THE RELATIONSHIP BETWEEN NET FARM INCOME, CASH RENTS, AND LAND VALUES IN KANSAS

by

HEATHER N. GIBSON

B.S. Kansas State University (2013)

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

2015

Approved by:

Major Professor
Mykel R. Taylor

Abstract

Land value research has been conducted over many decades with efforts being focused on a broad spectrum of topics encompassing many different issues. The research in this thesis will focus on understanding the relationship between net farm income, cash rent, and land value. This research could provide insight and direction in determining future land value behavior.

Understanding land prices is important to many different segments of the agricultural industry. Those involved in the industry want to know where land values are going and what the future looks like. Although certain segments may not be directly affected by land value movements, if value decreases the environment of the agriculture industry is changed. Farmers and ranchers are interested in future land values as they make purchase and sale decisions or as they consider future growth of their operation. Agribusinesses understand the affect a decrease in land value would do to farmer's decisions regarding capital purchases. Additionally, agriculture finance institutions are interested in the future movement of land value as they are concerned about the affects adverse movements in land value would have on their customer's balance sheet and ultimately their collateral position.

In this paper the relationship between land value and cash rent; where land value is a function of historical cash rent and cash rent is a function of net returns to the land will be tested for its' existence in Kansas. Data were collected for the nine crop reporting districts in Kansas from 1973 through 2012.

Table of Contents

List of Figures

List of Tables

Acknowledgements

A special thank you to my major professor, family, friends, and co-workers for their constant support throughout this process. My employer, American AgCredit, offered unending flexibility and cooperation which allowed me to complete my graduate studies. I am truly blessed to have the opportunity to work side-by-side with them in the agriculture industry.

Chapter 1 - Introduction

Research on land values has focused on a broad spectrum of issues, including model specification, estimation methods, and theoretical underpinnings. Specification of land value models have considered the factors that best explain the variation in land values, the relationship between land values and land rents, the role speculative forces play in land value, and the impact governmental policy has on land values among other topics. Understanding land pricing is important to many different segments of the agricultural industry. Those involved in the agricultural industry want to know why land values change and where land values are going in the future. Land values affect the environment in which farmers and ranchers, agribusinesses, and agriculture finance institutions operate.

Objectives

In this thesis, the relationship between land values and cash rents was modeled for Kansas agricultural land. The relationship was specified as land values being a function of historical cash rents, where cash rents are a function of net returns to land. This model has been used in other regions of the United States. Featherstone and Baker (1988) modeled this relationship for Tippecanoe County in Indiana between 1960 and 1984. This paper models the relationship for nine sub-regions of Kansas. The data covers the period 1973 to 2012, which allows for the analysis of net farm income, cash rent, and land value prior to and after the agriculture crisis of the 1980s.

Data and Methods

Data were gathered for nine crop reporting districts in Kansas from 1973 through 2012. The net farm income data were obtained from the Kansas Farm Management Association

(KFMA) at the county level. Average farm size, in acres, was also reported by KFMA allowing net farm income to be calculated on a per acre basis. An acre-weighted cash rent was used to account for irrigated, non-irrigated, and pastureland cash rent within a region. The acre composition of each region was calculated using KFMA planted acre data. The land values and cash rents for irrigated, non-irrigated, and pastureland were taken from Kansas Agricultural Statistics Service (KASS), Kansas Board of Agriculture, and the USDA. The land value data were not segmented into land classifications but, instead, represented the value for all land in farms.

Using an Ordinary Least Squares linear regression, cash rent was estimated as a function of net farm income and cash rent in the prior year. The predicted cash rent variable was then used in the land value regression. In this regression, land value was estimated as a function of predicted cash rent, land value in the prior year, and land value two years prior. To determine if the relationship between land value and cash rent existed within the crop reporting districts in Kansas, the predicted cash rent variable was analyzed for its' statistical significance in the land value equation.

Chapter 2 - Literature Review

Agricultural land values have been researched for decades. Efforts have focused on a broad spectrum of topics; however, much has focused on predicting land values or trying to determine contributing factors in the value of land. At the theoretical base of research into land values is the asset pricing model; the value of land is the discounted present value of returns expected from the land. Defined differently, land value is the capitalized value of the expected future stream of earnings. This theory laid the foundation for many researchers and their efforts to model land values.

Research by Burt (1986) sought to formulate a model that explained dynamic farmland prices in addition to providing insight into the behavior of land values. A series of equations and models were tested indicating the structure of agriculture land is best estimated using a "second-order rational distributed lag on land rents with the variables transformed to logarithms." Two major components that affect the land price are 1) the difference between equilibrium land price consistent with current expected rent and land price the previous year and 2) the land price in the previous year. This second component is closely related with a traditional measure of capital gains, which can be misleading. Burt's findings, however, support the argument rents are the primary source of value for farmland prices and there is little to support speculative forces driving farmland prices. Additionally, lagged land rent can, in itself, model farmland price behavior. Speculative forces can be viewed as the exaggeration of future expectation for an asset to grow in value and how this future expectation influences purchase and sale decisions.

Burt considered various measures to capture the effect of speculative forces including lending rates, inflation, oil and gas prospects, and urban development pressure. Although speculative forces can affect land values in certain regions for certain periods of time, Burt found that over time land primarily derives its' value from cash rents and speculative forces contribute very little to overall value. From this research an empirical relationship was established and it has been widely used in land valuation research (figure 1).

Figure 1: Empirical Relationship

In this relationship, land value is a function of historical rents and historical rents are a function of net returns to land. In other words, more productive land results in higher cash rent and, therefore, higher land values (Burt, 1986). This empirical relationship has been tested and expanded upon over time to determine the importance of various other factors that may affect land values.

Robison, Lins, and Venkataraman (1985) conducted a study that focused on the relationship between agricultural and non-agricultural land markets. This study examined cash rents and land values in U.S. agriculture between 1960 and 1981. They modeled land value as a function of the expected growth rate in net cash returns to land, inflation expectations, and property, income, and capital gains taxes. As a foundation, the capitalization formula was used; however, Robison, Lins, and Venkataraman sought to improve the formula by considering relevant factors that are a part of the decision maker's environment, which include taxes and inflation. They concluded cash rents and inflation rate in cash rents have explanatory power on land values. Also, by comparing the agricultural and non-agricultural sectors, they found non-agricultural demand for land plays a part in land valuation. This model was applied to twenty-four individual states across the United States. They discovered there is large variation in the type of variables that influence land values in different states (Robison, Lins, & VenKataraman, 1985).

Consideration has not only been given to the type of variables included in land value models, but the time representations of those variables as well. Clark, Fulton, and Scott Jr. (1993) studied differences in time series representations of land values and land rents. This study was done using research by Falk (1991) as a foundation. Falk showed the time series representation of land values and rents did not match, implying the capital asset pricing model did not hold. Falk discovered land values increase faster than rents when value and rents are increasing and decrease faster when value and rents are decreasing (Falk, 1991). Due to this, Clark, Fulton, and Scott Jr. advocated for the use of a new fundamental method of how land values are modeled. Unlike the capital asset pricing model, which depends on a precise relationship existing between land value and income from the land, this new fundamental method would need to allow for the complexity of rational bubbles, risk aversion, and changes in the agricultural environment. The results of this study suggested 1) land prices do not follow a time-series representation that has been seen in other work and 2) time series representation of land value and rent do not match (Clark, Fulton, & Scott, Jr., 1993).

Krause and Brorsen (1995) focused less on land values and looked more specifically at land rents. Historically, land values and rents were found to be correlated in their movement but they do not always move together. The authors argued, by analyzing cash rents, more information could be learned about the movements in land values. The authors used cross-sectional time-series data to examine the influence of certain factors on the rental value of land. Cash rents were modeled as a function of expected revenue, input price, and revenue risk. Revenue risk was modeled to show the variation in observed risk and therefore was the difference between expected revenues and actual revenues. The results indicated that, in the short run, cash rents are not very responsive to changes in expected revenue, input price, or revenue risk. Although risk did not cause a large response in cash rent, it was still found to be a significant determinant of cash rent value. The results of this study suggest that, with increased risk, cash rent will decrease. Knowing the link between cash rent and land value this implied risk is a determining factor in land valuation (Krause & Brorsen, 1995).

Ibendahl and Griffin (2013) also focused research efforts on cash rents and land values. Their research sought to determine if cash rents are a leader or follower to land price changes. To study this relationship the ratio between cash rents and land values was examined. Data were analyzed for a select number of states; Mississippi, Georgia, Ohio, Indiana, Iowa, Minnesota, and Illinois. The time period spanned from 1920 through 2010. The Ricardian Rent Theory was used by the authors and it states cash rents should reflect the current profitability associated with the land. It was found, however, that cash rents did not readily adjust to changes in profitability. Current cash rent values do not reflect current profitability of the land. Due to this, Ibendahl and Griffin tested the theory that cash rent changes lag behind land value changes. The land price to cash rent ratio was examined using up to a five year lag on land values. They found this model to work well when land prices are increasing but does not work when land values are decreasing. This difference was partly attributed to the control held by the farmer-tenants and the influence they have on the cash rent they pay. Farmer-tenants have more information available to them and would benefit from delaying rent increases when land prices increase (Ibendahl & Griffin, 2013).

Featherstone and Baker (1988) conducted a study on net income, cash rent, and land values. They modeled the empirical relationship shown in figure 1 using data from Tippecanoe

County in Indiana between the years 1960 through 1984. Data were gathered for corn and soybean returns, land price, and cash rent; all on a dollar per acre basis. The corn and soybean returns data were used to capture net returns to the land.

This paper examined how returns to land and land prices would be affected if the 1985 farm programs changed to a free market environment. The theory of land value used depended on the interaction between net returns to land, cash rents, and land values. Any adjustments in net returns to land would be observed in the value of cash rents, and eventually observed in land values. The estimations in Featherstone and Baker's paper were done using two models. The first represented cash rent as a function of net returns to land and lagged cash rent as

$$\mathrm{R}_t = \mathrm{I}_t + \mathrm{R}_{t-1}, \qquad (1)$$

where R_t represented cash rent, I_t , represented net income, and R_{t-1} represented cash rent in the prior year. The second model represented land value as a function of predicted cash rent from equation (1), lagged land value, and twice lagged land value. In this model, current land values were modeled by

$$L_t = \hat{\mathrm{R}}_t + L_{t-1} + L_{t-2}, \qquad (2)$$

where L_t represented land value, $\hat{\mathrm{R}}_t$ represented the predicted cash rent variable from equation (1), L_{t-1} represented land value in the prior year, and L_{t-2} represented land value two years prior. These models were applied using data from a single county in Indiana. To test the relationship illustrated in figure 1 for Indiana land values, the predicted cash rent variable, $\hat{\mathrm{R}}_t$, needed to be statistically significant in equation (2). Featherstone and Baker found the relationship to hold for this Indiana County during 1960 through 1985. Additionally, results confirmed that, with an increase in the returns to land, cash rents increase, causing an increase in land value (Featherstone & Baker, 1988). The work by Featherstone and Baker was expanded upon and applied to a larger sample for the research presented in this paper.

Chapter 3 - Data

Following Featherstone and Baker's study, data on returns, land price, and cash rent were gathered for Kansas. Data were compiled for the nine crop reporting districts in Kansas and covered the time period from 1973 through 2012. Kansas is divided into nine crop reporting districts (CRD): North West, West Central, South West, North Central, Central, South Central, North East, East Central, and South East (National Agricultural Statistics Service, 2015).

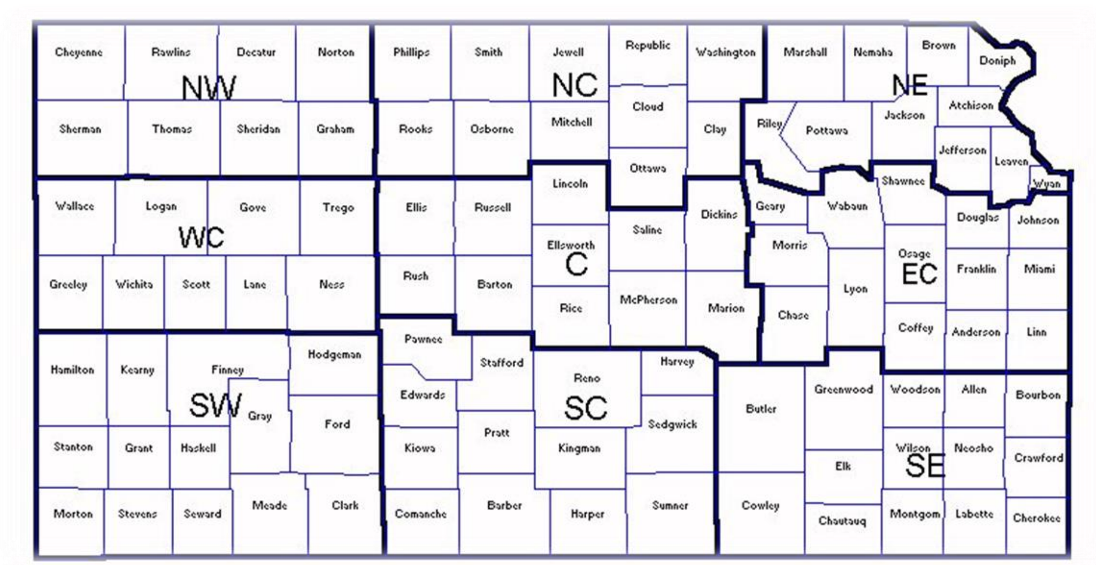

Figure 2: Kansas Crop Reporting Districts

The data sources for net returns, land price, and cash rent are shown in table 1 below. County level data for the state of Kansas would have been preferred; however, it was not available for all three variables.

