangeland is from 0 to 1, and the scale for improved pasture is from 0 to 3.[43] Productivity indices were created using the KS_SRPG, KIPI, and RIPPI indices and the parcel specific soil mapping units.

Topographical codes describe whether the parcel is *level* or *rolling*. The rolling binary variable is one if more than 50% of the acreage in the sale is defined as rolling by the county appraiser and zero otherwise. Utility codes provide information on the source (*public* or *private*) of utilities. Access codes define the type of road access to the parcel (*paved*, *semi-improved*, *dirt*, or *no road*).

The distances between a parcel and the Central Business District of Kansas City, Wichita, and communities with more than 10,000 people are calculated. A 21 character identifier for each parcel (PID) is available for each parcel used. Embedded within the PID are fields which specify the county, township, and section for the parcel. While the township identifier is different than the township and range identifier used in the Public Land Survey System, the physical boundaries are the same. As such, the PID contains all information normally present in a parcel's legal description, allowing GIS data to be matched to each parcel sold.

Sales and GIS data are combined to estimate the distance variable, necessary to use the exponential function. The LEO System, designed by the Kansas Geological Society, converts location reference, legal description of a parcel, to a parcel's center point location in geographic (longitude, latitude) coordinates (KGCC). The Geographic Information Systems (GIS) data for all Kansas cities came from the USGS Geographic Names Information System (GNIS). Using Cartesian coordinate geometry, the geodesic distance between a parcel and all Kansas cities is calculated. When talking about distance on the earth, "geodetic distance" and "geodesic distance" are the same things: the shortest path along the ellipsoid of the earth at sea level between one point and another. To calculate distance, latitude and longitude are converted from decimal degrees to radian degrees using the following formulas:

(6) $$long\_rad_i = long_i\_dec * (\pi / 180)$$

[42] Based on soil type and topographical characteristics

[43] For a more in-depth discussion of the indices see Kansas Department of Revenue (KDOR) Web site at http://ksrevenue.org/pvdaguse.htm.

(7) $$lat\_rad_i = lat_i\_dec * (\pi / 180).$$

The formulas used to calculate the distance are shown below:

(8) $$\begin{aligned} AA \; = \; & \sin(lat\_rad_i) * \sin(lat\_rad_{i+1}) \; + \\ & \cos(lat\_rad_i) * \cos(lat\_rad_{i+1}) * \\ & \cos(long\_rad_i \; - \; long\_rad_{i+1}) \end{aligned}$$

(9) $$CC = arc\cos(AA)$$

(10) $$distance = earthradius * CC$$

where *AA* is an intermediate calculation to use the "great circle" formula for calculating geodetic distances using latitude and longitude in radians. Lat_Rad_i ($Long\_Rad_i$) and Lat_Rad_{i+1} ($Long\_Rad_{i+1}$) are the latitudinal (longitudinal) location in radians of each parcel and each city, respectively. *CC* is the arc cosine of *AA*; and *distance* is the geodetic distance in miles between each parcel and each city.[44] *Earthradius* is the Earth's mean radius of 3,959 miles (Wikipedia).[45] This would be the radius of a hypothetical perfect sphere that had the same surface area as the Earth.

Summary statistics for the explanatory variables are listed in table 1. The average sales price per acre of land in nominal dollars was $2,873/acre, with a range of $20 to $989,461 per acre.[46] Parcels that sold ranged from 0.03 to 1,994 acres, with the mean of 162. The average productivity was 1.03, indicating that the average parcel sold had soil that was slightly above the average quality of the entire state. During the period, 55% of the acres sold were nonirrigated cropland and for irrigated, improved pasture, rangeland, 4%, 7%, and 34%, respectively. Most of the acreage sold, 61%, was considered level terrain; the remaining 39% was considered rolling terrain. The percentages of sales with private, public, and no utilities were 9%, 10%, and 81%, respectively. The percent of land sold with paved road access was 17%, but 53% of land sold had some kind of improved access other than pavement. About one-fourth of the sale acreage had dirt road access, and 5% of land sold with no road access.

