FACTORS IMPACTING KANSAS AGRICULTURAL LAND VALUES: 1986 - 2009

by

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B.B., Western Illinois University, 2008

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2013

Approved by:

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Abstract

Land accounts for more than 75% of a farm operation's total assets and thus knowledge of land values are very important to landowners. However, many other parties, including lenders, appraisers, investors, and researchers also have significant interest in land markets. Over the past few decades, land prices in Kansas have increased significantly for many different reasons. The main objective of this research is to estimate the impact of various factors on Kansas land values using a hedonic regression model.

In cooperation with the Property Valuation Department (PVD) of the Kansas Department of Revenue, farmland market transactions from 1986 to 2009 were obtained for this study. Hedonic models were estimated using Ordinary Least Squares to determine the impact of interest rates, urban areas, location, parcel size, and income on nominal and real Kansas land values.

The estimated nominal and real models explained 24.1% and 17.2% of the variation in land prices, respectively, and the results from this study are generally consistent with previous research. This research went further into investigating the relationship between PVD data and United States Department of Agriculture (USDA) surveyed data. Results from this study indicate that USDA surveys significantly underestimate the true market for land prices across Kansas.

Table of Contents

List of Figures

List of Tables

Acknowledgements

I would first like to thank my major professor, Dr. Kevin Dhuyvetter, for giving me the opportunity to finish my thesis. Without his patience, support, and willingness to see me finish the program, none of this would be possible. I will forever be indebted to him. I would also like to thank my committee members, Dr. Bryan Schurle and Dr. Allen Featherstone, for their assistance and support during my time at K-State.

Words cannot begin to describe how important my family was during this process. To my parents, thank for all the words of encouragement and financial support. To my brother, thank you for always being there for me even during the darkest hours of graduate school. You were the reason I went to K-State, and you were the reason I finished at K-State.

Finally, I would like to thank Smithfield Foods, Inc. and my boss, Dr. Dhamu Thamodaran, for allowing me the time and for challenging me to finish this program.

Chapter 1 - Introduction

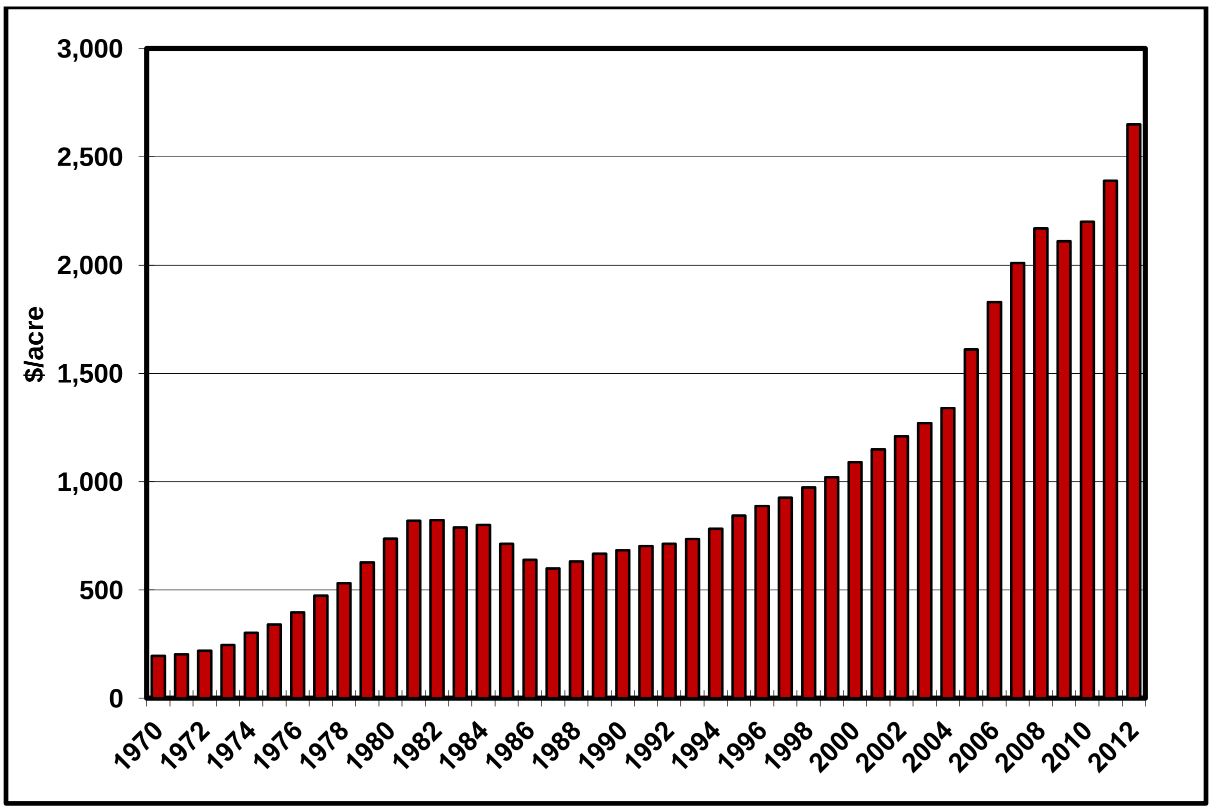
It is estimated that 84 percent of farm assets are comprised of real estate (Nickerson et al., 2012). Thus it is clear that land values have a significant impact on agricultural producers' balance sheets. Additionally, these values are also important to the banks that lend producers capital, as well as appraisers who are trying to properly estimate the market value of land. Landowners who own land as an investment, as opposed to farming or ranching themselves, find land values of interest to get an idea of what land market conditions are like. Other potential buyers or sellers in the market need to know land values to get an idea of current market conditions to help properly price land they are interested in buying or selling. Finally, economists and analysts have much interest in land values to get a sense for the overall health of the agricultural sector.

Since 1972, the National Agricultural Statistics Service (NASS) in cooperation with Kansas Agricultural Statistics (KAS) have been reporting land and cash rent values for the nine Crop Reporting Districts (CRD) in Kansas. Both land values and cash rents have been reported for non-irrigated crop land, irrigated crop land, and pasture land. The reported values are based on a survey sent to individuals who own land in the state of Kansas. The survey asks the landowners for their estimate of the market value of the land he or she owns or rents. However, due to the variability of terrain in each CRD, even if an individual survey respondent knows the true market value of his or her land, these values when aggregated may not properly estimate the value for the average tract of land in the region. That is, if the people surveyed are not a true representation for the CRD, then the reported values will not be accurate. A potentially larger concern is that the participants in the USDA survey may not follow land markets closely enough to provide correct values. That is, when landowners are asked to report the market value of their land, they may not be aware of the current land market for the area, thus providing inaccurate results. This discretion between NASS reported values and actual values of agricultural land will be one of the areas of focus for this thesis research.

1.1 Background

Over the past four decades, agricultural land prices have seen dramatic price fluctuations as seen in Figure 1.1.

Figure 1.1 Average Value per Acre of U.S. Farmland (1970-2012)



Source: USDA – NASS, August 2012

The early 1980's saw record prices followed by a dramatic decline during the "Savings and Loan Crisis" just a few years later. Since then, agricultural land prices have seen relatively steady growth, until recently. Beginning around 2005, land prices began increasing substantially on an annual basis. The exact driving force behind the recent run-up is due to a number of different factors. A number of people have suggested that one source of the strong demand is related to individuals buying tracts of land for alternative investment purposes. Yet others attribute the more recent increase in land values to be related to the increase in grain prices associated with increased demand from biofuels and export markets. Whatever the case may be, this issue is significantly important to agricultural producers, financial agencies, and others needing relevant information about land prices.

Many other sectors in the economy, such as residential and business development, are affected by the various changes in land prices. Taking land out of production and selling to developers is one issue many farmers are facing that farm near a large town or city. This is often referred to as "urban sprawl". Urban sprawl tends to increase prices of land around larger towns and cities to the point where farmers are no longer able to economically justify buying this land for continued production. Thus, land is bought by developers and an increased number of subdivisions and businesses are being built on what was once agricultural land. Studies focusing on "urban sprawl" (e.g., Brueckner, 2000; Burchell, 1997; Holcombe, 1999) are shedding light on the potential costs and benefits a community can receive when farmland is converted for commercial use.

Studies on real estate prices have become increasingly popular since the 1980's when prices fluctuated greatly. One popular method of analyzing land prices, the discounted net present value of net incomes, uses discounted expected future incomes, interest rates, and other factors to determine a value for the piece of land. Hedonic modeling is also used frequently to assign values to different attributes of the land (soil type, road access, proximity to urban areas, and other characteristics). Using this methodology, an individual can estimate how much of a premium or discount an attribute will bring to a particular tract of land. The method used for this study is the hedonic model, which estimated values for the different variables (land characteristics) used in this research. More discussion on other studies and methodologies will follow in subsequent chapters.

It is important to note that "price" and "value" have different definitions when land markets are discussed. Price refers to the monetary amount paid for the land while value can be defined as what the piece of land appraised for or what its economic worth is in the absence of an observed market price. However, for the remainder of this study, these terms are used interchangeably with the same meaning.

1.2 Objectives

The main objective of this research is to provide a better understanding of the factors impacting market land values and also to examine the relationship between KAS published land values and actual market transaction values. Specifically, this study will:

- Estimate the impacts that specific attributes (urban sprawl, land type, etc.) have on the price of land.
- Investigate the relationship between KAS surveyed agricultural land values and observed market transactions.

1.3 Thesis Organization

This thesis research is organized into six chapters. Chapter 2 will provide a brief summary of previous studies that have examined land values. This chapter will lay a foundation of research that has been done as well as studies that used similar methodology as this study.

Chapter 3 will present the theoretical and empirical models for this research. Additionally, the framework behind the estimated models and the variables used in those models will be presented. Chapter 4 will discuss the sources of the data used. In cooperation with the Property Valuation Department of the Kansas Department of Revenue, data were obtained on market transactions from 1986 to 2009. Other data used in this study will be discussed as well. Chapter 5 will present the results from the empirical models estimated. Estimated values for specific attributes will be presented and discussed here as well. Additionally, the analysis of PVD transaction data and NASS surveyed data will be presented. Finally, Chapter 6 will summarize the models and results used in this research as well as discuss potential limitations of the study. This section will also address the implications of the results found in the study as well as discuss other potential research that could be done.

Chapter 2 - Literature Review

This chapter will discuss previous studies that have been conducted on land valuation techniques. Like this research, many of the same methods and data have been used by other researchers in the past. The three most-widely used models in past research include time-series, structural, and hedonic. This research will utilize the hedonic model to quantify specific attributes that contribute to the value of land. Previous studies referenced for this research can be grouped into two categories. The first category of studies incorporates income from land as the major factor that leads to the value of land. The second category examines the impact of specific attributes, such as parcel size, land type, proximity to urban areas, among others, as a determinant for land price. The research in this thesis will include both income as well as parcel-specific attributes to explain Kansas land values.

2.1 Studies Related to Income

The first category of land valuation studies examines the relationship of some type of income as the primary characteristic in determining land values. Castle and Hoch (1982) believed that farm real estate price involved an additional component to the capitalized rent value of the land. They were able to show that capitalized rent only explained approximately half of the variation of land values in the 1970s and over a longer period from 1920 to 1978.

The premise behind this study was that an ordinary investor will buy, sell, or at least not buy land based on what the investor thinks next year's price will be. If next year's price is greater than this year's price, the investor would buy the land. If next year's price is expected to be less than this year's price, the investor would not buy the land. The expected price of land is assumed to be comprised of two different components; the earnings component (i.e., rent), and the capital gains component (i.e., land appreciation). The study finds that agricultural real estate prices cannot be explained simply by the income generated from agricultural production. Values are thought to include the capitalized value of future income generated by rent plus capital gains not associated with agricultural production.

Klinefelter (1973) estimated Illinois farmland values from 1951 to 1970 using least-squares regression. His proposed model stated price was a function of various attributes or $V = f(P, NR, E, A, C, T, GP)$ where P is the implicit price deflator of Gross National Product, NR is the three-year moving average of net farm rents for the previous three years, E is the expected future capital gains, A is the average farm size, C is the three-year moving average of corn yields, T is the number of voluntary transfers, and GP is the total amount of government payments received per acre. The estimated models were able to explain much of the variation in land prices. However, due to collinearity issues, several variables had to be dropped from the final estimated model. Like the Klinefelter study, this thesis also had collinearity issues when dealing with certain income variables.

2.2 Studies Related to Hedonic Models

The other common method when evaluating land prices is the use of hedonic regression. Hedonic regression has been around since the 1920s when Hass (1922) and Wallace (1926) quantified the impacts buildings, land types and productivity, and distance to market had on land prices.

More recently, Rosen (1974) brought forth a model for product differentiation based on the hedonic hypothesis. Rosen states that goods are valued based on the implicit prices for each of their characteristics. The model used in this study considered a single good as described by the n characteristics where $z = (z_1, z_2, \ldots, z_n)$, with z_i measuring the ith characteristic for the good. Rosen states, "In particular, a price $p(z) = p(z_1, z_2, \ldots, z_n)$ is defined at each point on the plane and guides both consumer and producers locational choices regarding packages of characteristics bought and sold" (p. 35). He later goes on to state that consumer tastes and producer costs are determined by the market clearing prices, $p(z)$, since both consumers and producers act on maximizing behavior.