Table 1: Data Sources

Variable	Segment	Source
Land Value	All Land in Farms and Building	Kansas Agricultural Statistics
Cash Rent	Irrigated, Non-irrigated, and Pasture	Kansas Agricultural Statistics
Net Farm Income	Net Farm Income per acre	Kansas Farm Management Association

Cash rent data were obtained from the Kansas Agricultural Statistics Service (KASS) from the years 1973 through 2012. These data were reported on a dollar per acre basis and segmented into irrigated, non-irrigated, and pasture land. The cash rent data were available at the CRD level.

Land values were also obtained from KASS from the years 1973 through 2012. They were reported on a dollar per acre basis and the land classification chosen was "All Land in Farms and Buildings". These data were collected for the nine CRDs within the state of Kansas.

Net farm income was used to measure the net returns to the land. The net farm income data were taken from the Kansas Farm Management Association's annual reports from 1973 through 2012. An average net income per farm was recorded for each association in the annual reports. The average number of acres operated by a given KFMA farm was used to convert the annual average net farm income to a per acres basis.

Kansas Farm Management Association (KFMA), is different from KASS in that it reports data for six associations rather than nine districts. There are six associations within the KFMA: North West, South West, North Central, South Central, North East, and South East (K-State Research and Extension, 2015).

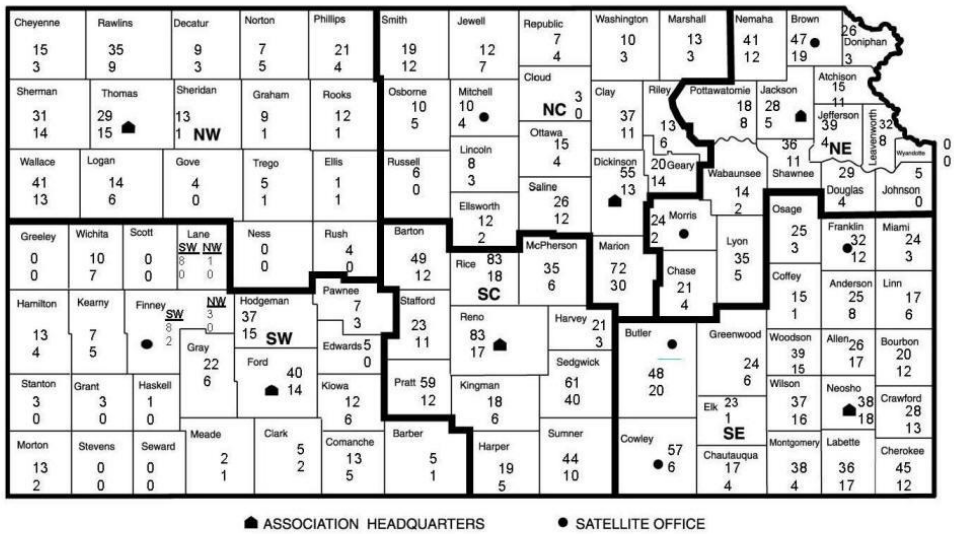

Figure 3: Kansas Farm Management Association Regions

Adjustments to the data were necessary because the KFMA associations are not the same geographic areas as the KASS crop reporting districts. For example, the southwest KFMA region is comprised of 23 counties whereas the southwest KASS CRD is comprised of 14 counties. To align the data and report net farm income, cash rent, and land value data consistently for a region, adjustments were made to the KFMA net farm income data.

County level data were available from the KFMA. Data from the counties which formed an association were disaggregated so that each county in Kansas reported an average net farm income. KFMA only reports acres at the county level if there were three or more farmer-members in that county. As a result, there were years and counties that did not have a net farm income per acre reported. For years and counties where this was the case, the net farm income per acre from the respective Kansas Farm Management Association the county belonged was used. By using this method every county in Kansas for the years 1973 through 2012 had a net farm income per acre reported. The individual counties were then re-aggregated to align with the KASS CRD's. For example, the table below shows the comparison of the counties that comprised the South West KFMA prior to the dis-aggregation and then the counties that comprise the South West CRD after the re-aggregation.

Table 2: Comparison of KFMA and CRD counties for the South West

KFMA	**CRD**
23 counties	14 counties
Greeley	-
Wichita	-
Scott	-
Lane	-
Hamilton	*Hamilton*
Kearny	*Kearny*
Finney	*Finney*
Hodgeman	*Hodgeman*
Pawnee	-
Stanton	*Stanton*
Grant	*Grant*
Haskell	*Haskell*
Gray	*Gray*
Ford	*Ford*
Edwards	-
Morton	*Morton*
Stevens	*Stevens*
Seward	*Seward*
Meade	*Meade*
Clark	*Clark*
Kiowa	-
Comanche	-
Barber	-

The KFMA also reported acreage data segmented into non-irrigated crop, irrigated crop, pasture, and farmstead acres. It was necessary to collect this data because the cash rent variable needed to be transformed to represent a weighted cash rent. Since the land value data were not segmented and broadly represented the value of all land in farms and buildings and the net farm income variable was capturing overall farm income. The cash rent variable needed to represent an average cash rent for all land. KFMA reported each segment of acres as well as a corresponding count of farms. The table below shows how this information is recorded by KFMA.

Table 3: North West Acre information reported by KFMA in 2008

NW KFMA ProfitLink Summary (167 farms)

Category	Total	Count
Total Acres	3509	167
Non-Irrigated Crop Acres	2072	164
Irrigated Crop Acres	610	97
Total Crop Acres	2403	166
Pasture Acres	1518	123
Farmstead Acres	30	12

The total acres for a given farm and the corresponding count of farms was used to formulate a reliable average number of acres per farm. The count is the number of farms within a given association which reported data for the corresponding land category. For example, the North West association had non-irrigated crop acre information for 164 farms whereas the association had irrigated crop acre information for 97 farms. The count and the total farms in the association can differ if there are member farms of KFMA that do not farm in a respective acre segment but are involved in agriculture in a different capacity. Therefore, to accurately represent an average number of specific acre segments per farm, the category of acres operated was multiplied by the count of farms then divided by the total farms in that association that were in the KFMA program that year. More specifically, the average number of irrigated acres in the NW association in 2008 was found by multiplying 610 irrigated acres by 97 farms, then dividing by the total farms in the association which was 167. This method was used to calculate an average number of total, irrigated, non-irrigated, and pasture acres per farm.

Similar to net income per acre, the KFMA data for irrigated, non-irrigated, pasture, and total acres had to be disaggregated to the county level so that the counties could be reformed into

CRDs. This allowed for a consistent representation of the regions in Kansas. For the counties and years that did not have enough farms reported, the irrigated, non-irrigated, pasture, and total acres were substituted from the respective KFMA association with which the county was previously associated. Once every county in Kansas for the years 1973 through 2012 had acres reported for irrigated, non-irrigated, pasture, and total, the counties could then be re-aggregated to align with the CRDs.

The above data compilations were done to calculate weighted cash rents which provide an all farmland rent for each of the nine CRDs. The percentage weights of irrigated, non-irrigated, and pasture acres in 2012 by region are shown in the table below.

Table 4: KFMA Regional Acre Composition in 2012

Region	Irrigated	Non-Irrigated	Pasture
North West	9.43%	68.35%	21.23%
West Central	7.24%	67.20%	23.22%
South West	6.31%	84.10%	9.39%
North Central	2.98%	66.81%	27.81%
Central	1.84%	73.03%	23.75%
South Central	7.99%	79.11%	10.97%
North East	3.34%	76.78%	17.05%
East Central	3.36%	67.44%	26.82%
South East	0.49%	75.77%	20.31%
Kansas	4.78%	73.18%	20.06%

The percentage weights were multiplied by the KASS cash rent associated with the land classification. For example, in the North West CRD for 2012 the percentage of irrigated, non-irrigated, and pasture acres reported were 9.43%, 68.35%, and 21.23% respectively. These percentages were then multiplied by the cash rents for irrigated, non-irrigated, and pasture for the North West in 2012 and summed. The summation of these calculations equaled an all farmland rent. This process was done for all nine CRDs. The summary statistics for net farm income, all farmland rent, and all farm land value for each CRD in Kansas is found in the table below.

Table 5: Summary Statistics for Model Variables in 2012 dollars per acre

Region	Variable	Mean	Standard Deviation	Minimum	Maximum
North West	Net Farm Income	35.95	29.84	-13.44	153.36
	Cash Rent	45.03	9.55	32.80	67.76
	Land Value	846.56	227.09	618.58	1,442.22
West Central	Net Farm Income	31.71	27.39	-11.49	153.11
	Cash Rent	40.51	10.72	28.47	66.16
	Land Value	772.49	240.67	536.55	1,336.14
South West	Net Farm Income	30.76	25.78	-11.86	152.77
	Cash Rent	45.07	11.98	30.99	78.15
	Land Value	887.33	230.05	648.85	1,382.02
North Central	Net Farm Income	42.50	39.76	-16.68	236.25
	Cash Rent	53.72	14.44	39.87	86.53
	Land Value	999.83	276.48	692.34	1,616.07
Central	Net Farm Income	41.31	36.33	7.67	221.14
	Cash Rent	48.11	14.22	32.91	80.86
	Land Value	1,086.06	330.08	756.02	1,766.54
South Central	Net Farm Income	40.86	33.56	-0.51	209.70
	Cash Rent	55.91	18.09	38.33	99.47
	Land Value	1,223.65	422.43	798.59	2,153.84
North East	Net Farm Income	62.61	48.70	-20.87	253.84
	Cash Rent	79.59	17.59	61.03	109.27
	Land Value	1,472.64	447.81	873.86	2,516.30
East Central	Net Farm Income	47.24	39.56	-10.34	215.04
	Cash Rent	55.79	16.70	38.32	91.08
	Land Value	1,289.04	406.44	683.22	2,435.95
South East	Net Farm Income	50.60	38.84	-12.52	190.34
	Cash Rent	50.42	15.32	34.26	80.48
	Land Value	1,044.05	304.41	644.76	1,741.85
Kansas	Net Farm Income	42.62	33.64	2.41	198.39
	Cash Rent	52.68	13.95	39.79	81.79
	Land Value	1,069.07	302.65	717.65	1,692.23

On average over the time period analyzed the North East CRD reported the highest net farm income, cash rent, and land value. The South West district reported the lowest average net farm income. The three lowest cash rent values were reported in the western one-third of the state with the lowest being in West Central. Similarly, land values are the lowest in the Western one-third of the state. Although the North East CRD reported the highest land value; East Central and South Central reported the second and third highest land values, respectively. Overall, in the state of Kansas during 1973 through 2012, net farm income averaged $43 per acre. During the time period it reached a high of $198 per acre and a low of $2 per acre. The cash rent value in Kansas averaged $53 per acre, reaching a high of $82 per acre and a low of $40. During 1973 through 2012 Kansas land value averaged $1,069. Values peaked at $1,692 but also reached a low of $718.

By examining the trend in Kansas data, shown in figure 4, a relationship can be identified between net farm income and land value. A similar year to year variability observed in land value can also be observed in net farm income. Additionally, the cash rent variable does not share the same year to year variability and instead has a smoothing effect over time.

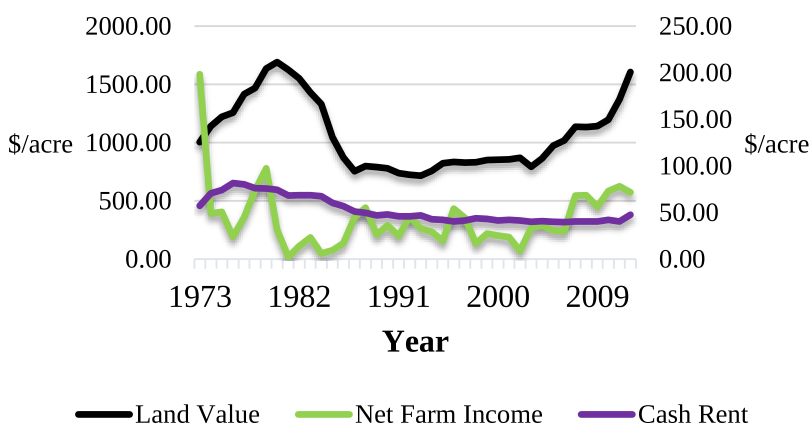

Figure 4: Trends in Kansas Land Value, Net Farm Income, and Cash Rent in 2012 constant dollars, 1972-2012

Chapter 4 - Cash Rent Model and Results

Theoretical Model

The asset pricing model is the foundation for land valuation. This theory states the value of land is the discounted present value of returns expected from the land. Burt (1986) explains land value as the capitalized value of the expected future stream of earnings from the land. Based upon this the land market equilibrium can be presented by the following equation

$$L_t = \sum_{k=0}^{\infty}(E_t R_{t+k}(1+r)^{-k}), \qquad (3)$$

where L_t is the equilibrium land value in time t, R_{t+k} is the residual real return to land in time t + k, E_t is the expectation on real returns to land in time t given information in time t, and r is the real discount rate. If it is assumed that the discount rate and the expectation on real returns is constant equation (3) can be written as

$$L_t = R_t^*/r \qquad (4)$$

where L_t is land price, R_t^* is the expected equilibrium return to land given the information available in time t, and r is the real discount rate (Burt, 1986) (Featherstone & Baker, 1988).

From equation (3) and (4) it is shown land valuation is determined by the expectations on future real returns to land and future interest rates. When new information is available expectations on these can change. Expectations on real returns to land then become a combination of return in the prior year and return in the current year. The process by which land value adjusts to this information is viewed as a function of current and historical rents.

Cash Rent Model

Featherstone and Baker's study relied on the empirical relationship that farmland value is a function of historical cash rents and cash rents are a function of historical residual returns to land. Following their methods, the land valuation models estimated for the nine crop reporting districts in Kansas for the years 1973 through 2012 are

$$\mathrm{R}_t = \mathrm{I}_t + \mathrm{R}_{t-1} \tag{5}$$

and

$$L_t = \hat{\mathrm{R}}_t + L_{t-1} + L_{t-2}, \tag{6}$$

where R_t is cash rent per acre in year t, I_t is net farm income per acre of the previous year, and L_t is the land price in year t. In equation (6), $\hat{\mathrm{R}}_t$ is the predicted cash rent which was estimated in equation (5). Although these were two separate equations they were linked by the cash rent variable.