Sales occurred in all years with a similar number of observations in each year, except 2004 when fewer sales occurred. Most years had between 11% and 13% of the total sales, but 2004 only had 5% of all of the sales observations. The small number of 2004 observations is due to a conflict in the data collection and the timing of county reports; therefore, not all 2004 sales were included in the data. The distance to Kansas City ranged from 12.8 miles to 425.8 miles, with a mean of 194.5 miles. The average distance to Wichita was 120.5 miles, and distances ranged from 3.0 to 295.9 miles. The distance to cities with a population of over 10,000 ranged from 0.65 miles to 151.1 miles, with a mean of 32.7 miles.

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[44] The source for the "great circle" distance is http://www.ac6v.com/greatcircle.htm denoted as GCD in references.

[45] The mean radius is derived by averaging the center-to-surface distances on all points on the globe. For the formula used to calculate the radius, see http://en.wikipedia.org/wiki/Earth_radius (Wikipedia).

[46] The maximum is based on conversations with developers that stated that four homes priced at about $500,000, could be built on one acre leaving a net profit of about $300,000

Results

Heteroskedasticity was tested for and was statistically significant in the model. However, using out of sample testing, the unadjusted model had better predictive ability than models that corrected for heteroskedasticity. The out of sample testing was done by randomly partitioning the data into thirds and estimating the model on two-thirds, predicting for the other one-third, and testing the RMSE of the residuals. The procedure was done three times and each time the out-of-sample OLS RMSE was lower than that of the model correcting for heteroskedasticity. Table 2 lists the parameter estimates and the explanatory power of the model assuming a homoskedastic error. The R-squared was 57%, and the RMSE was about 0.7180. Table 3 lists the percent change calculated for the binary variables.

Most of the variables were significant at the 1% level, except percent improved pasture, public utilities, no utilities, and dirt road access (table 2). Improved pasture percentage was significant at the 5% level, and dirt road access was significant at the 10% level. Public utilities and no utilities were not statistically significant at any generally accepted level. With the exception of no road access, all the variables had the expected signs.

Increasing total acres (*Lacres*) by 1% decreased sale price per acre by almost 46%. In comparison, Featherstone et al. and Nivens et al. found statistically significant acreage discounts around 19% and 20% in Kansas, respectively. Perry and Robison in Oregon found only a 9% discount for increasing acreage. The difference in these estimates may have to do with the inclusion of very small acreage sales. Because the research focuses on urban influences rather than purely agricultural sales, small acreages are included. However, including these sales may reflect developer purchasing tendencies as opposed to agricultural producer purchasing preferences.

Increasing land productivity increased per acre sale price by almost 9%. The productivity coefficient is somewhat lower than that of Nivens, et al., 17%.

Large economic impacts came from changes in the composition of the sales acreage. Relative to nonirrigated sales, increasing irrigated acreage raised the per acre price by almost 81%. Increasing the percent of improved pasture or rangeland lowered the sale price by almost 6% and 19%, respectively. The presence of irrigation resulted in a 48% premium in Featherstone et al., so this research found a higher premium for irrigation. This difference may reflect the fact that this research does not include some of the variables that were included in other studies that had more specific data. For example, the sales of irrigated land in these data do not include information about whether the irrigation equipment was included in the sale price.

Elasticities for binary variables are shown in table 3. Rolling land was discounted almost 5% per acre in sale price (table 3). This discount was anticipated in that rolling land is less productive than level land. The coefficients of *paved road* and *no road* were significantly different from zero at the 1% confidence level, while the coefficients for public utilities, no utilities, and dirt road were not statistically significant. The presence of *paved road access* and *no road access* increased the per acre sale price. The premium for no road may seem counterintuitive, but may occur because this coefficient is picking up some geographic influences. Over 90% of the sales with no road access occurred in eastern Kansas where the average sales price is higher than the rest of the state.