Rosen's study provided the theoretical model for this research as land is not homogenous, rather heterogeneous, as each parcel contains many characteristics. Since the hedonic price is the implicit price, or marginal cost an individual is willing to pay for each attribute, the sum of all marginal costs should equal the price of a good, in this case land.

Shonkwiler and Reynolds (1986) used a hedonic model to analyze the effects of physical and location characteristics on the sales price of land near an urban setting when alternative uses for the land are possible. Nonagricultural demand for land near urban areas was at the time, and still is, important. The model incorporated dummy variables for commercial or residential zones, percentage of cultivated land, parcel size, and distance to markets or large interstate roads to explain land values near Sarasota, Florida. Like the hedonic method used in the Shonkwiler and Reynolds study, this thesis will also attempt to capture the impact of nonagricultural demand.

A number of studies have quantified the various impacts certain land characteristics have on the price of land. Since land can differ significantly from one parcel to the next, it is important to analyze what attributes impact price. Huang et al. (2006) examined the different factors that impact the price of Illinois farmland values using a hedonic model. Specifically, they found that parcel size, swine farm density, distance to Chicago and other large cities, and ruralness negatively impacted the price of land while soil productivity, income, and population density had a positive impact.

Chicoine (1981) also used a hedonic regression model to quantify the impacts urban areas or towns have on the price of land. The data in this study included unimproved farmland sales in Will County, Illinois from 1970 – 1974. For geographic purposes, Will County encompasses the southwestern suburbs of Chicago, including Joliet. Chicoine found the greatest effect on land values in his sample was distance from Chicago. As distance increased, the price of land decreased. However, land sold that shared a border with an incorporated town often had a significant premium compared to land that did not. Access roads also increased the price of land. Another interesting result of this research was the impact of neighboring land-use characteristics. If land was adjacent to bodies of water, the negative impact found was hypothesized to likely be due to the potential for flood threat. A positive impact on price was found if neighboring lands were zoned for industrial or commercial use, likely reflecting future conversion of the farmland into some other use.

Like the studies mentioned above, this research included parcel size in the estimated models, and quantified the impact major metropolitan areas and other larger cities have on the price of land. A study by Taylor, Dhuyvetter, and Kastens (2003), used similar data as this thesis to quantify the impact major metropolitan statistical areas (MSA), among other variables, have on the price of non-irrigated crop land and pasture land values in Kansas. Taylor, Dhuyvetter, and Kastens included an Urban Location Index which assigned a value to a county which was weighted by the relative size and distance of each urban area. The results of this study show that the Urban Location index was statistically significant at the 99% confidence level and that it positively impacted the price of non-irrigated crop land and pasture lands. The study used cities larger than 500,000 people according to the 2000 Population Census. Similar to Taylor, Dhuyvetter, and Kastens, this study includes an Urban Location Index. However, this thesis will include all cities with a population of 25,000 or more in 2009 and within 160 miles of any Kansas border in the index.

Since land in Kansas has such a high degree of variability of land types, some regional variable needed to be included to explain any differences not captured by other variables. In a study by Nivens et al. (2002), satellite imagery was added to a hedonic land value model in order to account for land productivity. The base model estimated included socioeconomic, geophysical, and remotely sensed variables to explain Kansas land values. Specifically within geophysical variables, regional dummy variables (e.g., Crop Reporting Districts) were included to account for land productivity. It was found that the Northeast district received the highest price per acre of land, which was not surprising given the fact this is widely considered the most productive land in Kansas due to rainfall. Land in the western part of the state received the lowest price due to the low productivity of land resulting from the little rainfall experienced in this region.

The Nivens et al. (2002) study also included an interest rate variable; however it was not statistically significant in the base model. In an expanded model, which included remotely sensed variables, the interest rate variable was statistically significant though it did not possess the expected negative sign. The authors hypothesized that this was likely due to the small number of observations.

Another key characteristic to the price of land is the type of land. For instance, is the land zoned for commercial or residential uses? Is the land pasture, irrigated, dryland, or some combination of the three? A study by Tsoodle, Golden, and Featherstone (2006) used a double log hedonic model to explain Kansas land values. The data used in their study were the same PVD sales data utilized in this thesis, though not the same years. In their study, Tsoodle, Golden, and Featherstone analyzed the impact of land use type on sales price and found the irrigated and rangeland variables to be statistically significant. The pasture land type variable, however, was not statistically significant. The results were as expected with irrigated land receiving a premium compared to non-irrigated land.

2.3 Contributions of this Study

As previously mentioned, many studies have attempted to explain land values by quantifying the impact specific attributes have on the price of land. Much like these previous studies, this research quantified the impact that parcel-specific characteristics have on the price of land. However, one key difference in this research is that the time period utilized is longer. This study spans a period of 24 years. Also included in this study is the analysis of both a nominal value model and a real value model. That is, one estimated model uses nominal interest rates and nominal net farm income to explain nominal farmland values in Kansas. The other estimated model uses real interest rates and real net farm income values to explain real Kansas farmland values.

Another key difference in this research is the analysis of Property Valuation Department (PVD) data compared to NASS surveyed data. Limited information is available on this topic though results in this study are similar to what Taylor and Dhuyvetter (2013) reported. When analyzing land values from recent years (2010 – 2012), Taylor and Dhuyvetter found that NASS survey data substantially underestimated true market values based on PVD transaction data.

Chapter 3 - Methodology

This chapter discusses the analytical approach used to analyze historical (1986 to 2009) Kansas farmland values. The theoretical hedonic model is explained first. Finally, the empirical model used for this research is presented with an explanation of the dependent and explanatory variables.

3.1 Theoretical Hedonic Model

Due to the variation of land characteristics from parcel to parcel, the hedonic method can quantify the impact specific characteristics have on price. This method has been used many times in previous research to analyze how specific characteristics or traits impact price. Chicoine (1981) analyzed the factors that impacted farmland prices near the urban fringe. Neighborhood effects, soil productivity, and other market participant characteristics were quantified using the hedonic regression model. Each characteristic or attribute of land has a different impact on the price a buyer is willing to pay for that piece of land. For instance, one buyer may place a high value on recreational ground whereas another buyer may place a greater value on irrigated crop land. Therefore, the generic hedonic model can be presented as $P = f(c_1, c_2, c_3, c_i, \ldots mc_1, mc_2, mc_3, mc_i)$ where price (P) of a good, in this case land, is a function of the characteristics (c) of the good and the marginal costs (mc) a buyer is willing to pay for each characteristic.

3.2 Explanatory Variables

The following variables were used in this research to represent the different characteristics a parcel of land possessed. The coefficients associated with each of these explanatory variables were then estimated using Ordinary Least Squares regression and the results will be discussed in detail in Chapter 5.

Interest Rates

It is expected that interest rates (*Intrate*) will negatively impact the price per acre of land since the cost of financing to purchase the land will increase as interest rates increase. Opportunity costs also come into play as interest rates increase. A buyer may be willing to invest in other low-risk, interest-bearing vehicles such as certificates of deposits (CDs) as the returns for these investments increase as interest rates increase. Thus, rising interest rates will reduce returns associated with land ownership by increasing costs either directly (finance costs) or indirectly (opportunity costs) which will lead to buyers paying less for land, all else equal. The interest rates used in this study are fixed annual rates on new agricultural real estate loans as published by the Kansas City Federal Reserve Bank on a quarterly basis.

Size of Parcel

The size of the parcel sold (*Acre*) is expected to negatively impact price, however, it is also expected that this impact may not be a linear relationship. Therefore, the acre variable is squared (*Acresq*) to capture this expected nonlinear relationship. As cities expand, smaller acreage is needed to build the next development; therefore developers are willing to pay less per acre for larger tracts of land. Several researchers have provided further insight as to why sale size and price are negatively correlated. According to Postier (1990), larger tracts require more liquidity and equipment which limits the number of potential buyers in the marketplace. Xu, Mittelhammer and Barkley (1993) also found a negative relationship between price and parcel size to exist due to the limited number of buyers for larger tracts because of the need for greater financial resources. Chicoine (1981) states parcels that are larger than desired, add little or no utility to the buyer. The transaction costs associated with subdividing parcels could result in a declining marginal relationship indicating less will be paid for more acreage.

County Population

A county's population (*County*) is expected to positively influence the price of land for two main reasons. First, the number of potential buyers near the tract of land or local demand is greater as the county population increases. Also, increased competition for different non-agricultural uses a parcel of land may have is greater due to the number of people. The county population variable is also squared (*Countysq*) to allow the impact of county population to be nonlinear. The expected sign of the county's population squared variable is negative. That is, the effect of county population is expected to be positively related to land price, but at a diminishing rate.

Urban Location

The urban location variable (*Urban*) is a geospatial index value for each county based on the location of the county and its distance to metropolitan areas. Similar to county population, the sign on this variable is expected to be positive. While the county population variable is included to estimate the local impact, the urban location variable is trying to estimate the impact a larger city may have on land prices for reasons such as hunting or recreational use. Taylor, Dhuyvetter, and Kastens (2003) hypothesized that the presence of more bidders and alternative uses would increase the value of surrounding land values. By adding this variable into their research, they were able to quantify the impact of larger metropolitan markets on land values in Kansas.

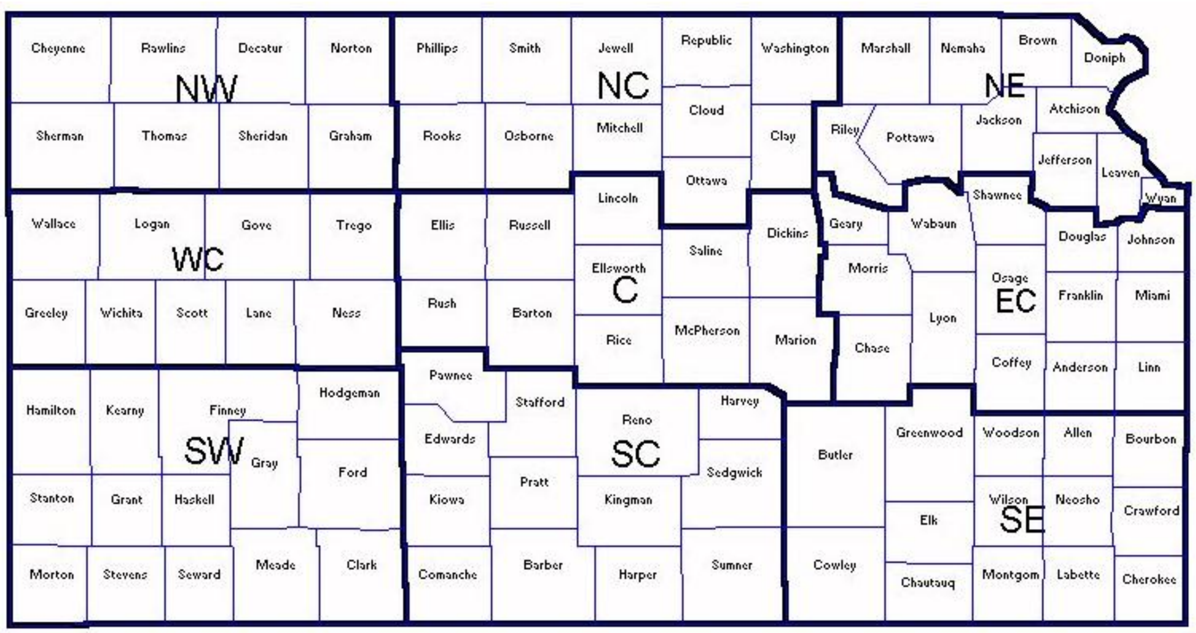
Rental Rate

The rental rate variable (*Rent*) is a weighted cash rental rate based on percent of land types. Land rental rates are published by the Kansas Agricultural Statistics Service of the USDA every year at the Crop Reporting District (CRD) level and are weighted by the percent of land type (non-irrigated, irrigated, pasture) for each parcel. This variable is expected to have a positive sign on the coefficient as previous research shows rent values are capitalized into land values (Castle and Hoch, 1982). Thus, it is expected that an individual would be willing to pay more for land as the income potential on that land (rental rate) increases. Klinefelter (1973) hypothesized when expected net returns from land increase, a higher present value should exist in that unit of land.

Crop Reporting Districts

To help clarify any regional differences not already explained by the location of counties, such as distance to market and access, each transaction was classified by the Kansas Agricultural Statistics Crop Reporting District (CRD) in which it was located, see figure 3.1. Binary variables were used to investigate the relationship among price fluctuations between each CRD where the Central District (*C*) is the base. For instance, the western most districts, Southwest (*SW*), West Central (*WC*), and Northwest (*NW*) are expected to have a lower per acre sales price as they are the furthest away from larger metropolitan areas. Also negatively impacting land in the western most districts would be the overall productivity of land relative to that of the eastern most districts. On the contrary, the eastern most districts, Southeast (*SE*), East Central (*EC*), and Northeast (*NE*) are believed to have a higher sales price per acre due to the relative overall productivity of land. The centrally located Crop Reporting Districts, South Central (*SC*), and North Central (*NC*) are expected to have coefficients that are relatively close to zero since any sales price difference is likely due to the difference in productivity. That is, land in the "*NC*" district does not vary much from the "*C*" district, therefore, the overall magnitude of the coefficient will likely show only a very small premium or discount.