The variables in equations (5) and (6) were tested using different lags on the dependent variable, L_t, to determine the appropriate number that would result in no autocorrelation. The data used in this thesis was time series so the presence of autocorrelation was a concern. Autocorrelation is defined as the correlation between the error terms from one year to the next. It was assumed the autocorrelation in the model was the first-order autoregressive process. Due to this, the general linear regression model is written as

$$Y_t = X_t\beta + u_t \tag{7}$$

where the errors can be written as

$$u_t = \rho u_{t-1} + e_t \tag{8}$$

In the presence of autocorrelation the least squares estimator is no longer efficient. The standard errors, as a result of the ordinary least squares method, are underestimated which causes the t-ratios to be overestimated. As a result, the confidence intervals and degree of statistical significance of the variables can be misleading (Pindyck & Rubinfeld, 1998).

The R_t variable in the cash rent equation, (5), was tested without a lag, with a one year lag, and with a two year lag. The equation then was shown as R_t= f (I_t), R_t= f (R_{t-1}, I_t), and R_t= f (R_{t-2}, R_{t-1}, I_t), respectively. To test for autocorrelation within the model, the Durbin-Watson alternative (D-Alt) test was used. If any of the versions of equation (5) presented a D-Alt test value lower than 0.05 there was evidence of autocorrelation in the model. For some regions, a three year lag was tested if the model still showed signs of autocorrelation after applying two lags. If the additional lags on the dependent variable did not resolve the autocorrelation, the Prais-Winsten (P-W) method was used. Prais-Winsten uses the generalized least-squares method to estimate the variable coefficients when there is correlation in the errors. This method fits a linear regression of the dependent variable on the independent variables that is corrected by the P-W transformed regression estimator, rho, denoted ρ. First, using equation (7) above a relationship was estimated for the dependent and independent variables. The errors, as a result of this estimation, are represented by equation (8). The Prais-Winsten method makes a transformation for the first observation of equation (7) in the following form

$$\sqrt{1-\rho^2}y_1 = \alpha\sqrt{1-\rho^2} + \left(\sqrt{1-\rho^2}X_1\right)\beta + \sqrt{1-\rho^2}\varepsilon_1. \quad (9)$$

After this transformation is made, equation (7) and (8) are re-estimated and the autocorrelation is corrected (Prais & Winsten, Trend estimators and serial correlation, 1954).

To remain consistent with previous studies on cash rent and land valuation, Featherstone and Baker (1988) and Burt (1986), a one year lag was used on the dependent variable in equation (5). The final form of the model used is as follows

$$R_t = I_t + R_{t-1}. \quad (5)$$

This form was used to predict cash rent for all nine CRD's. The D-Alt was assessed and if the statistic indicated autocorrelation the P-W method was used to transform the model. The D-Alt test indicated a number of CRD's had evidence of autocorrelation and due to this the P-W method was used for all CRD models. This transformation ensured the equation had no evidence of autocorrelation. The estimated coefficients reported are the result of the P-W method transformation.

The dependent variable in equation (6), the land value equation, was tested using three different versions in order to identify any evidence of autocorrelation. L_t was tested with a one, two, and three year lag. Through this process the model took the form L_t = f ($\hat{R}_t$, L_{t-1}), L_t = f ($\hat{R}_t$, L_{t-1}, L_{t-2}), and L_t = f ($\hat{R}_t$, L_{t-1}, L_{t-2}, L_{t-3}). The same approach used in equation (5) was used to determine the appropriate lag on L_t. Ultimately, a two year lag was found to be most appropriate for the land value equation and the final form of equation (6) used is shown below.

$$L_t = \hat{R}_t + L_{t-1} + L_{t-2} \qquad (6)$$

The results for equation (6) are reported in the same way as (5), showing the D-Alt. test statistic of the equation prior to the P-W method. The estimated coefficients are the result of the P-W transformed model. The P-W method was used consistently on each model to ensure there was no autocorrelation present in the models.

Cash Rent Model Results

Tables 6 through 15 report the estimation results for equation (5) and (6). Due to the use of lags, 39 years were observed in the estimations. Equation (5) and (6) were estimated for the state of Kansas and the following crop reporting districts: North West, West Central, South West, North Central, Central, South Central, North East, East Central, and South East.

Estimations for equation (5) are reported in the top portion of the tabled results. The variables R_{t-1} and I_{t-1}, were statistically significant at the 1% level for the majority of crop reporting districts. In the South West District model, however, I_t was statistically significant at the 5% level. At the state level, R_{t-1} and $I_{t-1,}$ were statistically significant at the 1% level. As mentioned before, each equation was transformed using the P-W Method which solved any autocorrelation in the model.

In equation (5) it was expected R_{t-1} would have a large, positive impact in explaining, $R_{t,}$ rent in the current year. This result was observed across all models for the nine CRDs. The variable I_t was expected to contribute less to the overall model but still remain positive. Intuitively, if the land was more productive, i.e. higher net farm income, the cash rent for that land would have increased. This relationship was observed across the nine CRDs as well as at the state level.

In the lower portion of the results tables, the estimation results for equation (6) are presented. L_{t-1} and L_{t-2} were statistically significant at the 1% level for the North West, West Central, North Central, Central, South Central, North East, East Central, and the South East District. The variable L_{t-2} was not statistically different from zero in the South West District model. L_{t-1} was, however, statistically significant at the 1% level for this district. Overall at the state level, L_{t-1} and L_{t-2} were statistically significant at the 1% level.

In the land value equation it was expected L_{t-1} and L_{t-2} would have large, positive impacts in explaining, L_{t}, land value in the current year. This expectation was only partially observed. L_{t-1} had a large, positive impact in each CRD model and at the state level. However, in each model, L_{t-2} had a small effect and was estimated with a negative sign.

Table 6: North West District Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
$\boldsymbol{R_t}$					
R_{t-1}	0.92	***	0.05	0.00	0.25
I_{t-1}	0.08	***	0.02	0.00	0.40
Constant	0.97		2.59	0.71	
Durbin-Watson Transformed	2.02				
R squared	0.89				
No. of Observations	39				
$\boldsymbol{L_t}$					
L_{t-1}	1.40	***	0.14	0.00	0.47
L_{t-2}	-0.60	***	0.12	0.00	0.76
Predicted R_t	3.72	**	1.70	0.04	
Constant	11.84		51.96	0.82	
Durbin-Watson Transformed	2.02				
R squared	0.94				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 7: West Central District Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
$\boldsymbol{R_t}$					
R_{t-1}	0.92	***	0.06	0.00	0.79
I_{t-1}	0.10	***	0.02	0.00	0.31
Constant	0.09		2.67	0.97	
Durbin-Watson Transformed	2.00				
R squared	0.87				
No. of Observations	39				
$\boldsymbol{L_t}$					
L_{t-1}	1.38	***	0.17	0.00	0.07
L_{t-2}	-0.54	***	0.14	0.00	0.12
Predicted R_t	2.50		2.27	0.28	
Constant	19.95		42.98	0.65	
Durbin-Watson Transformed	2.27				
R squared	0.95				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 8: South West District Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
$\boldsymbol{R_t}$					
R_{t-1}	0.90	***	0.07	0.00	0.15
I_{t-1}	0.08	**	0.04	0.02	0.23
Constant	1.96		3.36	0.56	
Durbin-Watson Transformed	2.14				
R squared	0.83				
No. of Observations	39				
$\boldsymbol{L_t}$					
L_{t-1}	1.03	***	0.15	0.00	0.44
L_{t-2}	-0.10		0.15	0.48	0.50
Predicted R_t	0.30		2.05	0.88	
Constant	51.92		51.79	0.32	
Durbin-Watson Transformed	1.72				
R squared	0.91				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 9: North Central District Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
$\boldsymbol{R_t}$					
R_{t-1}	0.94	***	0.06	0.00	0.04
I_{t-1}	0.04	***	0.01	0.01	0.09
Constant	0.94		3.19	0.77	
Durbin-Watson Transformed	1.80				
R squared	0.91				
No. of Observations	39				
$\boldsymbol{L_t}$					
L_{t-1}	1.56	***	0.15	0.00	0.06
L_{t-2}	-0.64	***	0.15	0.00	0.14
Predicted R_t	0.12		1.43	0.94	
Constant	74.93		55.50	0.19	
Durbin-Watson Transformed	2.25				
R squared	0.92				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 10: Central District Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
R_t					
R_{t-1}	0.93	***	0.05	0.00	0.37
I_{t-1}	0.06	***	0.02	0.00	0.64
Constant	0.42		2.50	0.87	
Durbin-Watson Transformed	1.94				
R squared	0.92				
No. of Observations	39				
L_t					
L_{t-1}	1.52	***	0.16	0.00	0.19
L_{t-2}	-0.64	***	0.14	0.00	0.20
Predicted R_t	1.64		1.86	0.38	
Constant	53.01		51.57	0.31	
Durbin-Watson Transformed	2.12				
R squared	0.94				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 11: South Central District Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
R_t					
R_{t-1}	0.91	***	0.05	0.00	0.07
I_{t-1}	0.09	***	0.03	0.00	0.17
Constant	0.74		2.72	0.79	
Durbin-Watson Transformed	2.14				
R squared	0.92				
No. of Observations	39				
L_t					
L_{t-1}	1.62	***	0.15	0.00	0.01
L_{t-2}	-0.69	***	0.13	0.00	0.03
Predicted R_t	0.45		1.48	0.76	
Constant	62.56		50.77	0.23	
Durbin-Watson Transformed	2.19				
R squared	0.96				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 12: North East District Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
$\boldsymbol{R_t}$					
R_{t-1}	0.94	***	0.03	0.00	0.01
I_{t-1}	0.06	***	0.02	0.00	0.03
Constant	0.24		2.88	0.93	
Durbin-Watson Transformed	2.07				
R squared	0.96				
No. of Observations	39				
$\boldsymbol{L_t}$					
L_{t-1}	1.57	***	0.15	0.00	0.93
L_{t-2}	-0.61	***	0.16	0.00	0.86
Predicted R_t	-0.92		1.72	0.60	
Constant	140.79		113.17	0.22	
Durbin-Watson Transformed	1.95				
R squared	0.91				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 13: East Central District Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
$\boldsymbol{R_t}$					
R_{t-1}	0.95	***	0.03	0.00	0.56
I_{t-1}	0.06	***	0.01	0.00	0.51
Constant	-0.66		1.95	0.74	
Durbin-Watson Transformed	1.88				
R squared	0.96				
No. of Observations	39				
$\boldsymbol{L_t}$					
L_{t-1}	1.56	***	0.16	0.00	0.97
L_{t-2}	-0.53	***	0.17	0.00	1.00
Predicted R_t	-1.74		1.42	0.23	
Constant	84.18		82.22	0.31	
Durbin-Watson Transformed	1.95				
R squared	0.93				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 14: South East District Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
$\boldsymbol{R}_t$					
R_{t-1}	0.98	***	0.03	0.00	0.06
I_{t-1}	0.08	***	0.02	0.00	0.14
Constant	-3.46	*	1.99	0.09	
Durbin-Watson Transformed	1.92				
R squared	0.96				
No. of Observations	39				
$\boldsymbol{L}_t$					
L_{t-1}	1.78	***	0.12	0.00	0.58
L_{t-2}	-0.79	***	0.13	0.00	0.86
Predicted R_t	-1.05		0.97	0.29	
Constant	66.99		43.91	0.14	
Durbin-Watson Transformed	1.90				
R squared	0.96				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 15: Kansas Results-Cash Rent Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
$\boldsymbol{R}_t$					
R_{t-1}	0.95	***	0.04	0.00	0.24
I_{t-1}	0.07	***	0.01	0.00	0.50
Constant	-0.69		2.22	0.76	
Durbin-Watson Transformed	1.86				
R squared	0.95				
No. of Observations	39				
$\boldsymbol{L}_t$					
L_{t-1}	1.73	***	0.13	0.00	0.33
L_{t-2}	-0.79	***	0.13	0.00	0.54
Predicted R_t	-0.21		1.24	0.87	
Constant	68.77		45.35	0.14	
Durbin-Watson Transformed	2.02				
R squared	0.96				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

The primary focus when the results were interpreted was on $\hat{R}_t$, predicted R_t from equation (5), and whether it proved to be significant in equation (6). The results presented in table 6 indicated cash rent was significant, at the 5% level, in determining land value in the North West District.

This aligned with what was found by Featherstone and Baker (1988) in their Indiana land valuation model. However, this only proved to be true for this particular region. The other eight CRD models failed to estimate predicted cash rent at any significance level. For example, equation (5) and (6) estimations for the state of Kansas, shown in table 15, indicated the cash rent variable was not statistically significant in the land value equation.

Ultimately, the results observed in equation (5) and (6) deviated from the results found in equation (1) and (2) by Featherstone and Baker (1988). The results observed in this study do not dismiss cash rents as an influencing factor in land values; however, it does indicate this relationship was not able to be detected with the data used and over the time period analyzed. Cash rent did not explain enough variation in land values across the state of Kansas to be included in equation (5) and (6). There are two main arguments as to why the relationship between land value and cash rent was observed in equation (1) and (2) but not in this study.