All binaries decreased sale price per acre, except the road access variables, which increased sale price (table 3). *Rolling*, *public utilities*, and *no utilities* were around -5%, -1%, and -1%, respectively, indicating a small economic impact of these variables on land sale price per acre. The small impact is reinforced by the fact that two of the three were not statistically different from zero. The premium on paved road access (10%) was slightly higher than the 9% found by Featherstone et al. *Dirt road* access increased sale price minimally at 2%. *No road* access increased per acre price by almost 17%, reflecting the fact that the estimated coefficient for this variable is strongly influenced by lack of regional dispersion of these sales.

The coefficient on the year dummy variables was used to reflect changes over time in the entire land market. All years were significantly different from zero at the 1% level (table 2). The negative sign indicated that the nominal value of land has been increasing over time, since each year is relative to 2004. In addition, one would expect these coefficients to increase in absolute value as the time between the sale and 2004 increased. This trend holds except between 2001-2002 and 1998-1999 (table 2). Between 2001 and 2002, the discount relative to 2004 was larger for 2002 than for sales in 2001. The discount for 1998 and 1999 were virtually the same.

With the exception of the *minGtr10000 intercept*, the coefficients estimated in the negative exponential portion of the model in equation (5) are statistically significant at the 1% confidence level (table 2).[47] The coefficient on the Kansas City intercept was 0.36, implying that the difference between per acre market and use value of a parcel within the Kansas City Central Business District was 36%. The rate of decay, or rate at which market value moves to use value, was about 2% per mile. Similarly, the coefficient on the Wichita intercept was 1.01, implying that per acre market value of a parcel within the Wichita Central Business District was 101% of use value. The decrease in value for Wichita was about 8% per mile. In essence, the difference between market value and use value for parcels in Wichita starts higher than those located in Kansas City, but the difference declines much faster per mile as one moves away from Wichita. The difference between market and use would dissipate for Wichita in one-fourth of the distance that it would take for the difference to disappear for parcels near Kansas City. These results differ from those of Anderson and Griffing, who found rates of decay of about 10% for the two contiguous counties in Nebraska that they examined.

The coefficient on the Greater 10,000 intercept was significant at the 5% level. It was much lower than either Kansas City or Wichita, implying that the difference between market and use value is much smaller for more rural areas. The decay rate for cities with more than 10,000 residents was much higher than either that of Kansas City or Wichita. Using the minimum distance for this type of city resulted in a change of almost 28% per mile, or about fourteen times faster than Kansas City and about three and one-half times faster than Wichita.

Figure 2 graphically displays the changes for Kansas City, Wichita, and the Greater10000 cities. All series are calculated at the mean of all variables, except distance, which varies to illustrate the difference in the rates of decay. This graph illustrates the difference in decay rates for the

[47] Taken together, each intercept with the corresponding decay rate can be interpreted as elasticities.

three distance measures. The premium over use value for parcels within the Wichita Central Business District is slightly higher than for parcels located in the Kansas City Central Business District, likely due to the lower agricultural use value in the Wichita region. However, the difference between market and use value remains much larger for a much longer distance for parcels around Kansas City. For cities of 10,000, market and use value converge by about 24 miles. For Kansas City and Wichita, market and non-urban use converge by 195 and 65 miles, respectively. This may be due to the differing growth patterns around Kansas City and Wichita, illustrating there is more upward pressure on sales price from the Kansas City area.

Summary and Conclusions

The negative exponential specification, which is frequently used in the literature for modeling land prices in urban fringe areas, was included in the model. All of the estimated coefficients on the distance variables were statistically significant. However, the rate at which market value and use value converged was very different for all three areas. This result contrasts with those of Anderson and Griffing for two contiguous urban counties in Nebraska.

This research used a dataset obtained from the Property Valuation Division (PVD) of the Kansas Department of Revenue that contained all arms-length agricultural land sales (over 23,000) that occurred between January 1996 and December 2004.

Each sale contained information on the site specific characteristics of the acreage sold and the location of the parcel sold. The location information was used to calculate the distance of the acreage from Kansas City and Wichita and to calculate the minimum distance of the acreage from a city with a population greater than 10,000. These distances were incorporated using a negative exponential component in the model to capture urban fringe effects on sale price, or market value.