Figure 3.1 Kansas Crop Reporting Districts



The Crop Reporting District variables ("*NW"*, "*WC"*…"*SE"*) used in this research are binary variables. These variables take on a value of one to specify a variable's presence in the sale or a zero if it is not present. Therefore, if a parcel is sold in the Northwest CRD "*NW*", only the variable "*NW*" would take on a value of one, while the rest of the CRD variables would be zero. As previously stated, the Central CRD variable "*C*" will be dropped to estimate the regional differences among the CRD. Thus the interpretation of all other CRD binary variables will be relative to the impact of the dropped variable.

Land Type

For each land transaction, PVD records many different characteristics about the parcel including the number of acres for each land type. The land types include non-irrigated cropland (*Dryland*), irrigated cropland (*Irrigated*), tame pasture (*Tpasture*), and native pasture (*Npasture*) and are computed as a percentage of the total acres of the parcel. Since the land types add up to one, one of the land types must be dropped to avoid perfect collinearity due to the inclusion of an intercept in the model. Therefore, the "*Dryland*" variable is excluded from the model to avoid this issue. Thus, the other land types will be relative to non-irrigated land when making comparisons. Irrigated land is expected to positively impact the price of land as it is, for the most part, the most productive land and less prone to production risk (e.g., drought). Tame and native pasture types are expected to negatively impact the price of land relative to non-irrigated land.

Net Farm Income

It is generally accepted that when net farm income is high relative to previous years, the price of land will also increase. That is, when farm profitability increases, farm owners have the ability and willingness to pay more for land. Therefore, the net farm income variable (*Income*) is expected to be positively related to the price of land. That is, as incomes rise so do land prices. The net farm income variable will be discussed in detail in the next chapter.

Before estimating the model, the data needed to be tested for collinearity. Collinearity can be a potential problem when the independent variables are highly correlated with each other. A correlation analysis indicated some variables had a strong positive correlation with others (Table 3.1). Therefore, a variance inflation factor test was performed using statistical software. This test quantifies the severity of collinearity by measuring the impact it has on the variance of an estimated coefficient. The test indicated the rental income variable was highly correlated with other variables. In order to fix this problem, the rental income variable was dropped from the model.

The model was also tested for heteroskedasticity. This occurs when the regression estimate errors have a non-constant variance. Since heteroskedasticity was present in this model, the White's Test was performed and the White standard errors were presented in the regression output. It is important to note, though heteroskedasticity was detected, the parameter estimates are not biased, rather OLS no longer provides the estimate with the smallest variance.

Table 3.1 Correlation Analysis of Explanatory Variables

	LnPrice-N	*LnPrice-R*	*Inrate-N*	*Intrate-R*	*Acre*	*Acresq*	*County*	*Countysq*	*Urban*
LnPrice-N	1.000								
LnPrice-R	0.986	1.000							
Inrate-N	-0.309	-0.179	1.000						
Intrate-R	-0.273	-0.162	0.753	1.000					
Acre	-0.170	-0.181	0.004	-0.010	1.000				
Acresq	-0.099	-0.106	0.000	-0.011	0.934	1.000			
County	0.146	0.145	-0.049	-0.048	-0.126	-0.081	1.000		
Countysq	0.108	0.107	-0.045	-0.045	-0.075	-0.047	0.949	1.000	
Urban	0.217	0.145	-0.386	-0.293	-0.016	-0.001	0.062	0.117	1.000
NW	-0.078	-0.078	0.018	0.015	0.145	0.099	-0.103	-0.041	0.244
WC	-0.083	-0.089	-0.007	-0.003	0.170	0.141	-0.095	-0.034	0.031
SW	0.026	0.020	-0.027	-0.023	0.128	0.094	-0.063	-0.039	-0.235
NC	-0.043	-0.046	-0.003	-0.002	-0.027	-0.040	-0.106	-0.046	-0.082
C	-0.054	-0.057	0.003	0.003	-0.055	-0.048	-0.012	-0.038	-0.259
SC	-0.001	-0.002	-0.005	-0.006	-0.031	-0.030	0.228	0.224	-0.031
NE	0.094	0.100	-0.001	-0.003	-0.108	-0.079	0.005	-0.024	0.024
EC	0.082	0.090	0.013	0.010	-0.101	-0.063	0.056	0.013	-0.064
SE	0.045	0.049	0.008	0.008	-0.071	-0.036	0.039	-0.038	0.349
Dryland	-0.011	-0.007	0.015	0.018	-0.122	-0.140	0.030	0.044	-0.067
Irrigated	0.138	0.142	-0.020	-0.022	0.062	0.033	-0.029	-0.007	-0.067
Tpasture	0.078	0.081	-0.007	0.000	-0.126	-0.086	0.050	0.007	0.182
Npasture	-0.095	-0.103	-0.003	-0.008	0.157	0.171	-0.040	-0.046	0.019
Income-N	0.259	0.164	-0.403	-0.312	0.015	0.016	-0.011	-0.023	0.388
Income-R	0.193	0.126	-0.222	-0.161	0.014	0.016	-0.023	-0.036	0.332

Table 3.1
Continued

	NW	*WC*	*SW*	*NC*	*C*	*SC*	*NE*	*EC*	*SE*
NW	1.000								
WC	-0.086	1.000							
SW	-0.113	-0.092	1.000						
NC	-0.120	-0.098	-0.128	1.000					
C	-0.120	-0.098	-0.129	-0.136	1.000				
SC	-0.127	-0.104	-0.136	-0.144	-0.145	1.000			
NE	-0.089	-0.073	-0.096	-0.101	-0.102	-0.108	1.000		
EC	-0.121	-0.099	-0.129	-0.137	-0.138	-0.146	-0.102	1.000	
SE	-0.145	-0.118	-0.155	-0.164	-0.165	-0.175	-0.123	-0.166	1.000
Dryland	0.068	0.089	-0.023	0.067	0.113	0.115	0.025	-0.160	-0.233
Irrigated	0.053	0.011	0.305	-0.050	-0.063	0.040	-0.068	-0.089	-0.113
Tpasture	-0.096	-0.077	-0.099	-0.086	-0.079	-0.106	0.196	0.151	0.183
Npasture	-0.053	-0.060	-0.085	-0.004	-0.049	-0.091	-0.084	0.142	0.216
Income-N	0.075	0.025	-0.068	-0.078	-0.079	-0.080	-0.004	0.063	0.139
Income-R	0.087	0.025	-0.083	-0.101	-0.097	-0.098	-0.004	0.082	0.177

Table 3.1 Continued

	Dryland	*Irrigated*	*Tpasture*	*Npasture*	*Income-N*	*Income-R*
Dryland	1.000					
Irrigated	-0.250	1.000				
Tpasture	-0.282	-0.069	1.000			
Npasture	-0.788	-0.214	-0.141	1.000		
Income-N	-0.070	-0.044	0.055	0.069	1.000	
Income-R	-0.081	-0.056	0.068	0.081	0.970	1.000

3.3 Empirical Model

The empirical model used in this research is a semi-log model where the dependent variable is the log of per acre land price (*LnPrice*). The explanatory variables with a brief description and their expected sign are reported in Table 3.2. The model was estimated two times. The first model estimated used nominal interest rates and nominal net farm income values to explain nominal Kansas land values (*LnPrice-N*). The second model adjusted for inflation and estimated the model in real 2009 terms, where the dependent variable is referenced as *LnPrice-R* (similar notation for other variables in real terms). The empirical model estimated is the following:

$$LnPrice = \alpha_0 + \alpha_1 * Intrate + \alpha_2 * Acre + \alpha_3 * Acresq + \alpha_4 * County + \alpha_5 * Countysq + \alpha_6 * Urban + \alpha_7 * +NW + \alpha_8 * WC + \alpha_9 * SW + \alpha_{10} * NC + \alpha_{11} * SC + \alpha_{12} * NE + \alpha_{13} * EC + \alpha_{14} * SE + \alpha_{15} * Irrigated + \alpha_{16} * Tpasture + \alpha_{17} * Npasture + \alpha_{18} * Income.$$

Table 3.2 Explanatory Variables with Expected Sign on Coefficient in Parentheses (+/-)

LnPrice-R = Log sales prices per acre in 2009 dollars
LnPrice-N = Log sales price in nominal terms
Intrate-R = Real Agricultural real estate annual fixed interest rate (-)
Intrate-N = Agricultural real estate annual fixed interest rate (-)
Acre = Number of acres in parcel (-)
Acresq = Squared number of acres (+)
County = Population of county in which parcel is located (+)
Countysq = Squared population of county in which parcel is located (-)
Urban = Urban Location Index (+)
NW = Crop Reporting District 10 (-)
WC = Crop Reporting District 20 (-)
SW = Crop Reporting District 30 (-)
NC = Crop Reporting District 40 (+)
SC = Crop Reporting District 60 (-)
NE = Crop Reporting District 70 (+)
EC = Crop Reporting District 80 (+)
SE = Crop Reporting District 90 (+)
Irrigated = Percent of total acres in irrigated land (+)
Tpasture = Percent of total acres in tame pasture (-)
Npasture = Percent of total acres in native pasture (-)
Income-R = Real Kansas Farm Management Association Net Farm Income (+)
Income-N = Nominal Kansas Farm Management Association Net Farm Income (+)
$\alpha 0$ - $\alpha 18$ = Parameters to be estimated

Chapter 4 - Data

A variety of sources were used for the data required for this analysis. There are three main categories in which these data fall: Land transaction data, county and regional data, and monthly data. These groups will be discussed in that order followed by a brief description of the sample selection.

Individual land transaction data used in this research were obtained from the Property Valuation Division (PVD) of the Kansas Department of Revenue and include all agricultural land transactions in Kansas from 1986 to 2009. In 1985, with the implementation of the Use-Value Appraisal, the PVD started to collect specific details on every land transaction in the state, which by law must be reported to the Kansas Department of Revenue on an annual basis. According to a thesis by Ryan Garrett titled, "Impact of Land and Land Market Characteristics on Kansas Agricultural Land Values," county appraisers collect these details using guidelines set forth in the Kansas Computer Assisted Mass Appraisal (KSCAMA) Residential/Agricultural Data Collection: Course 1-104-2. The characteristics obtained by the county appraisers on each land transaction include; parcel identification number, county number, sales class, certificate of value, month of sale, year of sale, sale type, sales price, sales validity code, agriculture use type, soil mapping unit, agriculture size, acres, agricultural use value, building value, topographical codes, utility codes, and access codes. Explanation of the codes and characteristics can be found in the data collection course aforementioned (Garrett, 2005).

The county and regional data used in this analysis were obtained from the Kansas Farm Management Association (KFMA), United States Department of Agriculture (USDA), and the Census Bureau. The KFMA is divided into six geographical regions of the state: Northeast, North Central, Northwest, Southeast, South Central, and Southwest. Average net farm income was obtained for each region for each year. Each county was assigned a net farm income value based on which KFMA region in which it was located.

The USDA publishes rental rates and land values for each Crop Reporting District on an annual basis. Average rental rates and average land values are for non-irrigated crop land, irrigated land, and pasture. For this study, rental rates and land values for a particular county depended on which CRD the county was in.

Finally, the Census Bureau's website, www.census.gov, was the source of population estimates for each county in Kansas and each year between 2000 and 2009. The Census Bureau also estimated county-level population in 1990 and 1980 with each census. For years between the 1980 and 1990 censuses as well as between the 1990 and 2000 censuses, a linear interpolation was performed to obtain estimates for those respective years. Like the county estimates, city-level data were obtained through the same methods as the counties. Cities with a population larger than 25,000 people in 2009 were included in this study. This includes cities in Kansas and cities within 160 miles of the Kansas border. Cities in Kansas include: Dodge City, Emporia, Garden City, Hutchinson, Kansas City, Lawrence, Leavenworth, Leawood, Lenexa, Manhattan, Olathe, Overland Park, Salina, Shawnee, Topeka, and Wichita. Starting to the west and working in a clockwise fashion, cities within 160 miles of the Kansas border in Colorado include: Colorado Springs, Pueblo, Fort Collins, Loveland, Greeley, Denver, Aurora, Lakewood, Thorton, Westminster, Arvada, Centennial, Boulder, Longmont, Broomfield, Castle Rock, Parker, Commerce City, Littleton, Northglenn, Englewood, Brighton, Wheat Ridge, and Lafayette. Cities with a population over 25,000 people in Nebraska include: Hastings, Grand Island, Kearney, Lincoln, Omaha, Bellevue, and Fremont. Cities with a population over 25,000 people in 2009 in Iowa within 160 miles of Kansas include: Des Moines, Ankeny, Urbandale, and West Des Moines. For Missouri, the cities include: Joplin, Springfield, Columbia, Jefferson City, St. Joseph, Kansas City, Independence, Lee's Summit, Blue Springs, Raytown, Liberty, and Gladstone. The cities in Arkansas include: Bentonville, Fayetteville, Rogers, Fort Smith, Russellville, and Bella Vista. Oklahoma cities within 160 miles of Kansas and a population over 25,000 include: Tulsa, Muskogee, Bartlesville, Owasso, Broken Arrow, Norman, Oklahoma City, Stillwater, Enid, Midwest City, Moore, and Shawnee. Amarillo was the only city within 160 miles of Kansas with a population over 25,000 in Texas. The cities above are used in the Urban Location Index variable which was introduced in the previous chapter. Figure 4.1 shows a graphical representation of metropolitan areas used in the urban location index.