First, recall the year to year variability seen in the net farm income and land value data from figure 4. These two variables appeared to track together over time and experienced similar variation, whereas the cash rent data was more a smoothed effect. The lack of year to year variation in the cash rent data were a result of the nature of cash rent contracts. These contracts between landlords and tenants would typically be renegotiated and locked in for the life of the contract. Therefore, the cash rent values would only update in the years when the contracts were renegotiated. Results from a KFMA member survey conducted in the fall of 2014 reported the average length of cash rent contracts was 3.3 years (Taylor, Ibendahl, & Herbel, 2015). In comparison to states in the Corn Belt where cash rent contracts are typically renegotiated annually. This allowed for more movement in cash rent data and ultimately allowed cash rent changes to affect the land value more quickly. This reasoning could explain why the results observed in Indiana were not observed in Kansas. Additionally, equation (5) and (6) are presented with a one year lag on the cash rent variable. The average cash rent contract length in Kansas according to the KFMA survey was a longer length of time than what the one year lag in the model captured.

Another reason why a relationship between cash rent and land value was not detected in Kansas may be due to the difference in the popularity of cash rent agreements. Iowa data were used in place of Indiana data to support this theory. This was a suitable proxy due to the similarities between corn-belt states. Iowa reported a much higher percentage of cash rent versus crop share agreements. A comparison of Iowa and Kansas cash rent agreements for non-irrigated farmland is summarized in table 16.

Table 16: Iowa vs. Kansas Leasing Agreements

	Kansas (2011)	**Iowa (2012)**
% Cash Rent	35.70%	75.77%
% Crop Share	55.70%	22.14%

In 2011 and 2012, approximately 36 percent of Kansas farmers who leased farmland utilized cash rent, when 76 percent of Iowa farmers who leased farmland used cash rent agreements. A crop share split was more common in Kansas and could explain why cash rent had little explaining power in the land value equation (Tsoodle & Schlegel, 2015) (Duffy & Johanns, 2014).

Figure 5 below shows the trend in the use of cash rent arrangements for the nine crop reporting districts for non-irrigated farmland (Tsoodle & Schlegel, 2015). The districts have been separated into thirds with North West, West Central, and South West categorized in the western third, North Central, Central, and South Central categorized in the central third, and North East, East Central, and South East categorized in the eastern third. Over the time period analyzed, the western third consistently used the least amount of cash rent arrangements, whereas the majority of cash rent agreements in Kansas were used in the districts in the eastern one-third of the state. Comparing 2003 and 2011, cash rent use was increasing among farmers who leased farmland, however, crop share still held the dominant share of lease agreements across districts (Tsoodle & Schlegel, 2015).

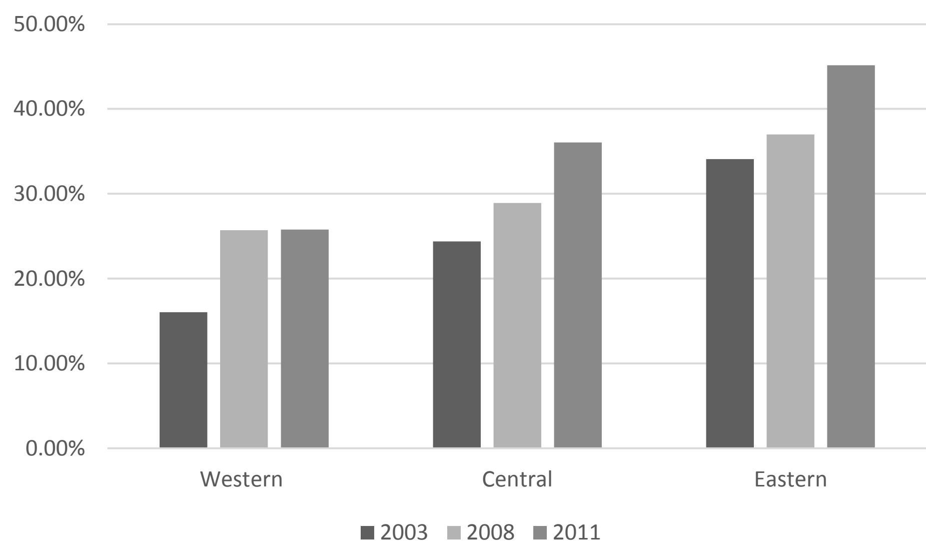

Figure 5: Use of Cash Rent Arrangements by Region in KS for Non-Irrigated Farmland

In addition to the two reasons discussed above, the variability in land quality in Kansas could also explain why there was not a relationship found between cash rent and land value. Recall from table 4, in 2012, Kansas was composed of approximately 5%, 73%, and 20% irrigated, non-irrigated, and pasture land, respectively. Due to the varying quality of land represented in the dataset, cash rent and land value associated with the quality of land varied. Compared to the Featherstone and Baker (1988) study which analyzed non-irrigated cropland in

Tippecanoe County, Indiana. The quality of land in this single county had more uniformity than the quality of land that comprised the crop reporting districts.

Short-Run and Long-Run Elasticity

Although the majority of the cash rent models did not estimate cash rent at a desirable significance level, information can still be gathered from calculating short-run and long-run elasticity. The table below represents the responsiveness of cash rent to changes in net farm income. These values are calculated based on the estimations from equation (5). The small short-run elasticity values indicate cash rent does not respond quickly to changes in net farm income. Conversely, the large long-run elasticity values suggest, over time, cash rent is very responsive to changes in net farm income. Based on this short-run and long-run relationship, cash rents can be classified as 'sticky'.

Table 17: Responsiveness of Cash Rent to Changes in Net Farm Income

CRD	Short-Run Elasticity	Long-Run Elasticity	Long-Run Multiplier
NW	0.11	1.36	0.98
WC	0.15	1.95	1.31
SW	0.09	0.93	0.83
NC	0.07	1.27	0.79
C	0.10	1.52	0.91
SC	0.12	1.43	1.04
NE	0.07	1.32	1.13
EC	0.10	1.85	1.18
SE	0.19	12.61	4.99
State	0.11	2.27	1.51

Similarly, the table below represents the responsiveness of land value to changes in cash rent. These values were calculated from equation (6) estimations. The short-run and long-run elasticity shown below are not intuitive due to the cash rent variable not being statistically significant in the majority of the CRD models.

Table 18: Responsiveness of Land Value to Changes in Cash Rent

CRD	Short-Run Elasticity	Long-Run Elasticity	Long-Run Multiplier
NW	0.17	0.83	17.86
WC	0.09	0.60	15.93
SW	0.01	0.13	3.93
NC	0.00	0.05	1.52
C	0.04	0.37	14.03
SC	0.01	0.18	6.45
NE	-0.03	-0.88	-25.28
EC	-0.03	1.60	81.03
SE	-0.02	-3.14	-138.28
State	-0.01	-0.13	-4.25

Chapter 5 - Net Farm Income Model and Results

The stickiness effect observed in the elasticity values calculated for the cash rent models confirmed cash rents do not adjust quickly enough in Kansas to be included in the land valuation model. This was justification for removing the cash rent variable from equation (6).

Net Farm Income Model

The purpose of equation (5) was to estimate a cash rent variable to be included in equation (6). Since the cash rent variable is being removed from equation (6), equation (5) is no longer needed. Equation (5) and (6) were modified and a new equation to estimate land values was used.

$$L_t = I_t + L_{t-1} + L_{t-2} \qquad (10)$$

Equation (10) represents a modified land value equation where L_t represents land value and is a function of net farm income, I_t, land value in the previous year, L_{t-1}, and land value two years prior, L_{t-2}. In this equation, $\hat{R}_t$, the predicted cash rent variable, was omitted and I_t , net farm income, was included.

Net Farm Income Model Results

Tables 15 through 24 present the equation (10) model results for the nine CRD's and the state of Kansas. Due to the existence of autocorrelation in some of the models the P-W method was used to transform equation (10) for each CRD. Therefore, the coefficients reported below are the result of the P-W transformed model estimations.

The lagged variables were all statistically significant at either the 1%, 5%, or 10% level. The lagged land value variables in this model behaved similarly to those in equation (6). There was a positive impact on the one period lagged land value, but that impact declined by the second period. It was expected I_t would have a positive impact on land values. Intuitively, if net farm income per acre increases, i.e. if the land is more productive, the land would be worth more and an increase in land values would be observed. This expectation was observed in the majority of model estimates.

Table 19: North West District Results-Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	1.39	***	0.12	0.00	0.61
L_{t-2}	-0.48	***	0.12	0.00	0.85
I_t	1.63	***	0.47	0.00	0.80
Constant	29.72		36.77	0.43	
Durbin-Watson Transformed	1.96				
R squared	0.95				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 20: West Central District Results- Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	1.55	***	0.12	0.00	0.12
L_{t-2}	-0.62	***	0.12	0.00	0.10
I_t	1.10	***	0.53	0.05	0.21
Constant	19.91		26.88	0.46	
Durbin-Watson Transformed	2.00				
R squared	0.97				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 21: South West District Results- Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	0.67	***	0.14	0.00	0.78
L_{t-2}	0.22		0.14	0.12	0.45
I_t	0.91		0.65	0.17	0.67
Constant	77.15		81.03	0.35	
Durbin-Watson Transformed	2.09				
R squared	0.83				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 22: North Central District Results- Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	1.53	***	0.13	0.00	0.09
L_{t-2}	-0.61	***	0.13	0.00	0.22
I_t	1.44	***	0.49	0.01	0.38
Constant	32.53		38.61	0.41	
Durbin-Watson Transformed	2.08				
R squared	0.96				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 23: Central District Results- Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	1.58	***	0.12	0.00	0.08
L_{t-2}	-0.66	***	0.12	0.00	0.22
I_t	1.76	***	0.57	0.00	0.33
Constant	32.06		36.53	0.39	
Durbin-Watson Transformed	2.03				
R squared	0.97				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 24: South Central District Results- Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	1.57	***	0.15	0.00	0.14
L_{t-2}	-0.64	***	0.14	0.00	0.19
I_t	1.63	*	0.95	0.09	0.16
Constant	26.68		42.13	0.53	
Durbin-Watson Transformed	1.82				
R squared	0.98				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 25: North East District Results- Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	1.33	***	0.17	0.00	0.86
L_{t-2}	-0.42	**	0.17	0.02	0.60
I_t	1.50	**	0.69	0.04	0.51
Constant	63.14		86.80	0.47	
Durbin-Watson Transformed	1.96				
R squared	0.91				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 26: East Central District Results- Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	1.50	***	0.17	0.00	0.67
L_{t-2}	-0.52	***	0.18	0.01	0.55
I_t	1.22		0.73	0.11	0.45
Constant	-10.97		72.01	0.88	
Durbin-Watson Transformed	1.93				
R squared	0.94				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 27: South East District Results- Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	1.62	***	0.12	0.00	0.88
L_{t-2}	-0.66	***	0.13	0.00	0.83
I_t	1.07	***	0.35	0.00	0.43
Constant	1.47		37.79	0.97	
Durbin-Watson Transformed	1.86				
R squared	0.97				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Table 28: Kansas Results- Net Income Model

Variable	Coefficient		Standard Error	P-Value	Durbin-Watson Alt.
L_t					
L_{t-1}	1.56	***	0.14	0.00	0.28
L_{t-2}	-0.62	***	0.13	0.00	0.57
I_t	1.50	***	0.58	0.01	0.20
Constant	22.26		37.79	0.56	
Durbin-Watson Transformed	1.93				
R squared	0.97				
No. of Observations	38				

Note: The ***, **, and * represent the level of statistical significance for the coefficient with 1%, 5%, and 10% significance, respectively.

Equation (10) found a statistically significant relationship between net farm income and land value for the majority of the nine CRD's. However, there were two exceptions; the East Central and South West Districts. While these results are unexpected, there are several possible explanations for the differences in results across CRD's. One reason a statistically significant relationship was not identified in the South West and East Central districts is the choice of data aggregation to the CRD level. There could be individual counties within a CRD that have this relationship, but if it was not strong enough or widespread throughout the CRD the model would not reveal it. This result indicates there was some other factor that had a larger impact on land value than net farm income.

In the case of the East Central district, urban pressure may be a larger factor in terms of land value than net farm income. The land value in the East Central counties reflects urban development pressure in addition to farm income. Population for each crop reporting district is graphed in figure 6. The East Central district contains more populous counties than any other district, including Johnson, Shawnee, and Douglas Counties. These counties are home to the suburban areas surrounding Kansas City, Missouri. As a result, land value may not be driven exclusively by net farm income because of the development potential of open land in this region for residential, commercial, or light industrial purposes (Bureau, 2010).

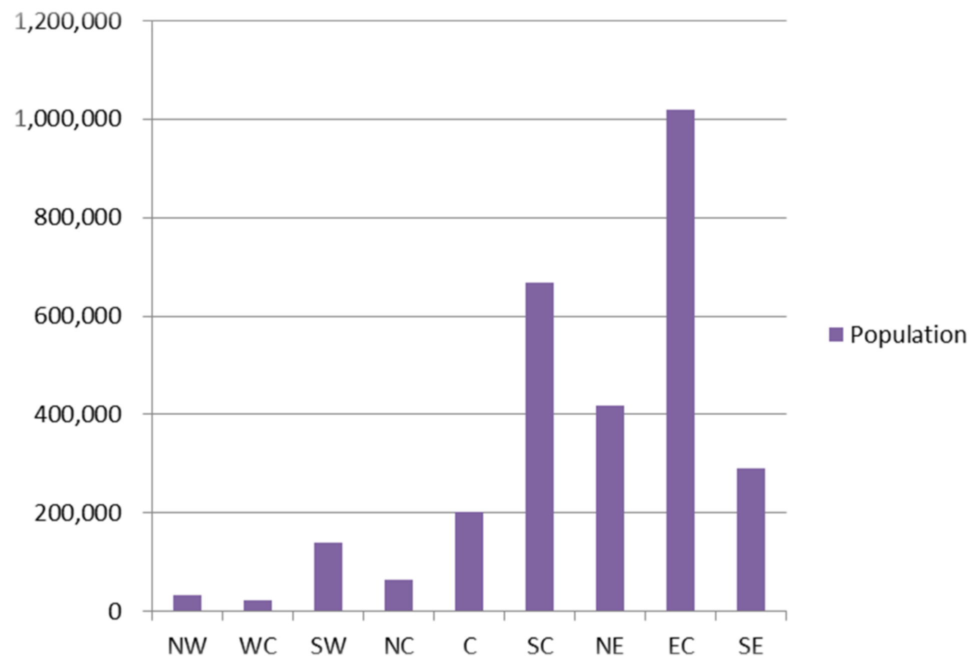

Figure 6: Population by CRD

The results of the model for the South West district did not confirm expected signs of estimated coefficients. While last year's land value was a statistically significant driver of current land value, previous land values and net farm income do not appear to affect land value. One explanation for this result is the quality composition of farmland in Southwest Kansas. The more irrigated farmland a region has, the less variation there is in crop yields and, ultimately, net farm income. The availability of irrigation water in perpetuity, if observed over time, would reduce the amount of year to year variability. This reduction of variability in net farm income may be different enough, relative to the other CRD's income variability, to explain why the South West land model yielded different results. Table 29 below shows irrigated acres as a percentage of total acres for each region. On average, the South West district reported the highest percentage of irrigated acres at 9.34 percent.