The objective of this research was to quantify the impacts of site-specific characteristics and urban pressures on agricultural land market value in Kansas. To address the objective of this research, a theoretically based model was developed to estimate market value of agricultural land in Kansas. Primarily a robust model that accurately captured the true market value of the heterogeneous nature of the characteristics of agricultural land was used. A semi-log hedonic model that combined site specific characteristics with negative exponential distance functions was estimated. The distance measures included were calculated as the distance of the land sold to both Kansas City and Wichita, Kansas and the distance between each parcel sold and all cities in Kansas with a population of over 10,000.

Parcels within the Wichita Central Business District received a slightly higher premium over use value, relative to those in the Kansas City area. However, the difference between market value (sale price) and use value remained much larger for a much longer distance to Kansas City, relative to distance to Wichita. In essence, the upward, urban pressure on price is greater for Kansas City. The distance to cities with a population over 10,000 was also statistically significant. This implies that the difference between use value and market value in rural areas is virtually zero. Enforcing this idea is the high rate of decay for these areas; it was fourteen times faster than that of Kansas City. These results imply that state property tax policy may differently affect land owners involved in sales in different areas. In Kansas, agricultural land is taxed based on its use value rather than its market value. Therefore, land owners who own land outside Kansas City may be receiving a larger tax benefit than those who own land outside of Wichita, Kansas. This issue will be examined in future research.

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TABLE 1

Summary Statistics of Agricultural Parcels Sold in Kansas Between 1996 and 2004.

Variable Definition	Statistic			
	Mean	STD	Min	Max
Sale Price Per Acre ($/Ac)*	2,873.46	20,326.22	20.20	989,461.21
Total Acres	161.95	182.90	0.03	1,994.20
Productivity Index	1.03	0.22	0.01	1.68
Percent Of Non-Irrigated Acres	0.55	0.42	0.00	1.00
Percent Of Irrigated Acres	0.04	0.18	0.00	1.00
Percent Of Tame Pasture Acres	0.07	0.21	0.00	1.00
Percent Of Native Pasture Acres	0.34	0.39	0.00	1.00
Property Has Level Terrain	0.61	0.49	0.00	1.00
Property Has Rolling Terrain	0.39	0.49	0.00	1.00
Property Has Private Utilities	0.09	0.29	0.00	1.00
Property Has Public Utilities	0.10	0.30	0.00	1.00
Property Has No Utilities	0.81	0.39	0.00	1.00
Access By Paved Roads	0.17	0.37	0.00	1.00
Access By Semi Improved Roads	0.53	0.50	0.00	1.00
Access By Dirt Roads	0.25	0.43	0.00	1.00
No Road Access	0.05	0.23	0.00	1.00
Sale Year 1996	0.11	0.31	0.00	1.00
Sale Year 1997	0.12	0.33	0.00	1.00
Sale Year 1998	0.12	0.32	0.00	1.00
Sale Year 1999	0.11	0.32	0.00	1.00
Sale Year 2000	0.12	0.33	0.00	1.00
Sale Year 2001	0.12	0.33	0.00	1.00
Sale Year 2002	0.13	0.34	0.00	1.00
Sale Year 2003	0.12	0.32	0.00	1.00
Sale Year 2004	0.05	0.21	0.00	1.00
Distance of Sale from Kansas City, Kansas	194.53	96.78	12.84	425.77
Distance of Sale from Wichita, Kansas	120.51	62.96	3.02	295.89
Distance of Sale from Towns with Population Greater than 10,000	32.69	24.97	0.65	151.06