Figure 4.1 Map of Cities used in Urban Location Index

The urban location index is a value given to a county based on the distance to a metropolitan area and the population of the metropolitan area. To calculate the distance between county and metropolitan area, the geographic centers of each were used in the Haversine Formula (Sinnott, 1984). The population for each metropolitan area was included to account for the difference in size for each of the metropolitan areas. The Urban Location Index formula is as follows:

$$ULI_j = \frac{\sum_{i=1}^{n}\left[V_i * \left(\frac{1}{d_i^k}\right)\right]}{\sum_{i=1}^{n}\left[\frac{1}{d_i^k}\right]},$$

where ULI_j is the Urban Location Index calculated for county *j*, V_i is the population for the metropolitan area *i*, d_i^k is the distance of county *j* to metropolitan area *i*, and $k = 1$. For example, a county in southeastern Kansas will have a low geographic value relative to Lubbock, Texas, but a high geographic value to Kansas City, Missouri. That same county may be equally distant from Kansas City as from Fayetteville, Arkansas, but the weight on Kansas City will be higher due to the larger population than Fayetteville. The counties with the highest ULI values will be those closest to the larger metropolitan areas (Taylor et al., 2003).

Monthly data, including interest rates and the Personal Consumption Expenditure index, were collected from a variety of sources. The interest rates used in this analysis are from the Kansas City Federal Reserve Bank's website, www.kansascityfed.org. The Kansas City Federal Reserve Bank publishes quarterly interest rates for agricultural real estate in the 10th District. The bank breaks down the 10th District by state and publishes various interest rates by state. The interest rates deemed appropriate for this study are agricultural real estate interest rates for the state of Kansas. However, since these are quarterly rates, an assumption was made to assign the first three months of the year, January, February, and March, the first quarter rate. The second three months, May, June, and July were assigned the second quarter rate. The same was done for the third and fourth quarters of each year.

One limitation to the Federal Reserve Bank's dataset is that it has only been published since the third quarter of 1987. This study analyzes land values to 1986, therefore missing interest rate data needed to be filled in. To do this, the monthly bank prime loan rates back to January of 1985 were obtained from the Federal Reserve's website. A simple regression was performed where the agricultural interest rate was the dependent variable, and the bank prime rate was the independent variable. This regression produced an R-squared value of 0.806, an intercept of 3.959, and a coefficient of 0.665. These values were then used to produce an estimate of the missing agricultural interest rate data needed for this analysis.

The Personal Consumption Expenditures (PCE) price index used for this research was from the Bureau of Economic Analysis' website, www.bea.gov. The PCE, which is regarded as a measure of inflation, has base year of 2005 and is published monthly.

To convert all nominal values used in this research to real values, the PCE index was used as a deflator. Land values, rental rates, and KFMA net farm income were all converted to 2009 values. To accomplish this, the nominal values were multiplied by the ratio of the 2009 average PCE index to the monthly PCE index value in which the transaction took place. For instance, $RV_t = NV_t * (PCE_{2009} / PCE_t)$, where RV_t is the real value of land, rental rate or KFMA net farm income in period t, NV_t is the nominal value in time period t in which the transaction occurred, PCE_{2009} is the average PCE index for 2009 and PCE_t is the PCE value for time period t. Interest rates also needed to be converted to real interest rates. To accomplish this, first the inflation rate needed to be calculated by using the equation $I = (PCE_t / PCE_{t-1}) - 1$. The real interest rates were then calculated by the equation $RR = ((1+N) / (1+I)) - 1$, where N is the nominal interest rate and I is the inflation rate from the previous equation.

The sample selection used for this analysis includes PVD farmland transaction data from 1986 to 2009. Before any filtering techniques were performed, a total of 191,317 observations were recorded by the PVD during this time frame. Since some data characteristics in the dataset are not relevant to this study, filtering needed to be performed to delete unwanted or irrelevant data. These data could be flawed which could potentially impact parameter estimates that are used in the model.

Since this study deals with farmland, any transaction that included a building only needed to be deleted from the dataset. Also, any transaction that was not an arm's length transaction needed to be deleted. An arm's length transaction occurs when a buyer and seller act independently and are not related in any way. This study kept a transaction with a building as long as the value of the building was not more than 10 percent of the total value of the transaction. This step was chosen so a parcel with many acres and a building with little or no value could remain in the dataset to be analyzed. Since any transaction with a building of less than 10 percent of the total sales price was included, the estimates will reflect the building value. This is not a major concern, however, due to the relatively small proportion of the total price. Also, if the home or building had more than 20 acres that went with the homestead or building site, then the transaction was deleted from the dataset.

As mentioned earlier in this thesis, previous research (Garrett, 2005; Tsoodle, Featherstone, and Golden, 2007) has shown that parcel size can affect the price of land. Smaller acreage will typically sell for more per acre than larger tracts, however very small parcels likely do not reflect farmland transactions in Kansas. In Garrett's (2005) research, parcels smaller than

25 acres were deleted from the dataset. Therefore, to be consistent with previous research any parcel with less than 20 acres was excluded from the dataset.

A consistent measure was needed to delete observations with what might be considered either too low or too high of a per acre sales price (i.e., those deemed to possibly be outliers for unknown reasons). Using KAS land value estimates, two linear trends relative to a base year, 2009, were estimated to effectively create a price ceiling and price floor, in which data outside of this range would be deleted. The price floor used pasture values in the Southwest CRD as this land type typically has the lowest value in Kansas. The price ceiling was created using irrigated values in the Northeast CRD as this land typically has the highest value in the state. This technique provided upper and lower bounds of per acre sales price across the 24-year time frame. The price floor and ceiling equations are;

$$\text{Price floor per acre} = (-8206.38 + 4.224783*y) / (281/50)$$

$$\text{Price ceiling per acre} = (-145252 + 73.48913*y) / (2833/7000)$$

where y is equal to the year in which the floor or ceiling is being estimated. The denominators for both equations are simply the estimated price floor and ceiling for 2009 (281, 2833) over the subjectively assumed price floor and ceiling prices for 2009 (50, 7000), respectively. After this filter was applied, one final potential problem still existed with the data. In 2001, there were many observations that recorded land types that had not been reported in previous years. After clarification on those land types, it was decided to drop them from the data set as the definitions of these land types can vary from county to county. Therefore, the final data set to be analyzed included 93,024 observations. However, in Table 4.2 the total number of reported sales for Kansas was 93,052. Due to some missing observations, the models were estimated with the

93,024 transactions previously mentioned. The summary statistics for the sample of data used for the analysis are reported in Table 4.1.

Figure 4.2 shows a histogram of the number of observations by parcel size. While there were parcel sizes over 500 acres, the vast majority of parcels had less than 200 acres. For example, of the 93,024 observations, over 77,000 are less than 200 acres.

Figure 4.2 Frequency of Observations by Parcel Size

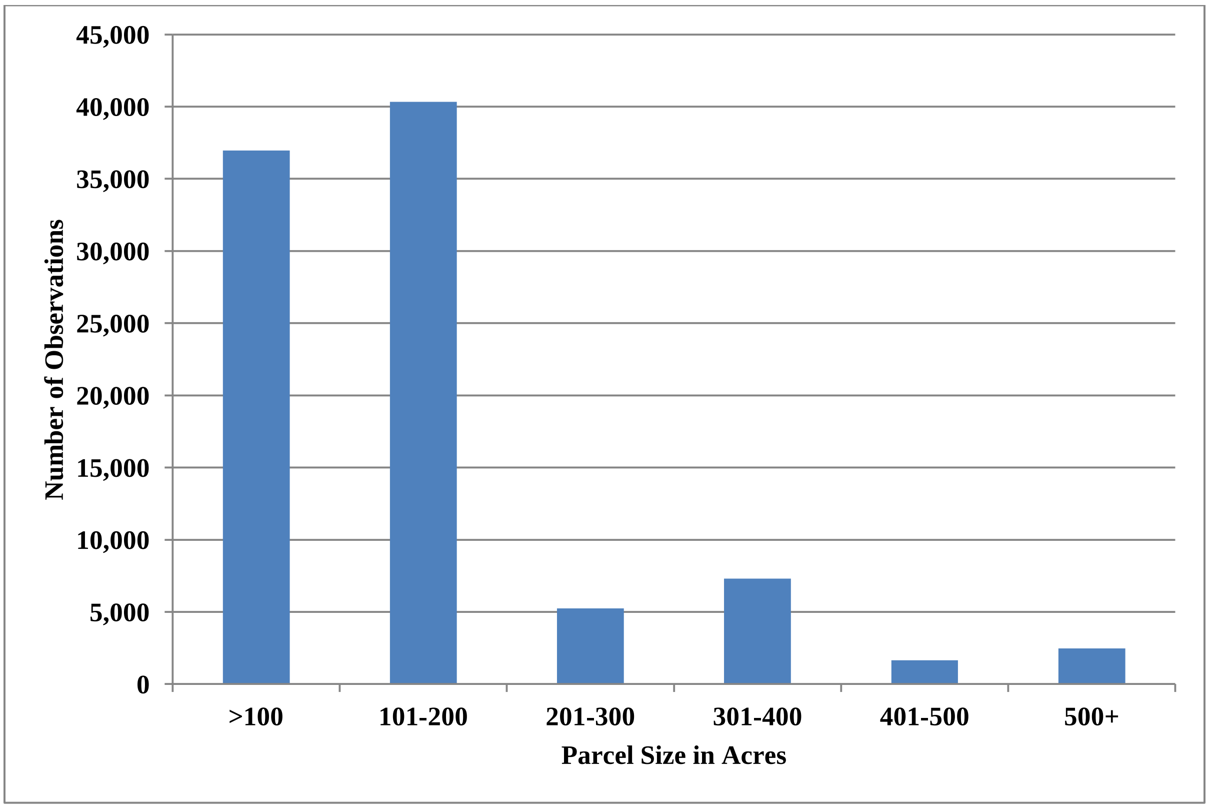


Table 4.2 shows the number of sales per year by CRD. The West Central and Northeast districts account for only 7% total sales, respectively. The Southeast district accounts for the most sales at approximately 17% of total transactions during this study. It is interesting to note the large year-over-year increases in the number of sales in the early- and mid-2000's. This was followed by a decline in the number of sales in 2009 during which the United States was

experiencing a significant recession. As previously mentioned, due to an issue with the data regarding land type classifications in 2001, many observations were filtered out in that year.

Table 4.3 reports the number of acres by year for each Crop Reporting District. During the 24 years this study analyzes, over 13.3 million acres were sold that are included in this analysis. According to the data, the Northeast district only accounted for a total of 3% of all acres sold. The Southeast district included 15% of the total acres sold, or approximately 1.97 million acres.

Table 4.1 Summary Statistics of the Sample (n = 93,024)

Variable	Mean	Std Dev	Minimum	Maximum
Intrate-N	8.656	1.423	6.450	12.130
Intrate-R	7.004	0.963	5.000	8.600
Acre	152.537	117.400	20.000	1460.000
County[1]	19.616	46.841	1.200	525.900
Urban[1]	246.294	46.871	106.400	609.900
NW	0.096	0.294	0.000	1.000
WC	0.066	0.248	0.000	1.000
SW	0.108	0.311	0.000	1.000
NC	0.119	0.324	0.000	1.000
C	0.121	0.326	0.000	1.000
SC	0.133	0.339	0.000	1.000
NE	0.070	0.256	0.000	1.000
EC	0.121	0.327	0.000	1.000
SE	0.166	0.372	0.000	1.000
Dryland	0.546	0.411	0.000	1.000
Irrigated	0.056	0.200	0.000	1.000
Tpasture	0.057	0.185	0.000	1.000
Npasture	0.340	0.393	0.000	1.000
Income-N[1]	46.999	27.006	-2.364	195.323
Income-R[1]	56.564	25.876	-4.217	197.412

[1] Initial value was scaled by dividing by 1,000

Table 2.2 Total Sales by District

	Crop Reporting Districts									
Year	NW	WC	SW	NC	C	SC	NE	EC	SE	Total
1986	229	107	78	241	165	240	126	229	200	1,615
1987	205	198	137	235	195	267	139	304	363	2,043
1988	304	205	256	345	298	393	199	350	386	2,736
1989	331	232	302	378	476	388	250	419	582	3,358
1990	382	207	358	367	417	435	236	423	657	3,482
1991	406	239	291	383	454	458	235	433	598	3,497
1992	362	190	373	438	537	516	253	500	752	3,921
1993	387	215	332	454	422	512	263	521	708	3,814
1994	419	216	411	433	513	544	268	500	646	3,950
1995	395	203	328	488	544	538	261	467	634	3,858
1996	357	243	414	517	474	621	293	540	749	4,208
1997	428	270	507	579	563	650	335	573	808	4,713
1998	505	344	492	545	575	580	350	537	775	4,703
1999	458	317	414	572	609	576	347	621	781	4,695
2000	235	152	266	318	273	339	186	293	470	2,532
2001	212	163	243	208	222	324	122	172	310	1,976
2002	354	305	587	659	573	609	391	566	827	4,871
2003	459	346	530	568	655	673	359	576	776	4,942
2004	562	417	614	640	744	780	431	637	833	5,658
2005	516	326	609	603	612	680	399	645	876	5,266
2006	446	371	677	682	684	733	387	691	836	5,507
2007	375	286	575	650	484	675	375	613	728	4,761
2008	391	278	557	519	449	589	236	444	656	4,119
2009	249	266	404	300	355	333	108	276	536	2,827
Total	8,967	6,096	9,755	11,122	11,293	12,453	6,549	11,330	15,487	93,052