Table 29: Percent of Irrigated Acres by CRD

Region	NW	WC	SW	NC	C	SC	NE	EC	SE
1975	3.74%	4.58%	5.22%	1.50%	1.65%	2.58%	1.57%	0.64%	0.27%
1980	4.82%	3.58%	8.66%	1.80%	0.98%	3.71%	2.75%	0.95%	1.02%
1985	7.37%	5.12%	9.01%	3.70%	5.05%	7.64%	1.73%	1.33%	1.22%
1990	7.06%	4.93%	11.38%	2.88%	3.94%	6.60%	3.08%	1.82%	0.76%
1995	6.35%	4.55%	12.98%	2.44%	3.21%	6.14%	1.16%	1.96%	0.39%
2000	8.48%	5.67%	11.43%	1.54%	3.14%	8.02%	1.14%	2.18%	0.35%
2005	7.95%	5.90%	7.71%	4.62%	3.54%	9.12%	5.03%	2.74%	0.41%
2010	8.52%	7.79%	8.30%	2.92%	1.82%	6.71%	4.28%	3.29%	0.30%
Average	6.79%	5.26%	9.34%	2.68%	2.91%	6.32%	2.59%	1.86%	0.59%

Although Burt (1986) dismissed speculative forces, such as oil and gas prospects, as contributable factors in explaining land value variation, the existence of speculative forces in the South West district could explain the different results. If land buyers purchase land primarily due to their future expectation of the land to grow in value, speculative forces are at play. In table 26 below, South West Kansas oil and gas production has been occurring since 1950 (The University of Kansas, 2015). In this case, oil and gas forces have been influencing land values over a period of 65 years and could be a primary source of value for the land in this area. Southwest Kansas is among the top four producing regions in crude oil production and the top producer in natural gas production. The oil production is not enough to distinguish southwest Kansas from other regions, however, the large natural gas production does make this region different. It also may not solely be gas production but the value of production relative to the agriculture value of production. It could be the majority of the land value is driven by oil production rather than the agriculture value.

Table 30: Kansas Oil and Gas Production 1950-2015

Region	Years	Oil Production (barrels)	Gas Production (mcf)
South West	1950-1959	2,028,498	535,712,332
	1960-1969	8,498,885	668,286,798
	1970-1979	7,807,002	760,873,541
	1980-1989	8,577,584	448,499,262
	1990-1999	10,358,957	596,665,201
	2000-2009	7,695,446	337,104,820
	2010-2015	6,786,817	166,269,362
	Average	**7,393,313**	**501,915,902**
Central	1950-1959	54,630,964	5,505,593
	1960-1969	36,966,962	9,585,472
	1970-1979	20,928,730	4,729,291
	1980-1989	17,836,935	5,237,610
	1990-1999	10,962,795	3,163,434
	2000-2009	8,540,744	2,216,490
	2010-2015	8,259,708	1,567,398
	Average	**22,589,548**	**4,572,184**
South Central	1950-1959	20,295,003	44,616,518
	1960-1969	21,456,462	132,418,775
	1970-1979	11,633,210	92,769,087
	1980-1989	11,506,573	72,766,781
	1990-1999	7,122,519	54,146,861
	2000-2009	5,654,313	47,042,092
	2010-2015	6,895,373	50,412,085
	Average	**12,080,493**	**70,596,028**
South East	1950-1959	22,034,273	2,796,329
	1960-1969	16,362,701	5,930,767
	1970-1979	8,914,469	2,041,901
	1980-1989	9,773,562	4,149,343
	1990-1999	5,592,983	3,863,563
	2000-2009	3,432,656	22,675,348
	2010-2015	3,021,619	30,080,482
	Average	**9,876,037**	**10,219,676**

The impact of water scarcity in the South West could also be a factor that has more of an impact than net farm income. Figure A1 illustrates the usable lifetime of the Ogallala Aquifer in Kansas. Although there were various degrees of depth throughout the western one-third of the state, the majority of southwest Kansas spanned over the deepest areas of the aquifer, and therefore, had the most useful life remaining (University of Kansas, 2015) . This attribute could potentially have made the land in that area more desirable or less risky in the minds of producers. Those who desire to purchase farmland in that area may have been willing to pay more than was justified by the productivity of the land. The water prospects for this region, over the time period analyzed, could have influenced land values more than the net farm income associated with the land. Although the topics discussed above are valid and justifiable reasons for what was observed in the South West, further research is necessary to explain the results with any degree of certainty.

Short-Run and Long-Run Elasticity

Elasticity between net farm income and land value was calculated to test responsiveness and sensitivity in the regions. The following formula was used to calculate the short-run elasticity value for each district

$$Elasticity_{SR} = Derivative\ of\ I_t \ * \left[\frac{Income_{2012}}{Land\ Value_{2012}}\right], \qquad (11)$$

where $Derivative\ of\ I_t$ is the 2012 estimated coefficient for I_t from the equation (10) models, $Income_{2012}$ is the average net farm income in 2012, and $Land\ Value_{2012}$ is the land value in 2012. The elasticity values in table 31 below were then used to show the effect a 1% increase in net farm income would have on land value. That was done using the following formula:

$$\Delta\ in\ Land\ Value = Land\ Value_{2012} * Elasticity \qquad (12)$$

Table 31: Short Run Elasticity of Land Value to Changes in Net Farm Income

	Elasticity	If I_t increases by 1% L_t increases by:
North West	0.106	$113
West Central	0.062	$60
South West	0.033	$35
North Central	0.073	$108
Central	0.077	$118
South Central	0.063	$105
North East	0.061	$154
East Central	0.037	$91
South East	0.061	$107
Kansas	0.067	$108

In the short run, the North East region land value was the most responsive to changes in net farm income. If net farm income increased by 1% the land value in the North East region increased by $154. In the South West and East Central regions, where net farm income was not statistically significant, land value is the least responsive to changes in net farm income. The land value in these regions responds to factors other than net farm income. The West Central district was also one of the least responsive regions. If income in the West Central district increased by 1% land value increased by $60. An explanation for why the West Central district displayed this elasticity is due to the similarities it shares with the South West district. The districts are close enough in proximity to be exposed to the same type of environment and share the same influencing factors that caused the South West district to stand out.

The table below represents the long run responsiveness of land value to net farm income. To calculate the long run elasticity it was necessary to manipulate the lag operators and determine the long-run multiplier (Sargent, 1979).

As expected, the long-run elasticity for each district is more elastic than in the short-run; land value has more time to react to changes in net farm income in the long run. Additionally, the implied capitalization rate was calculated using the following

$$Implied\ Capitalization\ Rate = 100 * \frac{1}{Long{-}Run\ Multiplier} \quad (13).$$

The capitalization rate provides information on the expectation of risk and can be viewed as a measure of risk in the regions. It is the implied capitalization rate for net farm income in the long run. The rates reported below indicate the South West region, at 12.19%, has the most risk relative to the other regions. The East Central region, at 1.56%, implies this region has the least amount of risk. This low rate could be expected due to the presence of urban pressure in the region and the ratio of agricultural and nonagricultural use of the land. Less of the overall land in this region is in agriculture so the agriculture risk is expected to be less.

Table 32: Long Run Responsiveness of Land Value to Changes in Net Farm Income

CRD	Short-Run Elasticity	Long-Run Elasticity	Long-Run Multiplier	Implied Capitalization Rate
NW	0.11	1.14	17.63	5.67%
WC	0.06	0.96	17.04	5.87%
SW	0.03	0.30	8.21	12.19%
NC	0.07	0.92	18.12	5.52%
C	0.08	0.91	20.87	4.79%
SC	0.06	0.93	24.06	4.16%
NE	0.06	0.70	16.97	5.89%
EC	0.04	1.97	63.95	1.56%
SE	0.06	1.49	25.94	3.86%
State	0.07	0.97	21.71	4.61%

Chapter 6 - Future Land Values

To expand the research conducted in this study, the estimated coefficients from the model presented in equation (10) were used to predict land values for the next three years. Price, net farm income, and yield data were needed from 1995 to 2016 to estimate gross farm income. This variable was modeled as a function of historic average crop yields and basis-adjusted future prices. Crop yields and futures price data were collected for corn, soybeans, grain sorghum, and wheat. Once estimated, the gross farm income variable will be used to estimate the predicted net farm income variable.

The yield data were collected from the six Kansas Farm Management Associations from 1990 through 2013. KFMA reported each commodity with an average yield for non-irrigated owned and rented acres, and irrigated owned and rented acres. The owned yield and rented yield were first averaged, then acre weights for irrigated and non-irrigated were used to form a weighted average yield for a given district. The percentage weights used were the same as those used to calculate weighted cash rent in equation (5) and (6). To estimate the crop yields in 2014, 2015, and 2016 a trend yield was used based on the crop yields during 1995 through 2013. Each crop's yield was regressed over time and the estimated intercept and coefficient were used to arrive at a projected trend yield for 2014, 2015, and 2016.

All futures price information was recorded from a single point in time. Futures prices used from 1995 through 2013 were the average of harvest contracts for each crop. Wheat futures prices were taken as the July contract from the Kansas City Board of Trade (KCBT). Corn and soybeans futures prices were taken as the October contract from the Chicago Board of Trade (CBT). Grain sorghum is not traded on the exchanges, so the corn contract was used. The last year of data analyzed in this study was 2013, so predictions were made for the next three years.

The futures prices used were the average of harvest contracts for each crop in the month of November, 2013. The harvest futures prices for wheat were the 2014, 2015, and 2016 July contracts from the KCBT. For corn and soybeans the 2014, 2015, and 2016 October CBT contracts were used. Grain sorghum utilized the corn futures prices.

Data to calculate cash price were available at various locations across Kansas. A single location was chosen to represent each CRD. For the wheat basis over the period 1995 through 2013, a five year average of the June weekly average was used. The basis is calculated as the difference between the cash price bid at a given location and the nearby futures price. In this case, the nearby contract was the July KCBT contract. Corn, soybeans, and grain sorghum basis data was a five year average of the September weekly average from the years 1995 through 2013 of the nearby basis, which was calculated using the October CBT contract. The harvest contract futures prices were added to the basis levels in each region to arrive at a cash price for each crop from 1995 through 2013. To calculate cash price expectations for the next three years the wheat basis data used was the June average over the period 2011 – 2013 and was calculated using the July KCBT contract. Corn, soybeans, and grain sorghum basis data was the September average from the years 2011 – 2013 of the nearby basis, which was calculated using the October CBT contract. The futures prices from 2014 - 2016 were added to the basis levels in each region to arrive at a cash price expectation for these years.

The basis reporting locations chosen for the CRD’s are listed in table 33. For various regions, the primary reporting location did not report each commodity basis over the entire time period. For example, in the Central region, Great Bend only reported the basis for grain sorghum in 1995, 1996, and 1997. As a result, the grain sorghum basis from 1998 through 2013 was taken from Hutchinson, which was chosen as the secondary reporting location for the Central region.

The average basis for each crop across regions is reported in Table 33, as well. The basis for the four crops is different across the regions which means the cash price relative to the futures price will be different across regions. To account for this difference, a basis adjusted futures price was used for each region, rather than using the same futures price for all regions.

Table 33: Basis Reporting Locations

Region	Primary Reporting Location	Secondary Reporting Location	Average Basis			
			Corn	Sorghum	Soybeans	Wheat
NW	Colby	Goodland	-0.23	-0.51	-0.80	-0.41
WC	Scott City	-	-0.11	-0.46	-0.66	-0.44
SW	Dodge City	-	-0.09	-0.44	-0.60	-0.41
NC	Salina	Beloit	-0.29	-0.24	-0.49	-0.13
C	Great Bend	Hutchinson	-0.18	-0.32	-0.60	-0.36
SC	Hutchinson	-	-0.22	-0.42	-0.53	-0.28
NE	Emporia	Topeka	-0.27	-0.46	-0.16	-0.36
EC	Emporia	Topeka	-0.27	-0.41	-0.16	-0.36
SE	White Water	-	-0.22	-0.46	-0.49	-0.31

To appropriately allocate the crop cash price and respective yield within a CRD, the return per crop was acre-weighted. This weighted crop return was calculated using USDA-NASS harvested acre data for each CRD. To project weighted acres for corn, grain sorghum, soybean, and wheat acres in 2014 to 2016 average weights were calculated from 2010 through 2013.The equation below was used to estimate gross farm income from 1995-2016:

$$GFI_t = [P_t^C + B_t^C] * Y_t^C * w_c + [P_t^{SB} + B_t^{SB}] * Y_t^{SB} * w_{sb} + [P_t^S + B_t^S] * Y_t^S * w_S + [P_t^W + B_t^W] * Y_t^W * w_w \quad (14)$$

where P_t was the futures price for the respective commodity, B_t was the basis for the respective commodity, Y_t was the five year average yield of each commodity in the CRD, and 'w' represented the percentage allocation of each crop in a given CRD. The futures price and basis together form the estimated cash price for the given commodity. In equation (14) $[P_t^C + B_t^C] *$

$Y_t^C * w_c$ represents the weighted returns to corn, $[P_t^{SB} + B_t^{SB}] * Y_t^{SB} * w_{sb}$ represents the weighted returns to soybeans, $[P_t^S + B_t^S] * Y_t^S * w_S$ represents the weighted returns to grain sorghum, and $[P_t^W + B_t^W] * Y_t^W * w_w$ represents the weighted returns to wheat.