23,436 Observations

*Dollar values are in nominal dollars

TABLE 2

Combined Hedonic and Negative Exponential Model Results

Variable	Parameters	Std. Dev.
Hedonic		
Intercept	8.6692***	0.0362
Lacres	-0.4571***	0.0043
Lprod	0.0896***	0.0129
Pct_Irr	0.8067***	0.0281
Pct_Imppast	-0.0578**	0.0253
Pct_Grass	-0.1878***	0.0130
Rolling	-0.0465***	0.0099
Pub_Util	-0.0097	0.0224
No_Util	-0.0056	0.0165
Paved_Road	0.0911***	0.0134
Dirt_Road	0.0227*	0.0119
No_Road	0.1540***	0.0215
D1996	-0.4204***	0.0263
D1997	-0.3682***	0.0258
D1998	-0.2552***	0.0260
D1999	-0.2521***	0.0261
D2000	-0.2050***	0.0259
D2001	-0.1383***	0.0258
D2002	-0.1474***	0.0255
D2003	-0.0705***	0.0260
Negative Exponential		
Kansas City_Intercept	0.3579***	0.0423
Kansas City	0.0152***	0.0008
Wichita_Intercept	1.0146***	0.0432
Wichita	0.0816***	0.0033
Gtr 10000_intercept	0.1614**	0.0800
Gtr 10000	0.2815***	0.0226
R-Square	0.5658	
RMSE	0.7180	

Standard errors are in parentheses. *, **, *** indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

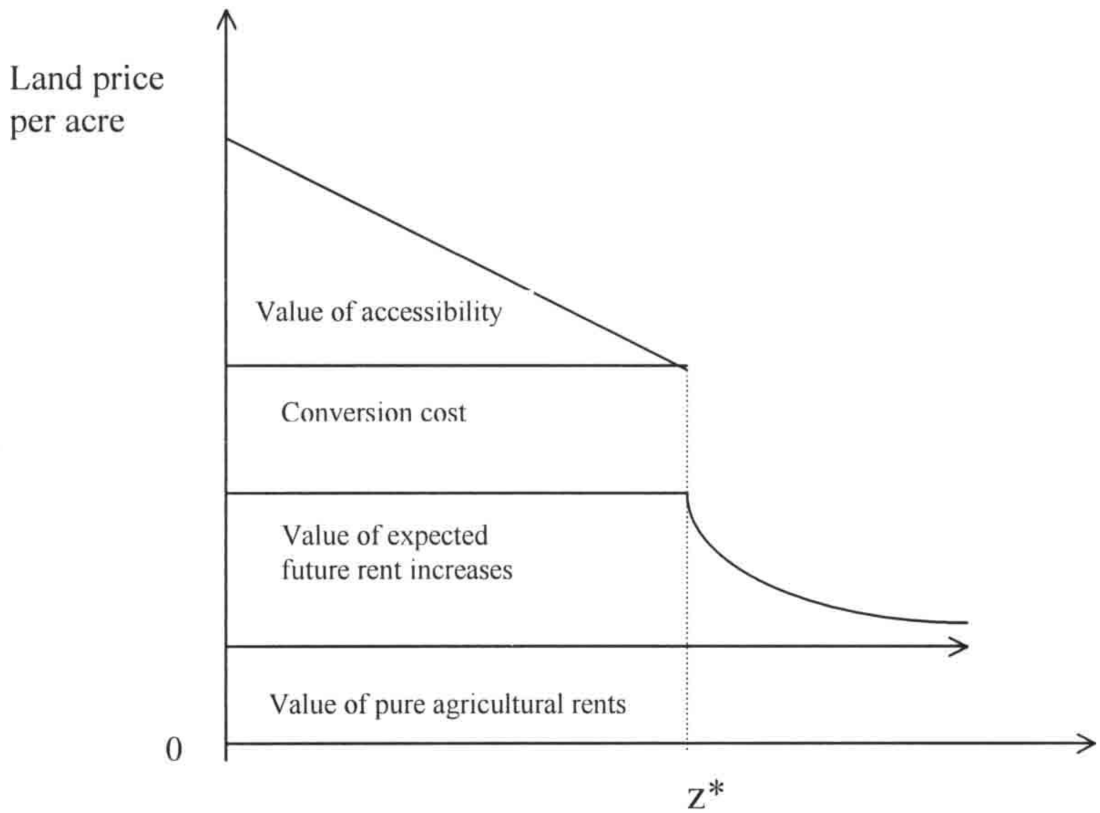
TABLE 3

Binary Effects

Variable	Coefficient	Percent Change
Rolling	-0.0465	-0.0454
Pub_util	-0.0097	-0.0097
No_util	-0.0056	-0.0055
Paved_road	0.0911	0.0954
Dirt_road	0.0227	0.0230
No_road	0.1540	0.1665
D1996	-0.4204	-0.3432
D1997	-0.3682	-0.3080
D1998	-0.2552	-0.2252
D1999	-0.2521	-0.2228
D2000	-0.2050	-0.1854
D2001	-0.1383	-0.1292
D2002	-0.1474	-0.1371
D2003	-0.0705	-0.0681