Table 4.3 Total Acres Sold by District by Year

	Crop Reporting Districts									
Year	NW	WC	SW	NC	C	SC	NE	EC	SE	Total
1986	44,721	21,238	14,813	33,553	22,551	36,180	6,002	28,448	24,162	231,668
1987	39,393	39,923	33,119	30,865	26,073	39,591	7,386	35,045	43,051	294,445
1988	61,796	42,115	48,944	47,053	39,879	53,750	8,612	40,764	49,507	392,419
1989	60,728	48,019	63,243	49,455	63,175	51,305	10,074	52,976	82,119	481,094
1990	75,418	44,947	71,256	51,108	55,752	60,626	9,239	48,754	91,532	508,631
1991	86,070	51,205	52,239	49,473	61,882	63,657	10,594	50,262	83,286	508,669
1992	69,123	37,819	83,499	57,714	73,103	71,928	10,130	52,765	104,598	560,680
1993	81,817	41,274	58,031	58,883	53,695	68,502	10,888	52,982	91,346	517,417
1994	83,765	43,593	78,466	58,261	62,441	75,422	10,682	52,183	80,338	545,151
1995	76,383	46,279	76,477	64,556	68,634	75,256	9,491	49,443	75,171	541,690
1996	65,495	51,707	76,133	65,118	57,900	95,683	10,701	62,104	92,320	577,163
1997	83,405	64,662	95,682	74,675	67,825	85,908	13,543	57,772	91,385	634,858
1998	100,116	77,610	84,922	74,910	75,021	81,873	14,701	51,912	95,361	656,425
1999	92,115	64,364	71,704	72,663	73,213	81,650	16,177	63,304	83,383	618,573
2000	45,829	30,149	50,081	43,418	36,948	48,176	10,189	35,462	56,706	356,956
2001	32,424	23,434	32,711	19,923	18,688	32,104	9,777	13,599	31,279	213,939
2002	63,810	63,054	109,083	84,325	72,450	79,968	37,202	65,081	100,091	675,062
2003	86,342	75,680	95,909	80,015	80,482	82,934	35,071	65,510	94,754	696,697
2004	113,551	97,097	110,973	87,773	97,794	107,675	45,478	65,199	101,579	827,118
2005	116,268	69,770	134,916	90,531	78,642	87,436	41,034	75,183	130,775	824,555
2006	107,264	89,493	146,146	97,996	95,668	110,214	41,732	78,539	108,685	875,736
2007	72,575	75,243	110,081	94,666	65,097	95,314	44,225	73,455	98,425	729,081
2008	78,716	71,122	116,525	76,440	64,050	86,718	23,963	53,126	91,407	662,068
2009	47,025	63,777	73,194	45,194	48,229	49,609	11,480	32,567	67,568	438,644
Total	1,784,150	1,333,573	1,888,147	1,508,569	1,459,191	1,721,477	448,370	1,256,435	1,968,828	13,368,739

Chapter 5 - Results and Analysis

The primary focus of Chapter 5 is to present the results obtained from estimating the semi-log-model introduced in Chapter 3. Specifically, parameter estimates will be reported and discussed as to how they compare to expectations mentioned in Chapter 3. The results of the two models (variables in nominal versus real terms) will be compared. The first model introduced will be based on nominal values while the second model accounts for inflation using real values. Finally, to address the other objective of this thesis research, KAS surveyed land values will be compared to actual PVD land transaction data.

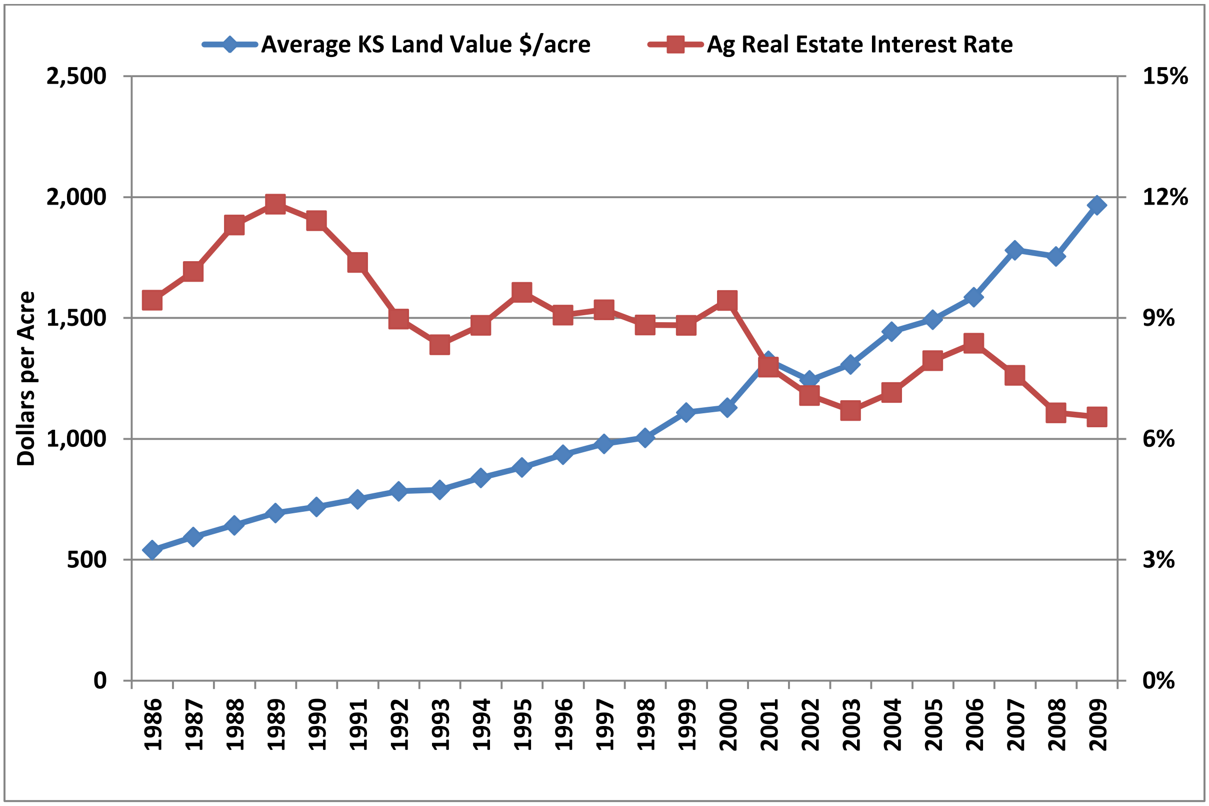
5.1 Nominal Model Results

The first model to be discussed was estimated using nominal values for net farm income and interest rates in order to explain nominal Kansas land values. The model was estimated from 93,024 observations across a 24-year time period and was able to explain 24.1% of the variation in land prices. Because of the large number of observations available for estimating the model, most variables are statistically different from zero at the 99% confidence level. Table 5.1 displays the results of the regression. The following is a discussion of each of the variables.

Interest Rates

As expected, the parameter estimate of the interest rate variable (*Intrate-N*) is negative and significant at the 99% significance level. In Table 5.1, the coefficient for the interest rate variable is -0.109 implying a one percentage point increase in the interest rate will decrease the per acre sales price of land by 10.9%. This negative relationship is expected, as the cost of financing increases, potential buyers will not be willing to pay as much for land. The negative relationship is consistent with the previous research of Garrett (2005). Figure 5.1 shows the average Kansas land values and average agricultural real estate interest rates for Kansas. Land values increased at a steady pace, while interest rates trended down over the 24 years. This further supports the notion of buyers willing to pay more in the presence of lower interest rates.

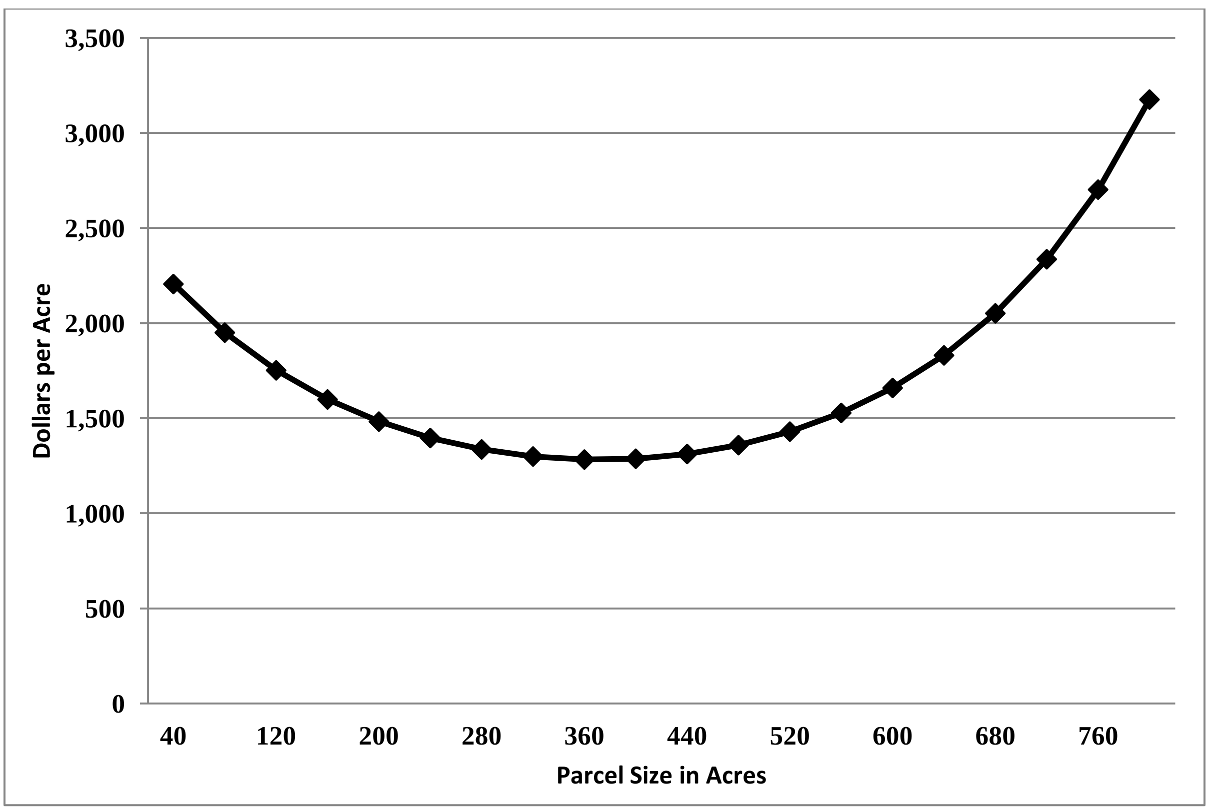
Figure 5.1 Average Kansas Land Values vs. Average Kansas Ag Real Estate Interest Rates



Size of Parcel

The sale size variables, *Acre* and *Acresq*, were found to be significant at the 99% level. Both variables possess the expected sign as discussed earlier (negative on linear term and positive on squared term). A one-unit increase in parcel size (*Acre*) is associated with a 0.37% decrease in the price per acre. However, due to the squared term (*Acresq*), the impact is not linear in nature as illustrated in Figure 5.2. As mentioned earlier, as the size of the tract of land increases, the number of potential buyers decreases due to financing issues, no utility with additional acreage, among other reasons. This variable's negative impact on price per acre of land is consistent with previous research (Huang et al., 2006). Figure 5.2 shows the relationship between parcel size and land price (other values at their means). Prices decline as parcel size increases up until 371 acres at which point prices increase with increasing parcel size. This suggests as the parcel gets very large, significant premiums are paid. This result could be explained by a small sample size of very large parcels. Another argument could be made that investors focusing on agricultural production (as opposed to land development) will pay a premium for larger tracts of land.