In order to formulate a predicted net farm income variable a relationship was defined between net farm income and gross farm income from equation (14). That relationship is defined as

$$I_t = \alpha + \beta(GFI_t) \qquad (15)$$

where I_t represents predicted net farm income and GFI_t represents estimated gross farm income. GFI_t was estimated for the years 1995-2016 and the relationship estimated in equation (15) was used to calculated I_t for the years 1995-2016.

The I_t variable from equation (15) was used in the following formula to calculate a predicted land value from 1995 to 2016 for each district. Equation (16) below represents the calculation for the predicted land value in 1996.

$$Predicted\ Land\ Value_{1996} = Constant + Derivative\ of\ L_{t-1} * L_{1995} + Derivative\ of\ L_{t-2} * L_{1994} + Derivative\ of\ I_t * I_{1996} \qquad (16)$$

The constant and derivatives of the above variables were taken from the land value model estimations found in tables 19 through 28. L_{1995} and L_{1994} represent the real land value in 1995 and 1994, respectively, and I_{1996} represents the estimated net farm income in 1996. Equation (16) was used to predict land values for each of the nine CRD's and the state of Kansas.

Forecast Results

The forecasted land values for each CRD are shown in tables 34 through 43. The tables report the predicted and nominal land value as well as the estimated and observed net farm income for comparison. Figures 7 through 16 show the predicted land values and estimated net farm income graphed over time for each CRD. The last three data points for net farm income are projected values. The trend shown in the figures was similar for all nine CRD's. The predicted land value was consistently estimated as increasing, but increasing at a decreasing rate. The estimated net farm income is projecting the continuation of suppressed net farm income and in some regions, future decreases. The values in the tables show the predicted land value higher than the nominal value. The estimated net farm income and the observed net farm income follow a similar pattern; however, the estimated net farm income has less variation from year to year. Figure 17 below represents the estimated net farm income and the observed net farm income for Kansas.

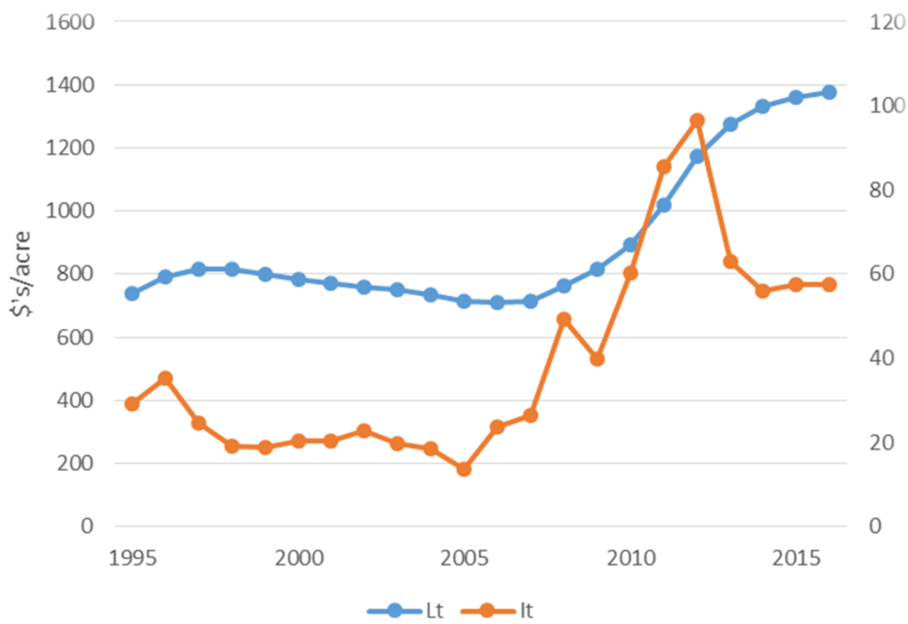

Figure 7: North West Land Value and Net Farm Income-Forecast

Table 34: North West Land Value and Net Farm Income-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	740	491	29	20
1996	792	488	35	25
1997	815	500	25	33
1998	814	490	19	18
1999	801	490	19	26
2000	785	530	20	33
2001	770	555	20	20
2002	760	550	23	15
2003	749	520	20	-3
2004	736	570	18	28
2005	715	640	14	18
2006	709	650	24	27
2007	716	690	27	23
2008	765	730	49	74
2009	814	760	40	43
2010	892	789	60	30
2011	1019	913	86	86
2012	1175	1065	97	102
2013	1277		63	69
2014	1332		56	
2015	1362		58	
2016	1377		58	

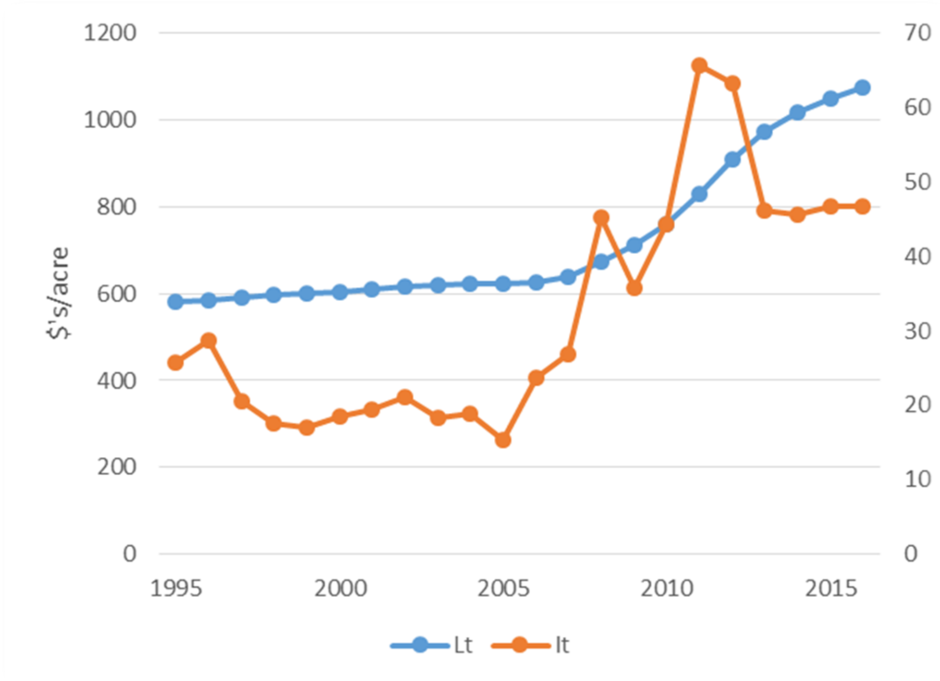

Figure 8: West Central Land Value and Net Farm Income-Forecast

Table 35: West Central Land Value and Net Farm Income-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	582	386	26	18
1996	585	399	29	16
1997	592	410	21	35
1998	598	410	17	21
1999	601	405	17	22
2000	604	435	18	24
2001	609	445	19	18
2002	615	460	21	18
2003	620	430	18	-2
2004	623	480	19	24
2005	622	530	15	21
2006	627	550	24	23
2007	639	600	27	11
2008	675	630	45	73
2009	713	650	36	43
2010	759	685	44	33
2011	830	812	66	45
2012	910	971	63	75
2013	971		46	55
2014	1016		46	
2015	1050		47	
2016	1074		47	

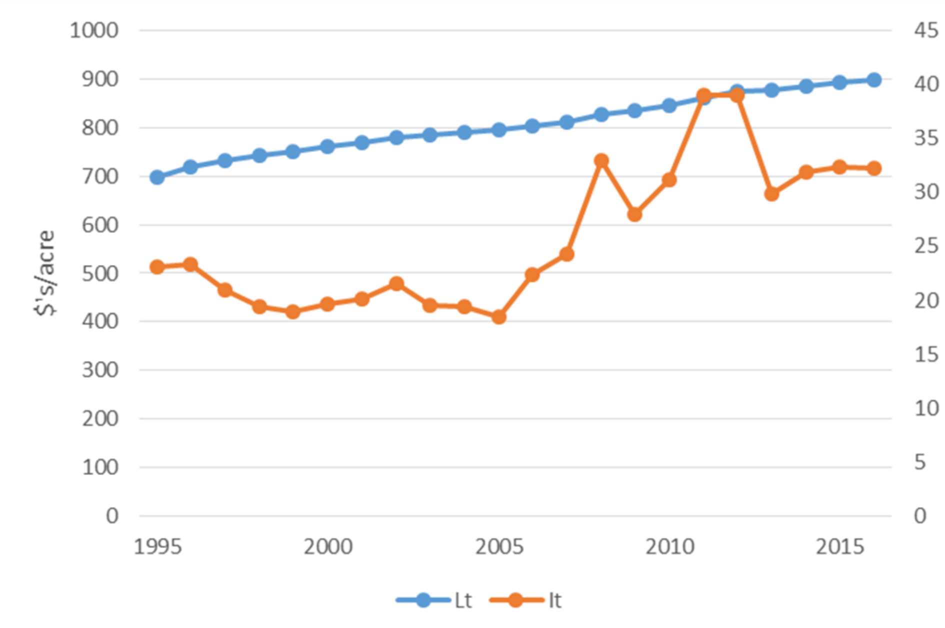

Figure 9: South West Land Value and Net Farm Income-Forecast

Table 36: South West Land Value and Net Farm Income-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	699	464	23	17
1996	720	469	23	13
1997	732	480	21	30
1998	742	490	19	27
1999	752	500	19	17
2000	761	525	20	33
2001	770	540	20	21
2002	779	550	22	13
2003	785	520	19	5
2004	791	570	19	26
2005	796	610	18	18
2006	804	620	22	14
2007	812	660	24	17
2008	827	700	33	44
2009	834	710	28	43
2010	845	768	31	31
2011	861	896	39	42
2012	874	1061	39	25
2013	879		30	38
2014	886		32	
2015	892		32	
2016	898		32	

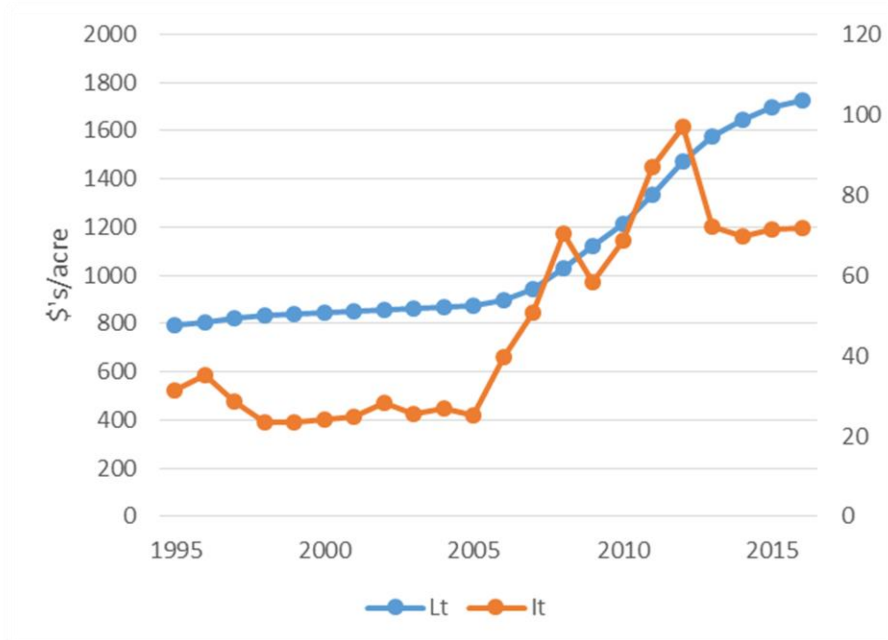

Figure 10: North Central Land Value and Net Farm Income-Forecast

Table 37: North Central Land Value and Net Farm Income-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	794	527	31	21
1996	806	526	35	17
1997	823	540	29	50
1998	834	550	23	36
1999	841	580	23	23
2000	845	605	24	34
2001	849	625	25	22
2002	857	640	28	26
2003	863	595	25	10
2004	870	670	27	40
2005	873	800	25	25
2006	895	850	40	27
2007	943	970	51	38
2008	1031	990	70	73
2009	1119	1000	58	76
2010	1215	1058	69	62
2011	1334	1245	87	79
2012	1473	1477	97	105
2013	1576		72	75
2014	1647		70	
2015	1695		72	
2016	1725		72	