FIGURE 1

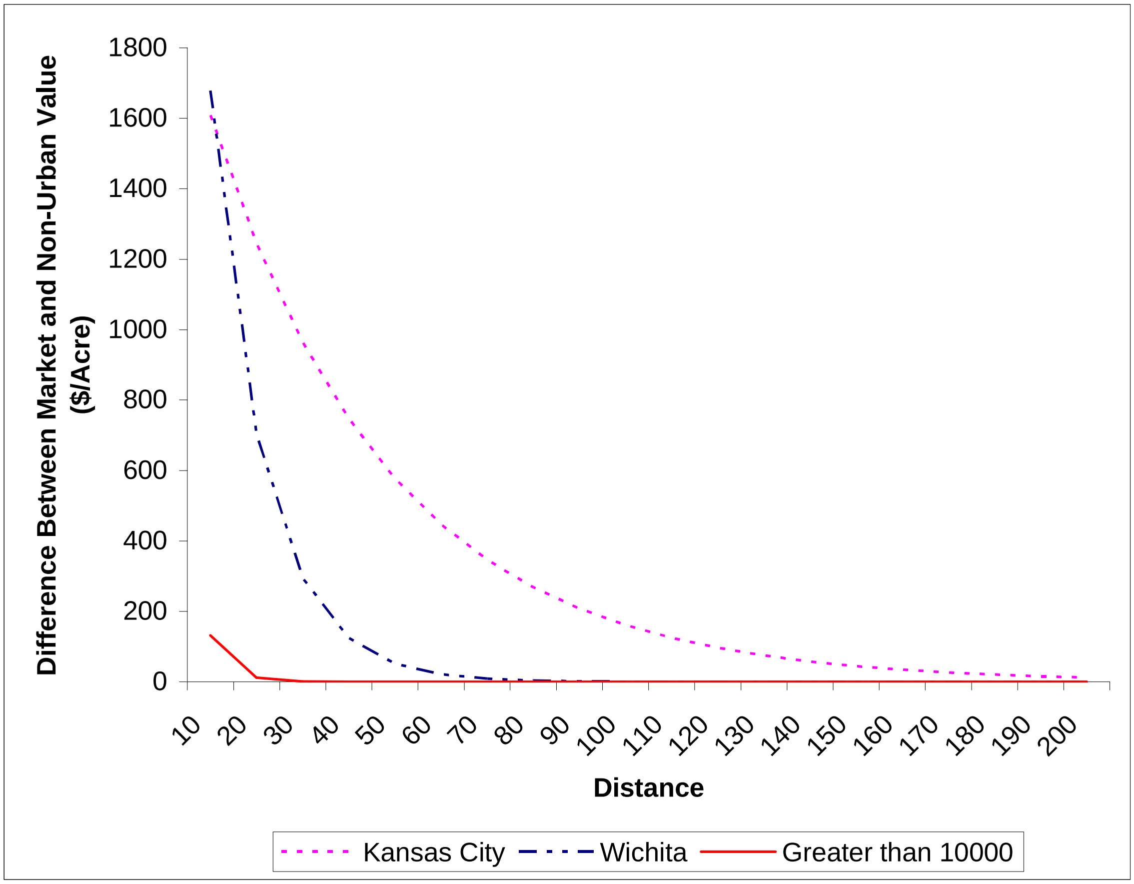
Analysis of Components of Per Acre Land Price*



* Source: Anderson (2002). Z* is the distance of a parcel from the CBD.

FIGURE 2

Difference Between Market and Non-Urban Value



Entrepreneurship and the Neo-Classical Model of Economics: A Reality Check from Eight Case Studies of NJ Food Industry Startups

by
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