Figure 5.2 Impact of Parcel Size on Kansas Land Values

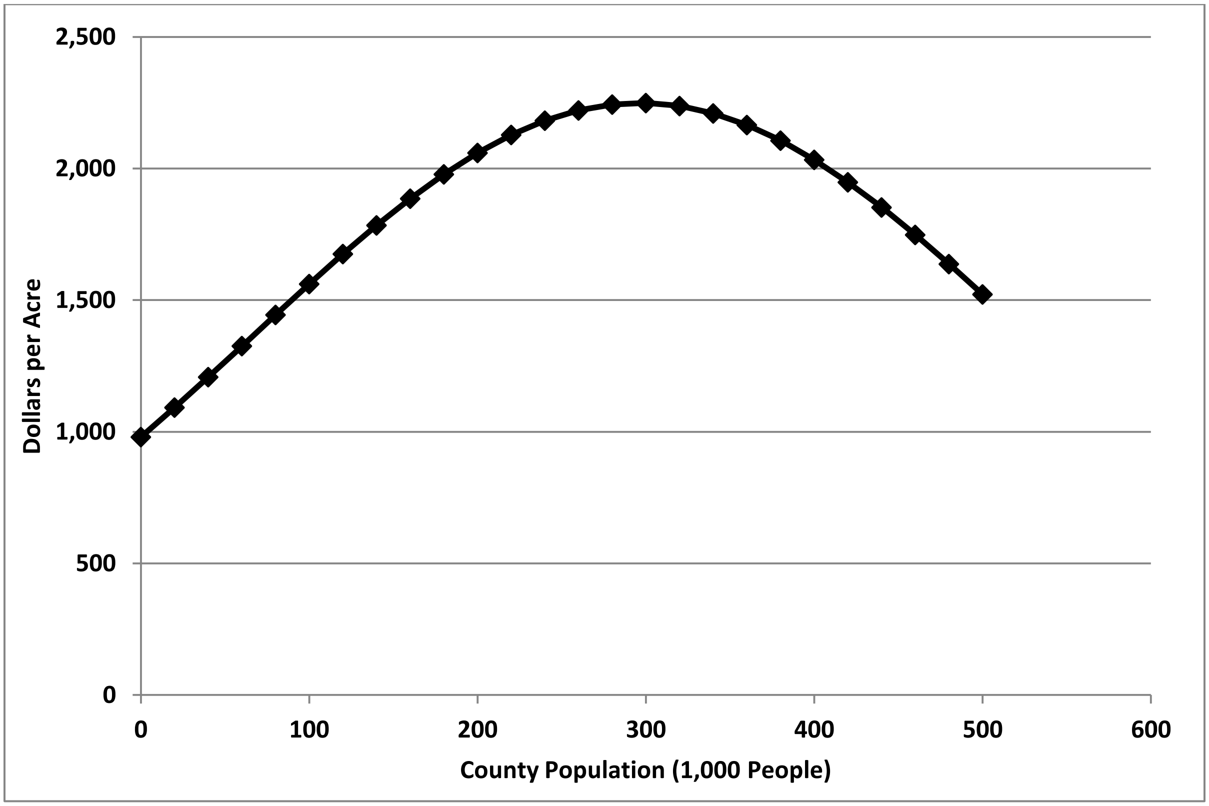


County Population

Both the *County* and *Countysq* variables were significant at the 99% level, and both have the expected sign as discussed in Chapter 3. According to this model, if the population of the county in which the land is located increases by one unit, or 1,000 people, the sales price per acre of land is expected to increase by 0.56%. However, if the population of a county increased by 100,000 people, land would not increase by 56% due to the nonlinear relationship. Because of this fact, the *Countysq* variable must be accounted for in the impact of county population on sales price per acre (see Figure 5.3).

To illustrate an example, Sedgwick and Pratt counties are both in the South Central district; however, they differ greatly in terms of county population. In 2008, Sedgwick County had approximately 482,317 people while Pratt County had a population of 9,366. When all variables except county population are evaluated at the mean, a tract of land in Pratt County would be expected to sell for $1,032 per acre while the same piece of land in Sedgwick County would be expected to sell for $1,624 per acre.

Figure 5.3 Impact of County Population Size on Kansas Land Values



Urban Location

The urban location index variable, *Urban*, was significant at the 99% confidence level and possessed the positive sign on the coefficient as expected. A one-unit change in the *Urban* variable will increase price per acre by 0.25%.

Crop Reporting Districts

The coefficients for each of the regional crop reporting districts (CRD) were statistically significant at the 99% level except the South Central (*SC*) and Southeast (*SE*) districts. However, not all the signs of the coefficients were as expected, relative to the default Central district. The *NW* and *WC* districts did have negative signs as discussed in Chapter 3. This is consistent with prior beliefs that land in central Kansas has a higher value relative to land in the western part of the state. According to the regression model, land in the Northwest (*NW*) district is discounted 17.1% compared to the same piece of land located in the Central district. The *SW* district had a positive sign which was not expected. It is likely capturing some other regional difference that has not been identified. The *NC* district has a positive sign which is likely due to the productivity of land being slightly higher than the Central district. The results indicate a parcel of land in the *NC* district has a 5.7% premium to the same tract of land located in the *C* district. Over the 24-year span of data, prices in the *NC* district were higher than those in the *C* district. Finally, the eastern most districts did have the expected signs as predicted. Relative to land in the *C* district, land in the *NE* and *EC* districts have a higher sales price per acre. A tract of land in the *NE* and *EC* districts is approximately 25.1% and 19.7% more valuable, respectively, than the same piece of land in the *C* district. This increase can likely be attributed to the overall productivity of land in those respective districts.

Land Type

The estimated coefficients for each of the land types, irrigated cropland, tame pasture, and native pasture, were statistically significant at the 99% confidence level and possessed the expected sign as discussed in Chapter 3. According to this model, as the percent of irrigated land, *Irrigated*, increases by one percentage point, and non-irrigated cropland decreases by the same amount, the sales price per acre is expected to increase by 0.67%. The parameter estimate on *Tpasture* indicates that as the proportion of tame pasture increases by one percentage point and the non-irrigated cropland decreases by one percentage point, the sales price per acre will decrease by 0.12%. Finally, if the proportion of native pasture, *Npasture*, is increased by one percentage point while decreasing non-irrigated cropland by the same amount, the sales price per acre is expected to decline by 0.15%. These findings are consistent with previous research (Tsoodle, Featherstone, and Golden, 2007).

Net Farm Income

The coefficient on the net farm income variable (*Income-N*) was found to be statistically significant at the 99% confidence level and is positive as expected. With a parameter estimate of 0.00473, this model implies as net farm income increases by one unit ($1,000), the sales price per acre of land will increase by 0.47%.

Table 5.1 Nominal Regression Model Results

Variable	Parameter Estimate	S.E	t-statistic	p-value
Intercept	6.8971	0.0336	205.569	<.0001
Intrate-N	-0.1086	0.0021	-52.980	<.0001
Acre	-0.0037	0.0001	-60.240	<.0001
Acresq	0.0000	9.94E-08	49.700	<.0001
County	0.0056	0.0002	29.120	<.0001
Countysq	-0.0000	4.41E-07	-21.420	<.0001
Urban	0.0025	0.0001	33.089	<.0001
NW	-0.1711	0.0113	-15.139	<.0001
WC	-0.1274	0.0125	-10.200	<.0001
SW	0.1428	0.0116	12.317	<.0001
NC	0.0567	0.0095	5.957	<.0001
SC	-0.0192	0.0094	-2.032	0.0544
NE	0.2513	0.0111	22.661	<.0001
EC	0.1971	0.0100	19.780	<.0001
SE	-0.0175	0.0108	-1.615	0.1090
Irrigated	0.6730	0.0133	50.644	<.0001
Tpasture	-0.1216	0.0136	-8.955	<.0001
Npasture	-0.1532	0.0074	-20.595	<.0001
Income-N	0.0047	0.0001	45.750	<.0001
R-Square	0.2408			
F-Value	1638.77			<.0001
Number of Observations	93,024			
RSME	0.7388			

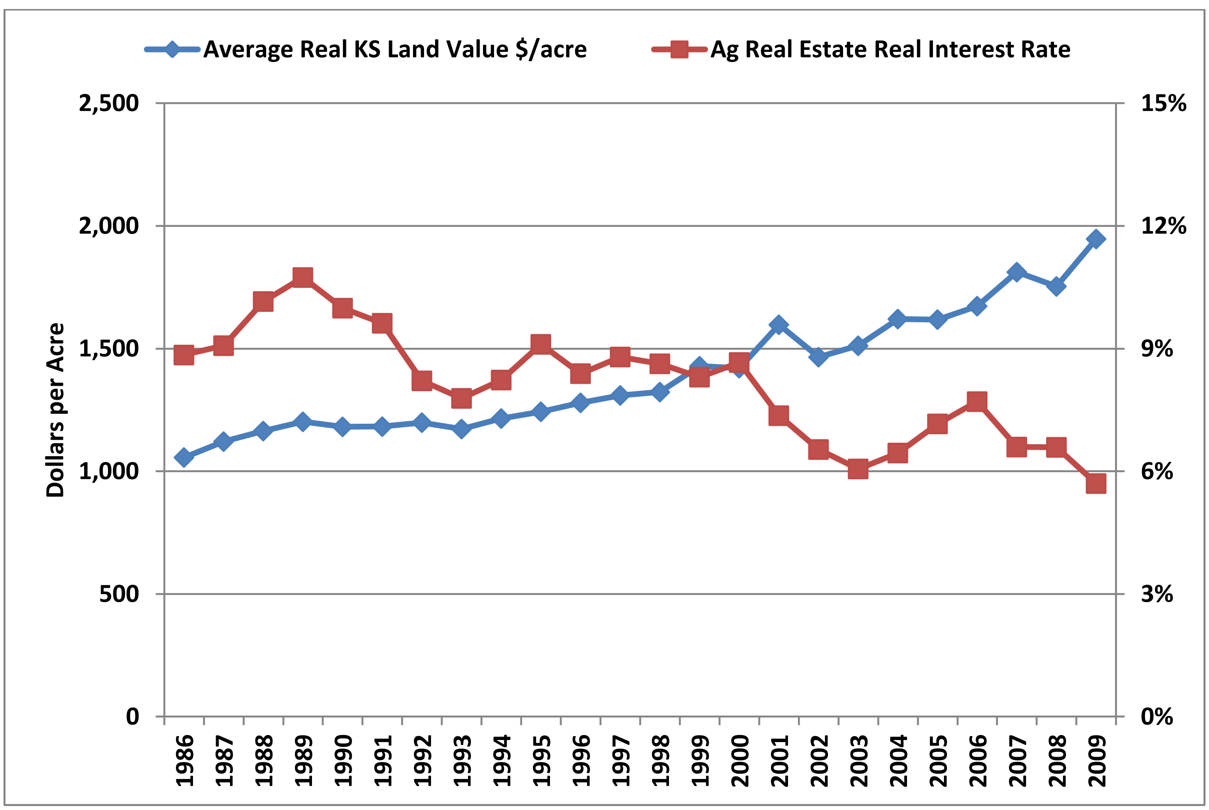
5.2 Real Model Results

The second model was estimated using real values for interest rates and net farm income to explain real Kansas agricultural land values. The model used the same 93,024 observations during the same time period, but only explained 17.2% of the variation in the real price of land. Results from estimating this model are reported in Table 5.2.

Interest Rates

As was predicted in Chapter 3, and consistent with the nominal model, the expected sign for the interest rate variable indicates a negative relationship with land values. The *Intrate-R* variable was found to be statistically significant at the 99% confidence level. A one percentage point increase in the real interest rate results in a decrease of 8.4% in the real sales price per acre. The results of this study are consistent with the findings of Garrett's (2005) research in terms of direction, but the magnitude is larger than what he found. Garrett found that a one percentage point increase in real interest rates will decrease the per acre sales price by 3.2%. While the magnitude of the coefficient is smaller than that of the nominal model, it is still important to observe the inverse relationship as shown in Figure 5.4.

Figure 5.4 Average Real Land Values vs. Average Kansas Ag Real Estate Real Interest Rates



Size of Parcel

The *Acre* and *Acresq* variables were both statistically significant at the 99% level and both had signs as expected. The real model did not differ much from the nominal model in terms of magnitudes of the coefficients as a one-unit increase in the number of acres will decrease the real sales price per acre by 0.37%. The positive sign on the *Acresq* variable suggests a non-linear relationship does exist. That is, prices decline as the parcel size increases, but at a diminishing rate.

County Population

Just like the nominal model, both the *County* and *Countysq* variables were statistically significant at the 99% confidence level. As was the case with the parcel size variable, the magnitude of the county population variables did not differ much from the nominal model. A one-unit increase in the population of a county will increase the real sales price per acre by 0.52%, but does so in a nonlinear fashion as indicated by the *Countysq* variable.

Urban Location

Again, the urban location variable, *Urban*, is statistically significant at the 99% confidence level and possessed the expected sign discussed in Chapter 3. That is, land in counties that are located in closer proximity to urban centers, sells for higher prices than more rural counties, all else equal.

Crop Reporting Districts

Some notable differences were observed when comparing the two models in terms of the crop reporting district variables reflecting where the land is located. Similar to the nominal model, the *SC* district is not significantly different from the default region (*C*). However, unlike the nominal model, all other districts, including the *SE* district were statistically significant at the 99% confidence level. The *NW* and *WC* did have the expected signs previously predicted as was the case in the nominal model. According to this model, a parcel of land in the *NW* and *WC* districts would be discounted 12.4% and 10.3%, respectively, to the same piece of land in the *C* district. The eastern most districts, *NE*, *EC*, and *SE* also had the expected signs as discussed in Chapter 3. It is believed the reason the eastern most districts have a higher price per acre of land relative to the *C* district is due to the overall better productivity of land in these districts. Each of the eastern districts had larger premium relative to the same piece of land in the *C* district than was found in the nominal model.

Land Type

Each of the land types, irrigated cropland, tame pasture, and native pasture were statistically significant at the 99% level and each had the expected signs. As the proportion of irrigated land in a parcel is increased by one percentage point and non-irrigated cropland decreased by one percentage point, the real sales price per acre will increase by 0.66% according to this model. A one percentage point increase in *Tpasture* or *Npasture* with a corresponding one percentage point decrease in non-irrigated land will decrease the real sales price per acre of land by 0.11% and 0.16%, respectively.