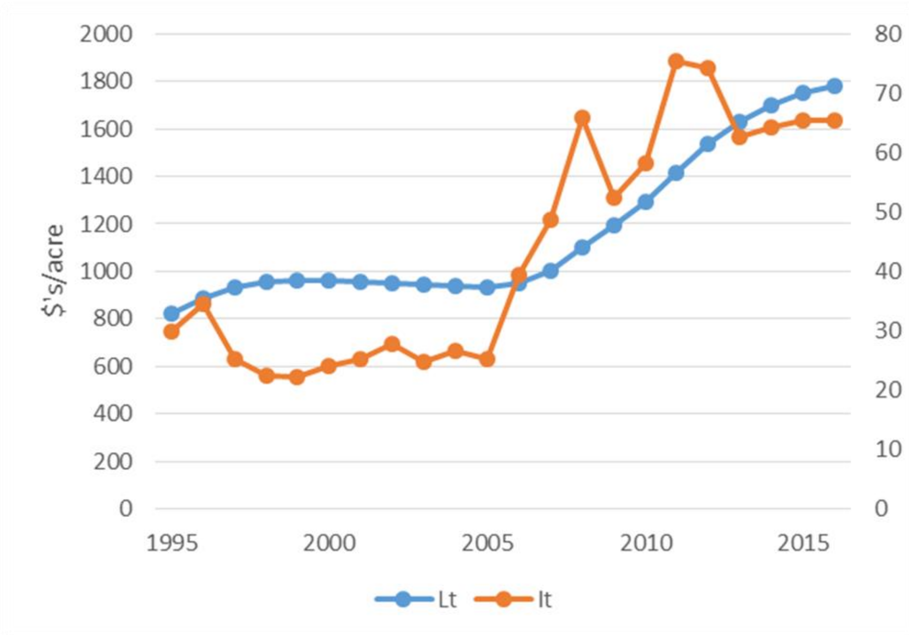

Figure 11: Central Land Value and Net Farm Income-Forecast

Table 38: Central Land Value and Net Farm Income-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	821	545	30	26
1996	888	521	35	15
1997	934	540	25	51
1998	957	560	23	44
1999	963	620	22	13
2000	961	610	24	29
2001	954	630	25	24
2002	951	660	28	19
2003	944	610	25	8
2004	938	680	27	32
2005	932	780	25	32
2006	951	810	39	25
2007	1001	940	49	30
2008	1098	990	66	62
2009	1194	1000	52	72
2010	1292	1079	58	61
2011	1412	1281	75	82
2012	1535	1539	74	72
2013	1629		63	67
2014	1700		64	
2015	1750		65	
2016	1783		65	

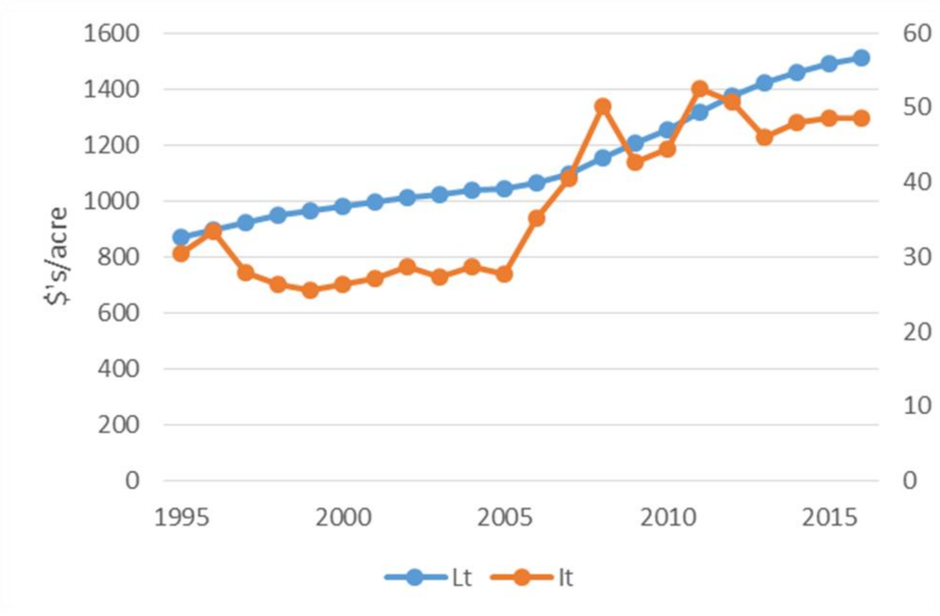

Figure 12: South Central Land Value and Net Farm Income-Forecast

Table 39: South Central Land Value and Net Farm Income-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	872	579	30	27
1996	896	554	33	16
1997	923	570	28	48
1998	947	590	26	46
1999	966	590	25	19
2000	982	640	26	34
2001	997	655	27	27
2002	1012	685	29	10
2003	1025	640	27	16
2004	1037	710	29	33
2005	1046	810	28	32
2006	1064	900	35	23
2007	1097	990	40	32
2008	1152	1050	50	46
2009	1205	1080	43	55
2010	1256	1152	44	41
2011	1315	1376	52	58
2012	1373	1665	51	43
2013	1419		46	64
2014	1457		48	
2015	1488		49	
2016	1513		49	

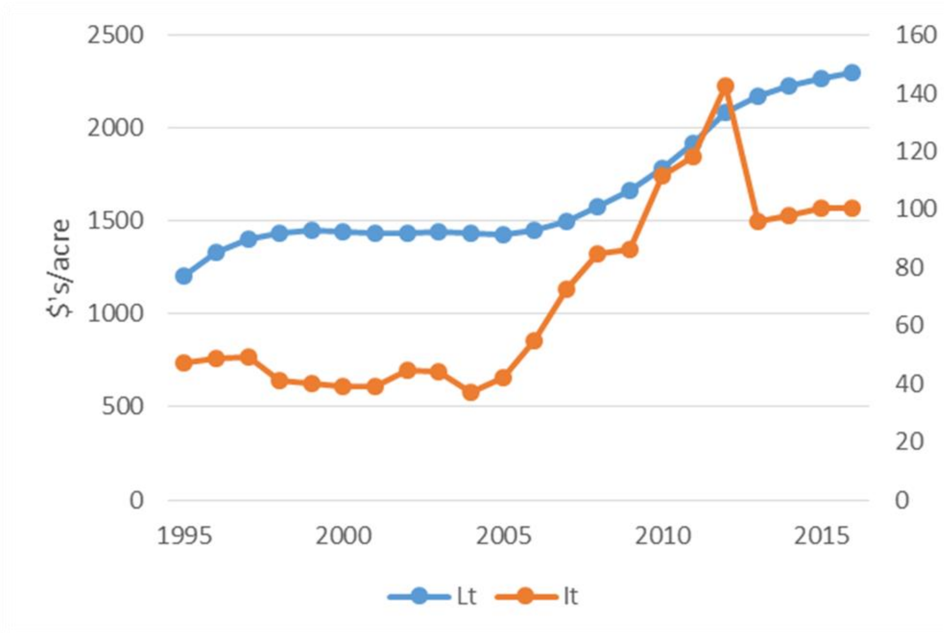

Figure 13: North East Land Value and Net Farm Income-Forecast

Table 40: North East Land Value and Net Farm Income-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	1205	800	47	51
1996	1333	811	49	32
1997	1407	810	49	89
1998	1438	830	41	55
1999	1447	900	40	19
2000	1445	920	39	27
2001	1438	945	39	40
2002	1438	990	45	40
2003	1440	910	44	9
2004	1433	1020	37	37
2005	1429	1270	42	71
2006	1447	1460	55	54
2007	1498	1800	72	59
2008	1578	1820	85	108
2009	1664	1680	86	108
2010	1784	1775	112	88
2011	1917	2107	118	92
2012	2081	2516	143	158
2013	2172		96	103
2014	2229		98	
2015	2269		100	
2016	2300		100	

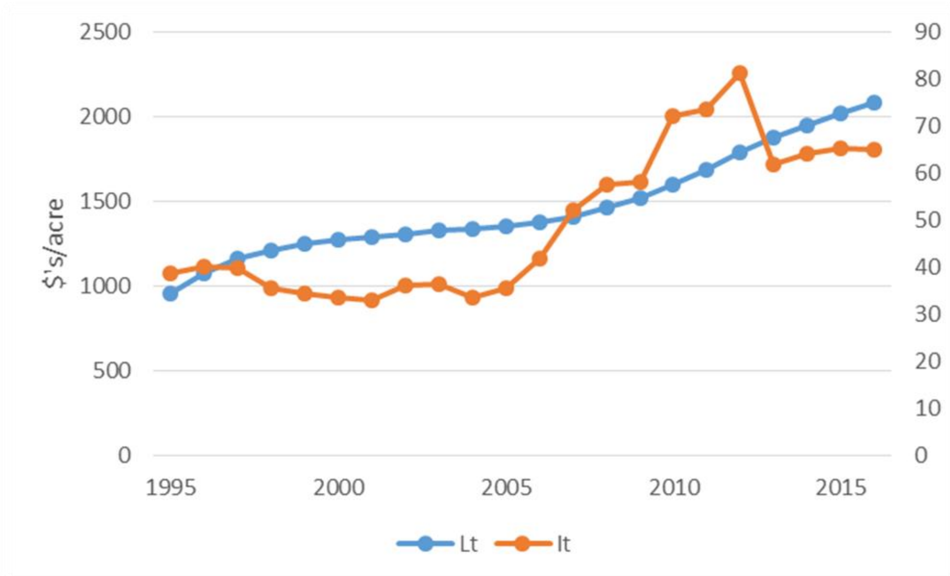

Figure 14: East Central Land Value and Net Farm Income-Forecast

Table 41: East Central Land Value and Net Farm Income-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	954	633	39	35
1996	1077	813	40	26
1997	1159	790	40	87
1998	1211	800	35	67
1999	1246	855	34	5
2000	1271	850	33	19
2001	1288	875	33	21
2002	1306	920	36	39
2003	1324	850	36	4
2004	1337	970	33	30
2005	1351	1150	35	60
2006	1373	1270	42	46
2007	1410	1540	52	34
2008	1461	1560	57	53
2009	1520	1590	58	81
2010	1598	1712	72	83
2011	1687	2032	74	66
2012	1789	2436	81	64
2013	1873		62	75
2014	1948		64	
2015	2018		65	
2016	2084		65	

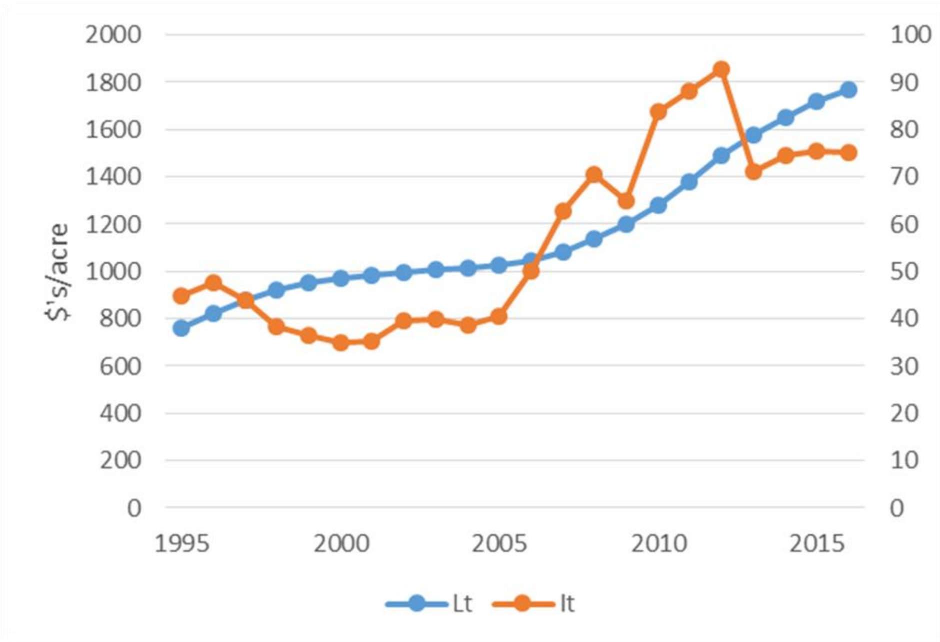

Figure 15: South East Land Value and Net Farm Income-Forecast

Table 42: South East Land Value and Net Farm Income-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	758	503	45	51
1996	820	548	48	18
1997	877	575	44	65
1998	920	590	38	85
1999	952	615	36	8
2000	972	650	35	14
2001	985	685	35	36
2002	997	690	40	31
2003	1008	645	40	33
2004	1016	740	39	52
2005	1024	870	40	47
2006	1043	940	50	38
2007	1080	1040	63	24
2008	1138	1100	70	81
2009	1200	1130	65	96
2010	1283	1225	84	79
2011	1381	1451	88	107
2012	1490	1742	93	62
2013	1578		71	100
2014	1653		75	
2015	1717		76	
2016	1771		75	

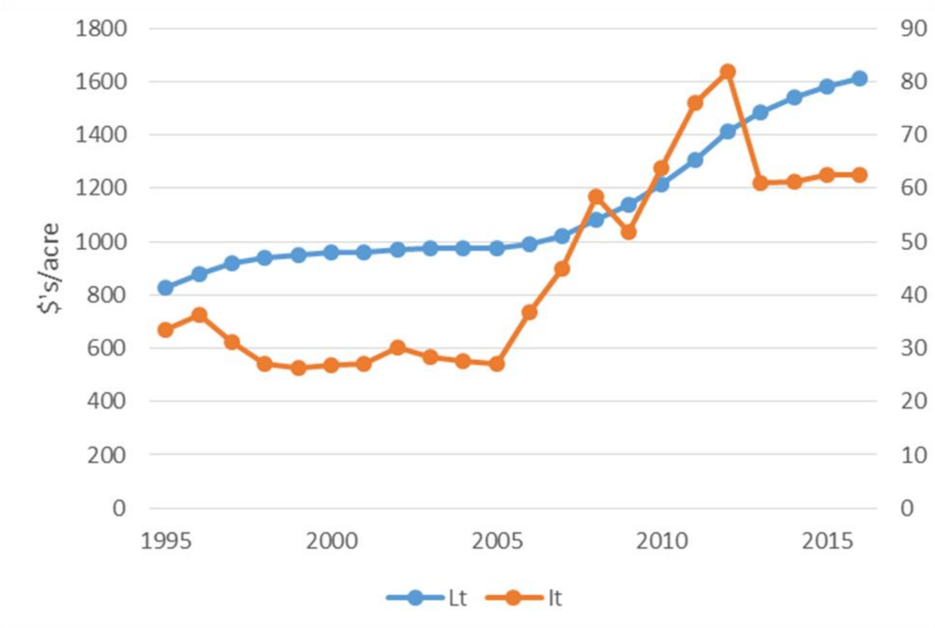

Figure 16: Kansas Land Value and Net Farm Income-Forecast

Table 43: Kansas Land Values-Forecast

Year	Predicted L_t	Nominal L_t	Predicted I_t	Observed I_t
1995	825	548	33	20
1996	880	570	36	54
1997	918	579	31	44
1998	940	590	27	17
1999	952	617	26	27
2000	959	641	27	25
2001	962	662	27	24
2002	968	683	30	9
2003	973	636	28	34
2004	976	712	28	36
2005	976	829	27	31
2006	990	894	37	30
2007	1022	1026	45	68
2008	1080	1063	59	69
2009	1140	1067	52	56
2010	1214	1138	64	73
2011	1306	1346	76	78
2012	1411	1608	82	72
2013	1486		61	
2014	1541		61	
2015	1582		63	
2016	1614		63	