Net Farm Income

The real value of net farm income, *Income-R*, was found to be statistically significant at the 99% confidence level. As was the case with the nominal model, the sign was as expected while the magnitude of the parameter estimate was relatively small. A one-unit increase ($1,000) in real net farm income will increase the real sales price per acre by 0.27%.

Table 5.2 Real Regression Model Results

Variable	Parameter Estimate	S.E	t-statistic	p-value
Intercept	6.9175	0.0328	210.946	<.0001
Intrate-R	-0.0842	0.0027	-31.218	<.0001
Acre	-0.0037	0.0001	-61.190	<.0001
Acresq	0.0000	9.80E-08	50.330	<.0001
County	0.0052	0.0002	27.520	<.0001
Countysq	-0.0000	4.32E-07	-19.870	<.0001
Urban	0.0022	0.0001	31.006	<.0001
NW	-0.1240	0.0111	-11.204	<.0001
WC	-0.1029	0.0123	-8.337	<.0001
SW	0.1314	0.0114	11.516	<.0001
NC	0.0603	0.0093	6.454	<.0001
SC	-0.0082	0.0093	-0.888	0.4003
NE	0.2718	0.0109	25.048	<.0001
EC	0.2244	0.0098	22.951	<.0001
SE	0.0301	0.0105	2.870	0.0045
Irrigated	0.6622	0.0131	50.503	<.0001
Tpasture	-0.1100	0.0134	-8.229	<.0001
Npasture	-0.1581	0.0073	-21.548	<.0001
Income-R	0.0027	0.0001	25.669	<.0001
R-Square	0.1719			
F-Value	1072.57			<.0001
Number of Observations	93,024			
RSME	0.7286			

While both models have several similarities in terms of variables, it is important to note some of the differences in the models. The semi-log nominal model did a better job at explaining the variation with an R-squared of 0.2408. However, the real model did have a slightly smaller RSME at 0.7286 versus the nominal model of 0.7388 suggesting the predictive ability of the real model might be as good, or slightly better, than the nominal model. Another difference in the models was that crop reporting district *SE* was statistically significant in the real model, but not in the nominal model.

5.3 Comparison of KAS and PVD Land Values

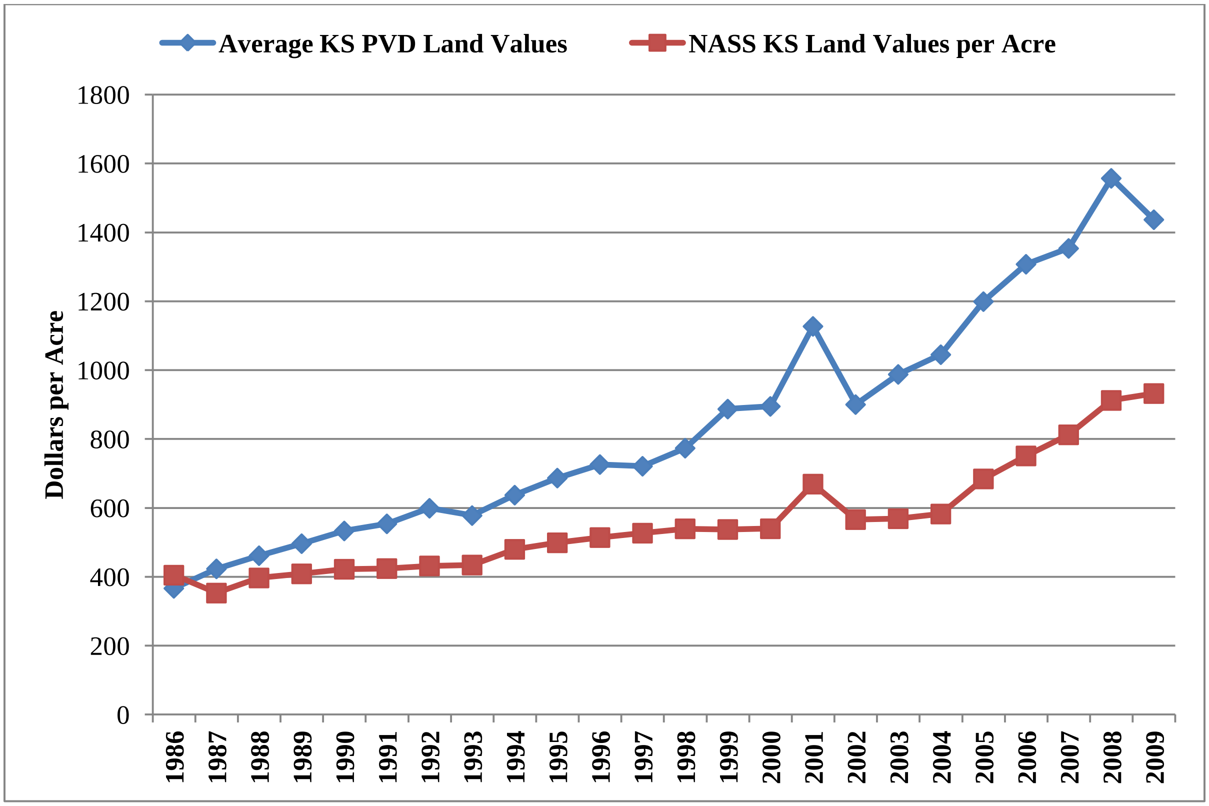
The other objective of this thesis was to compare PVD land sales data against Kansas Agricultural Statistics (KAS) surveyed land values. The USDA's NASS Field office in Kansas is operated in cooperation with the Kansas Department of Agriculture and is known as KAS. Each year, NASS sends short surveys to landowners asking a variety of questions regarding the land they own or rent. Specifically, questions about the type of land, acreage, rental rates, and estimated market price are included in this survey. NASS then compiles the data and reports the average estimated market value of land for each crop reporting district. It is important to note that only the average land value is reported. NASS does not include the number of respondents, range, median, or mode of the surveyed values. This section will look at the state average land sales values as well as individual crop reporting districts weighted by acres and land type. Specifically, acre-weighted transaction data from PVD are compared against NASS averages that reflect land type weights comparable to the PVD data.

Kansas

In Figure 5.5, the state average of PVD sales price per acre is plotted along with the NASS surveyed estimates for the state of Kansas. It is clear from Figure 5.5 that respondents to the survey grossly underestimate the value of their land. On average, over the 24-year period, respondents underestimated their land values by approximately 47%. The largest underestimated instance came in 2004, when PVD values were 79% above the NASS surveyed data. In fact, estimated NASS values in 2009 mirrored actual PVD sales values of the late 1990s. According to the data, in absolute terms, NASS values typically lagged PVD values by approximately 10 to 13 years.

Though NASS survey data clearly underestimates market values, the average yearly increase is much closer to that of actual PVD data. Over the 24-year time span, the average annual increase reported by NASS is 4% while the average annual increase in PVD data is 7%. It is important to note, due to issues with the data in 2001, values shown in Figure 5.5. are likely influenced by this. In 2001, a noticeable increase in values was observed while values decreased significantly the following year.

Figure 5.5 NASS Surveyed Values and PVD Actual Values for Kansas



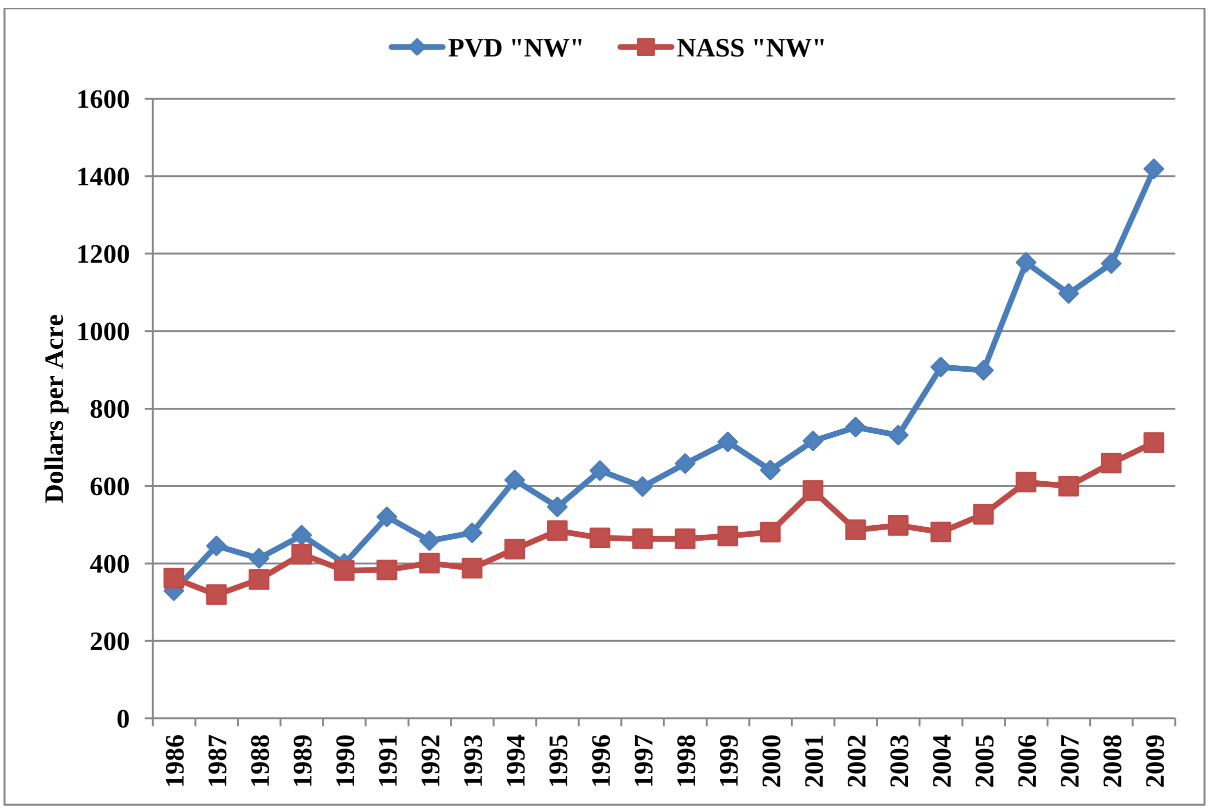
Northwest, West Central, and Southwest Crop Reporting Districts

Due to budget constraints, NASS did not report CRD level land value data from 1986 through 1988. The Department of Agricultural Economics at Kansas State University published values for periods of time when NASS did not. During the 24-year span from 1986 to 2009, PVD land values were actually 42% above the estimated values reported by NASS in the Northwest CRD. More recently, in 2008 and 2009, PVD values in this CRD were 78% and 99% larger than NASS values, respectively. Figure 5.6 displays the results.

The West Central CRD was similar to the other districts in the state in that land values were understated. During the time frame, values were only underestimated by 67%, though significant variability was observed. Since 2000, land values reported by the PVD were 95% larger than the estimates produced by NASS.

The largest difference in values for the state of Kansas came from the Southwest CRD. During the same time frame as stated before, on average, PVD sales data for all cropland and buildings were 107% larger than the estimates produced by NASS. Year-over-year percentage changes as reported by NASS indicate land values increased by 3% per year in this district. PVD data shows land values actually increased by 10% per year on average. The percentage increase in PVD data is largely influenced by a 105% increase from 1986 to 1987. After deleting that observation, values in the Southwest CRD increased by only 6% on an annual basis.

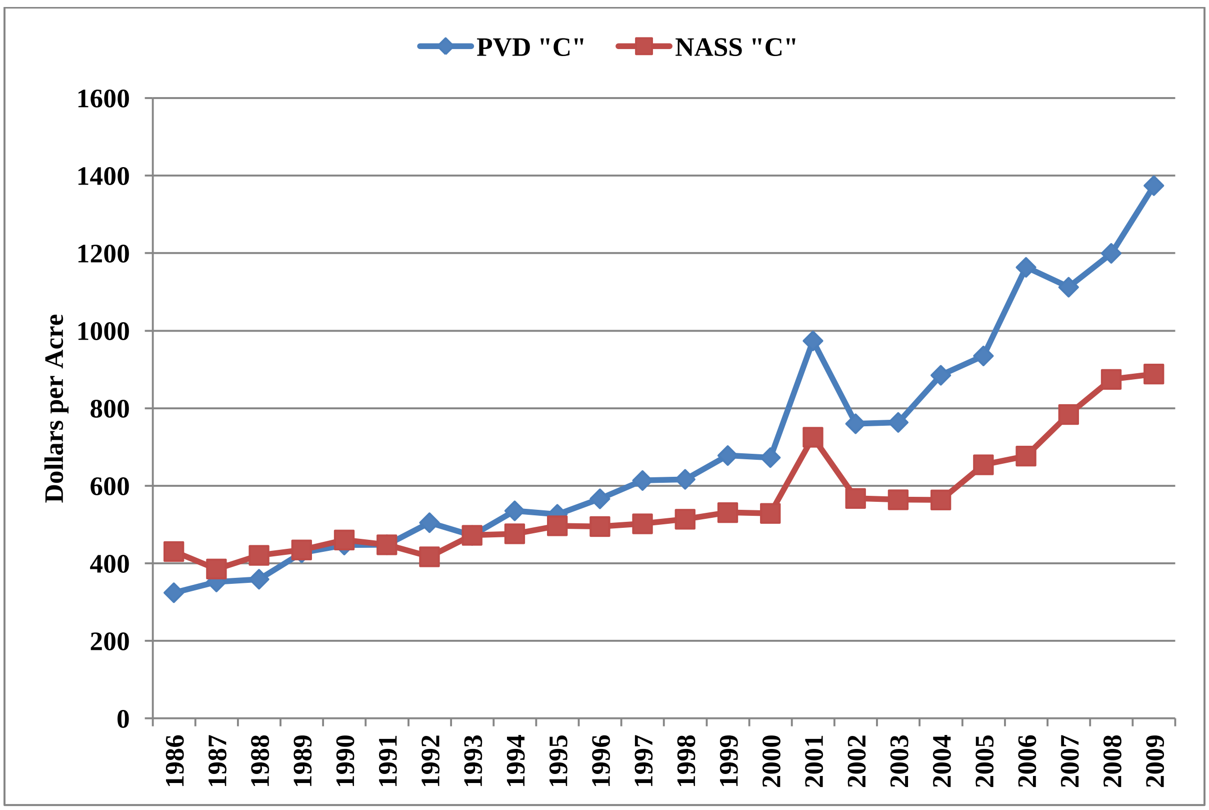
Figure 5.6 PVD Values in Northwest and NASS Values for Northwest



North Central, Central, and South Central Crop Reporting Districts

The landowners located in the central districts of Kansas performed the best in terms of estimating land values. PVD values in the North Central district were 28% larger than surveyed estimates over the course of 24 years. On average, PVD data were 21% above what NASS survey data suggests for the Central district. Values reported by PVD for the South Central district were on average 32% larger during the time span. Annual percent changes as indicated by the PVD data, were on average between 6% and 7% for the central districts. This compares to 3% and 5% annual percent increases as reported by NASS.

Figure 5.7 PVD Values for Central and NASS Values for Central



Northeast, East Central, and Southeast Crop Reporting Districts

PVD sales data reported in the Northeast district were on average 32% larger than NASS survey estimates. PVD data indicate land prices in the Northeast district increased by an average annual rate of 7% while NASS values increased at a 5% rate annually.

Average land values in the East Central district reported by the PVD were on average 48% above the data provided by NASS. In 2009, PVD sales were only 2% above the estimated values from the NASS survey. This is largely due to the fact actual land values, as reported by the PVD, decreased 20% from the previous year while NASS land values increased on average 13% annually from 2005 to 2009. This was the closest value for this time period for any district in this dataset. Again, the fact that NASS values increased annually at a higher rate than PVD data is due to the large year-over-year drops the PVD data captures that NASS survey values do not.

Actual market values as reported by the PVD were approximately 75% higher than that of the NASS surveyed values in the Southeast district. PVD market values increased annually at an average rate of 8% while NASS reported values increased at 5% annually for this district.

While landowners surveyed by KAS consistently underestimated the market value of their land, annual increases were much closer to that suggested by the PVD data. It is believed landowners are not purposely understating their land values on the survey. Rather, landowners do not fully understand or closely follow land markets thus proving such disconnect. Land markets, like many other markets, fluctuate very quickly and this has been even more so over the past decade.

These findings were similar to what Taylor and Dhuyvetter (2013) found though different years were used (they analyzed only the most recent three years, i.e., 2010-2012). However, a study by Shultz (2006) found that prices in North Dakota were much closer when comparing estimated values and actual transactions. On average, actual transactions from 2001 to 2004 were only 6% higher than NASS estimated values, and 9% higher than the North Dakota Land Value Survey. Another study by Zakrzewicz, Brorsen, and Briggeman (2012) found that land transaction data in Oklahoma were consistently higher than USDA and the Federal Reserve Bank of Kansas City surveyed estimates. Their analysis included data from 1976 to 2009 for transaction data and Federal Reserve survey and from 1997 to 2009 for USDA surveys. This research also mentioned the difficulty in obtaining transaction data and the reality that these data are often noisy, and subject to potential outliers. While every effort was made to minimize potential problems associated with outliers, potential issues may still exist impacting results reported in this research due to the subjective nature of the data filtering process.

Chapter 6 - Summary

Analysts, academics, and people within government agencies have estimated that over 75% of a farmer's assets are in land. Though land is one of the largest investments in a farming operation, it is not just important to the landowners, but also the bank that finances the purchase, the appraiser valuing land, as well as many other individuals. There were two main objectives of this thesis. The first was to identify and estimate the impact various factors have on agricultural land values within Kansas using a hedonic regression model. The second objective was to investigate the relationship between KAS surveyed land values and PVD sales data.

Many researchers have studied the impacts that different factors have on land prices. The literature shows that two main approaches are taken when evaluating land prices. The first approach utilizes a net present value model which assumes, in the simplest form, that buyers value land only for the economic returns it produces. That is, future income generated from the land is discounted at a constant rate. The summation of the discounted future returns is equal to the value of land. The other main approach used in land valuation is the hedonic regression method. This method estimates values to each attribute of land whether it be productivity, type of land, parcel size, utility access, among many other features.

This thesis incorporated the hedonic method in order to estimate the impacts of interest rates, population, parcel size, location, type of land, and net farm income on land prices. The data for this study came from several sources. Land price data were obtained from the Property Valuation Department (PVD) which is a division of the Kansas Department of Revenue. The PVD records market values among other site specific attributes such as location, type of land, and parcel size for each land transaction. The PVD data incorporated in this research were over a 24-year time period from 1986 through 2009. The data were filtered to eliminate any observations that were deemed to not be applicable to this study.

Interest rate data were obtained from the Kansas City Federal Reserve Bank and reflected average interest rates on agricultural real estate loans in the state of Kansas. Population data came from the Census Bureau which provided estimates for each county in 1980, 1990, and each year from 2000 to 2009. Population estimates for metropolitan areas in Kansas and surrounding states were obtained from the Census Bureau.

Net farm income data for the time period analyzed were obtained from the Kansas Farm Management Association. A land transaction was assigned a net farm income value based on the KFMA region the parcel was located in. To convert the income into real values, a technique involving a deflator was used. The deflator used Personal Consumption Expenditure (PCE) data in order to convert all net farm income and land values to 2009 values. The PCE data were also used in order to convert nominal interest rates into real interest rates.

The hedonic model was estimated two separate times, first using nominal net farm income, interest rates, and net farm income values, then using real values for the same variables. The nominal model used 93,023 observations and explained 24.1% of the variation in nominal land values. The only variables that were not statistically significant were the South Central (*SC*) and Southeast (*SE*) crop reporting districts. The interest rate variable (*Intrate*) and size of parcel (*Acre*) negatively impacted the price of land as was expected. The county population (*County*) and distance to larger cities (*ULI*) positively influenced land which as was also expected. Land in the Northwest (*NW*) and West Central (*WC*) districts had lower prices than land in the default Central (*C*) district. Land in the eastern most districts, *NE*, *EC*, and *SE* were at a premium compared to the *C* district as was expected. Irrigated land positively influenced the price of land when compared to non-irrigated land. This is to be expected due to the overall productivity of the land. Both native and tame pastures were valued less than non-irrigated land. The net farm income variable (*Income*) also positively impacted the price of land as was expected.

The model was also estimated using real net farm income and real interest rates in order to explain real land values in Kansas. The R-square on this model was 0.1719. The only variable that was not statistically significant at the 99% confidence level was the South Central (*SC*) district. Each of the variables possessed the same signs as the nominal model.

Finally, this study analyzed the relationship between PVD sales data and KAS survey data. The analysis found that PVD sales data were 47% higher than estimated USDA land values over the time span. Respondents to the survey in the central most districts did a better job estimating land values, where "better" is defined as being closer to PVD sales values, than did their counterparts in the western most districts from 1989 to 2009. Respondents in the central districts were the most consistent, where "consistent" is defined as less year-to-year variability, at underestimating market values for all agricultural land and buildings. Since landowners have no incentive to underestimate the true market value of their land, it is believed they simply do not keep up with the fast pace of land markets.

This thesis was similar to previous studies in that all of the variables considered as explanatory variables were similar to what others have previously used for the most part. However, this research looked at the impacts of these variables over a much longer time period than previous studies. One limitation to this study is that no rental rate variable was included in the final models estimated due to collinearity issues. Future research should consider ways to include this variable as rental rates are one type of proxy for income producing potential of the land. Other research ideas could quantify the impact of government payments on land values over this time period. Even the productivity of land could be analyzed during this time frame. Another potential issue in this research was the data obtained from the PVD in 2001. Many observations were reported as land types that could vary from county to county. Therefore many transactions were deleted from the final dataset for that year.

An important conclusion to take away from this research involves the analysis of PVD sales data compared to NASS surveyed estimates. Over the course of this study, land markets tended to trend higher with only a couple years of annual decreases. Since NASS surveyed data lagged actual PVD data, it is likely the same will hold true if land markets see several years of consecutive annual decreases. That is, if actual land prices begin to decrease for a number of years, NASS surveyed estimates likely will not capture the downward trend due to the lag of NASS estimates. The results reported in this analysis of transaction data and surveyed estimates could be an opportunity for future research as the results in this research are not always consistent with previous research.

References

Brueckner, J. 2000. "Urban Sprawl: Diagnosis and Remedies." *International Regional Science Review* 23(2): 160-171.

Burchell, R. 1997. "Economic and Fiscal Cost (and Benefits) of Sprawl." *The Urban Lawyer* 29: 159.

Castle, E.N., and I. Hoch. 1982. "Farm Real Estate Price Components, 1920 – 78." *American Journal of Agricultural Economics* 64(1): 8 – 18.

Chicoine, D.L. 1981. "Farmland Values at the Urban Fringe: An Analysis of Sale Prices." *Land Economics* 57(3): 353-362.

Garrett, R. 2005. *Impact of Land and Land Market Characteristics on Kansas Agricultural Land Values*. Master Thesis ed. Manhattan, KS: Kansas State University, Agricultural Economics.

Hass, G.C. 1922. "Sales Prices as a Basis for Farm Land Appraisal." Technical Bulletin 9, Minnesota Agricultural Experiment Station, St. Paul.

Holcombe, R. 1999. "In Defense of Urban Sprawl." *PERC Reports*, 17(1): 3-5.

Huang, H., G. Miller, B. Sherrick, and M. Gomez. 2006. "Factors Influencing Illinois Farmland Values." *American Journal of Agricultural Economics* 88(2): 458 – 470.

Klinefelter, D.A. 1973. "Factors Affecting Farmland Values in Illinois." *Illinois Agricultural Economics* 13(1): 27 – 33.

Nickerson, C., M. Morehart, T. Kuethe, J. Beckman, J. Ifft, and R. Williams. 2012 "Trends in U.S. Farmland Values and Ownership." EIB-92. U.S. Dept. of Agriculture, Econ. Res. Serv. February 2012.

Nivens, H.D., T.L. Kastens, K.C. Dhuyvetter, and A.M. Featherstone. 2002. "Using Satellite Imagery in Predicting Kansas Farmland Values." *Journal of Agricultural and Resource Economics* 27(2): 464 – 480.

Postier, K.D. 1990. *Factors Influencing Farmland Values in Kansas: 1977 – 1989*. Master Thesis ed. Manhattan, KS: Kansas State University, Agricultural Economics.

Rosen, S. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *The Journal of Political Economy* 82(1): 34 – 55.

Sinnott, R.W. 1984. "Virtues of the Haversine." *Sky and Telescope* 68(2): 159.

Shonkwiler J.S. and J.E. Reynolds. 1986. "A Note on the Use of Hedonic Price Models in the Analysis of Land Prices at the Urban Fringe." *Land Economics* 62(1): 58 – 63.

Shultz, S. 2006. "Differences Between Agricultural Land Value Surveys and Market Sales." *Journal of the ASFMRA* 75(3): 142 – 149.

Taylor, M.R. and K.C. Dhuyvetter. 2013. "2012 Kansas County-Level Land Values and Cash Rents for Non-irrigated Cropland and Pasture." available online. http://www.agmanager.info/farmmgt/land/county/CountyValuesRents_Mar_2013.pdf

Taylor, M.R., K.C. Dhuyvetter, and T.L. Kastens. 2003. "Cropland and Pasture Land Values in the Great Plains." Proceedings of 2003 Risk and Profit Conference, available online. http://www.agmanager.info/events/risk_profit/2003/mTaylor.pdf

Tsoodle, L.J., A.M. Featherstone, and B.B. Golden, 2007 "Combining Hedonic and Negative Exponential Techniques to Estimate the Market Value of Land." *Agricultural Finance Review*, 67 (2): 225 – 239.

Tsoodle, L.J., B.B. Golden, and A.M. Featherstone. 2006. "Factors Influencing Kansas Agricultural Farm Land Values." *Land Economics* 82(1): 124 – 139.

Wallace, H.A. 1926. "Comparative Farmland Values in Iowa." *Journal of Land and Public Utility Economics* 2(Oct.): 385 – 392.

Xu, F., P. Mittelhammer, and P. Barkley. 1993. "Measuring the Contributions of Site Characteristics to the Value of Agricultural Land." *Land Economics* 69(4): 356 – 369.

Zakrzewicz, C., B.W. Brorsen, and B.C. Briggeman. 2012. "Comparison of Alternative Sources of Farmland Values." *Agricultural Finance Review* 72(1): 68 – 86.