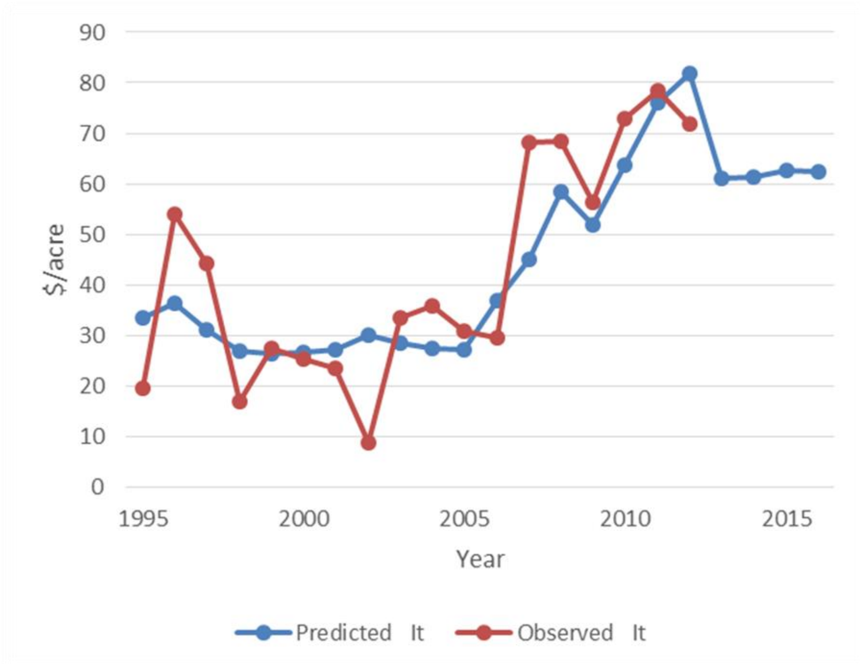

Figure 17: Predicted Net Farm Income and Observed Net Farm Income

The percentage change in land value from year to year in each region is reported in table 44. Starting in 2012, the majority of forecast models estimated a year after year decrease in the percentage change in land value. The only exception was for the South West district which experienced a year to year increase in land value from 2013 to 2014, but then experienced a decrease in land value growth in 2014 to 2015 and 2015 to 2016.

Table 44: Percentage Change in Year to Year Land Value

	% Changes in Land Value Over Time									
	NW	WC	SW	NC	C	SC	NE	EC	SE	Kansas
1995										
1996	7.03	0.65	3.03	1.53	8.12	2.74	10.62	12.97	8.27	6.65
1997	2.96	1.20	1.58	2.10	5.18	2.97	5.50	7.56	6.85	4.32
1998	-0.14	0.88	1.48	1.35	2.51	2.59	2.23	4.53	4.99	2.43
1999	-1.65	0.55	1.25	0.78	0.64	2.03	0.66	2.91	3.42	1.27
2000	-1.95	0.57	1.24	0.56	-0.28	1.70	-0.16	1.95	2.16	0.68
2001	-1.92	0.72	1.14	0.46	-0.66	1.51	-0.50	1.40	1.30	0.39
2002	-1.25	1.09	1.19	0.97	-0.39	1.53	0.02	1.37	1.19	0.64
2003	-1.48	0.73	0.79	0.70	-0.74	1.22	0.14	1.35	1.08	0.47
2004	-1.75	0.55	0.77	0.71	-0.54	1.15	-0.53	1.03	0.82	0.27
2005	-2.80	-0.22	0.58	0.38	-0.65	0.87	-0.26	1.04	0.82	0.08
2006	-0.81	0.81	1.00	2.58	2.02	1.81	1.25	1.59	1.80	1.42
2007	0.88	1.94	1.00	5.35	5.26	3.05	3.56	2.72	3.63	3.18
2008	6.82	5.63	1.86	9.33	9.67	5.00	5.30	3.65	5.31	5.74
2009	6.47	5.60	0.88	8.51	8.74	4.60	5.48	4.01	5.47	5.54
2010	9.61	6.44	1.33	8.55	8.17	4.25	7.21	5.15	6.90	6.44
2011	14.16	9.43	1.92	9.84	9.31	4.74	7.46	5.56	7.64	7.63
2012	15.33	9.62	1.53	10.39	8.72	4.41	8.53	6.06	7.88	8.03
2013	8.66	6.73	0.47	7.02	6.15	3.32	4.41	4.66	5.95	5.31
2014	4.31	4.65	0.84	4.48	4.31	2.66	2.61	4.01	4.75	3.68
2015	2.27	3.30	0.71	2.89	2.96	2.14	1.81	3.61	3.87	2.69
2016	1.13	2.30	0.65	1.77	1.89	1.67	1.33	3.28	3.11	1.99

The predicted land values indicate a pending decrease in land values, based on expected net farm income for the years 2014, 2015, and 2016. The expected decrease in land value has yet to be realized. The Kansas City Federal Reserve Bank, which is a member of the 10th district, published their February 2015 edition of the Agricultural Newsletter. This newsletter provides survey results from 360 agricultural banks across the 10th district. The survey focused on reporting indictors of farm financial conditions and land values. Survey findings reported farm income has been decreasing since 2010, but also reported land values remained steady in 2014 (Kauffman, 2014). The 2014 value remained steady, however, the growth in land values have been slowing. Table 45 reports the annual average percentage change in land value for 2012 through 2014. The changes are positive which indicate land value continued to increase, but at a decreasing rate (Federal Reserve Bank of Kansas City, 2014).

Table 45: Annual Average % Change in Land Value

Year	Non Irrigated	Irrigated	Pasture
2012	25.10	28.05	16.30
2013	16.39	18.91	13.30
2014	3.13	3.88	8.20

The forecasted land values, as a result of this study, align with the expectations of the KC Fed and its' survey audience. Land Value was modeled as a function of net farm income in this study, however, this was likely a key indicator for survey respondents and why they expected decreasing growth rates. The low commodity prices have a direct impact on farm income and the futures prices for the next two years indicate the prices are expected to remain low. Survey respondents are observing the current commodity market, expecting further decreases in income, and expecting land value growth to respond.

To further confirm the difference in land valuation across states, the Chicago Federal Reserve Bank, which represents the 7th district, published their newsletter which presented a different agricultural environment. The 7th district is composed of Illinois, Indiana, Iowa, Michigan and Wisconsin, which encompasses the Corn Belt region. Their newsletter reported a 3 percent decrease in good farmland values in 2014 as well as a decrease in net farm income (Chicago Federal Reserve, 2015).

Chapter 7 - Conclusion

The research in this paper contributed to land value research by focusing on the specific relationship between land value and cash rent value. Specifically the empirical relationship between land value and cash rent value was tested for its' presence in Kansas. The relationship; where land value was a function of historical cash rent and cash rent was a function of net returns to the land, was found to exist for a single county in Indiana by Featherstone and Baker (1988).

Results from this study determined the relationship was not observed in the majority of the nine crop reporting districts in Kansas during the time period analyzed. Ultimately, it was discovered land valuation in Kansas behaved differently than that observed by Featherstone and Baker in Indiana. Adjustments were made to the original land valuation model to better estimate values for Kansas. Land value, in this research, was estimated as a function of net farm income, land value in the prior year, and land value two years prior. Results from the majority of the modified models indicated net farm income had a positive effect and was important in determining land value. This confirms land valuation in Kansas behaves differently than in the "I" states.

There were two regions where net farm income did not prove to be different from zero, indicating it was not the primary driver of land value. In these regions, net farm income did not track closely enough to the variation in land value. This may be due to the presence of non-agricultural factors and the value they add to the land or the lower variability in yield due to irrigation.

Forecasted results indicated a decrease in net farm income and, therefore, predicted a decrease in the growth of land value for 2014 through 2016. There has been a downward trend in net farm income in Kansas and this trend is expected to continue; implying future decreases in land value.

If the relationship observed in equation (10) holds, and decreases in land value are expected, the interest now lies in how long it will take land values to realize the decrease in net farm income and adjust. The answer will affect the environment within which farmers and ranchers, agribusinesses, and agriculture finance institutions operate.

The information regarding future land value is needed by farmers and ranchers as they plan the next 5 to 10 years of their operations. Producers are coming off some high income years and may still have cash reserves. Decisions regarding the use of this cash are important. Do they choose to purchase land now, in hopes of growing their operation, at a relatively high price or wait until the prices drop, as they are expected? Or rather than depleting their cash reserves, do they choose to retain this working capital to provide cushion for the next few years of projected low income?

Decisions made by producers have an effect on agriculture lending banks and loan demand. Additionally, banks need the information provided by this study to become aware of the responsiveness of land values to net farm income changes. This information can be an important tool in performing sensitivity analysis for borrowers. If a borrower lives in a certain region of Kansas and their net income decreased by a given amount, analysts could project how this would change their real estate collateral position in the future.

The entire agribusiness industry would be affected if the projected net farm income and land value decrease is realized. Farmers and ranchers restrict capital purchases in bad years and expand capital purchases in good years. With bad years on the horizon agribusinesses could expect to see less capital being spent by agriculture producers, affecting the agribusinesses' bottom line.

This study revealed the importance of valuing Kansas land based on net farm income directly rather than cash rent value. Based on the results within this research, a shift in how future research in Kansas land value is done may be necessary. Knowing there are differences in land valuation across regions in Kansas future research may also need to account for the impact of speculative forces and the different agriculture environments.

References

Bureau, U. C. (2010). *General Population Characteristics: Kansas.* Retrieved from U.S. Census Bureau: http://www.census.gov/prod/cen2000

Burt, O. R. (1986). Econometric Modeling of the Capitalization Formula for Farmland Prices. *American Journal of Agricultural Economics*, 10-26.

Chicago Federal Reserve. (2015, February 12). *AgLetter: Midwest Farmland Values Down Slightly.* Retrieved from Chicago Federal Reserve: https://www.chicagofed.org/publications/agletter/index

Clark, J. S., Fulton, M., & Scott, Jr., J. T. (1993). The Inconsistency of Land Values, Land Rents, and Capitalization Formulas. *American Journal of Agricultural Economics*, 147-155.

Duffy, M., & Johanns, A. (2014). *Farmland Ownership and Tenure in Iowa.* Iowa State University Extension and Outreach.

Falk, B. (1991). Formally Testing the Present Value Model of Farmland Prices. *American Journal of Agricultural Economics*, 1-10.

Featherstone, A. M., & Baker, T. G. (1988). Effects of Reduced Price and Income Supports on Farmland Rent and Value. *North Central Journal of Agricultural Economics*, 177-189.

Federal Reserve Bank of Kansas City. (2014). *Farmland Values--Annual Percent Changes.* Retrieved from Federal Reserve Bank of Kansas City-Tenth Federal Reserve District: www.kansascityfed.org/research/indicatorsdata/agcredit/

Ibendahl, G., & Griffin, T. (2013). The Connection Between Cash Rents and Land Values. *Journal of the ASFMRA*, 239-247.

Kauffman, N. (2014, February 13). *Cropland Values Holding Steady.* Retrieved from Federal Reserve Bank of Kansas City: http://www.kc.frb.org/research/indicatorsdata/agcredit/#/articles/research/agcredit/2015/ag-credit-02-13-15.cfm

Krause, J. H., & Brorsen, B. W. (1995). The Effect of Risk on the Rental Value of Agricultural Land. *Review of Agricultural Economics*, 71-76.

K-State Research and Extension. (2015, April). *Kansas Farm Management Association.* Retrieved from www.AgManager.info.

National Agricultural Statistics Service. (2015, April). *Agricultural Statistics Districts.* Retrieved from www.nass.usda.gov.

Pindyck, R. S., & Rubinfeld, D. L. (1998). *Econometric Models and Economic Forecasts* (4th ed.). Boston: Gary Burke.

Prais, S. J., & Winsten, C. B. (1954). Trend estimators and serial correlation. *Cowles Commission*, Working paper 383.

Robison, L. J., Lins, D. A., & VenKataraman, R. (1985). Cash Rents and Land Values in U.S. Agriculture. *American Journal of Agricultural Economics*, 794-805.

Sargent, T. J. (1979). Difference Equations and Lag Operators. In *Macroeconomic Theory* (pp. 171-202). Orlando, FL: Academic Press, Inc.

Taylor, M. R., Ibendahl, G., & Herbel, K. (2015). *Unpublished data from Kansas Farm Management Association Survey on Farmland Leases.*

The University of Kansas. (2015). *Kansas Geological Survey: County Production.* Retrieved from Oil and Gas Production: http://www.kgs.ku.edu/PRS/petro/interactive.html

Tsoodle, L., & Schlegel, J. (2015, January 22). *Farm Management: Leasing Papers.* Retrieved from AgManager.info: http://www.agmanager.info/farmmgt/land/lease/papers

University of Kansas. (2015). Current and Projected Conditions of the Ogallala/High Plains Aquifer in Kansas. *Kansas Geological Survey.* University of Kansas.

Appendix A - Usable Lifetime of Ogallala Aquifer

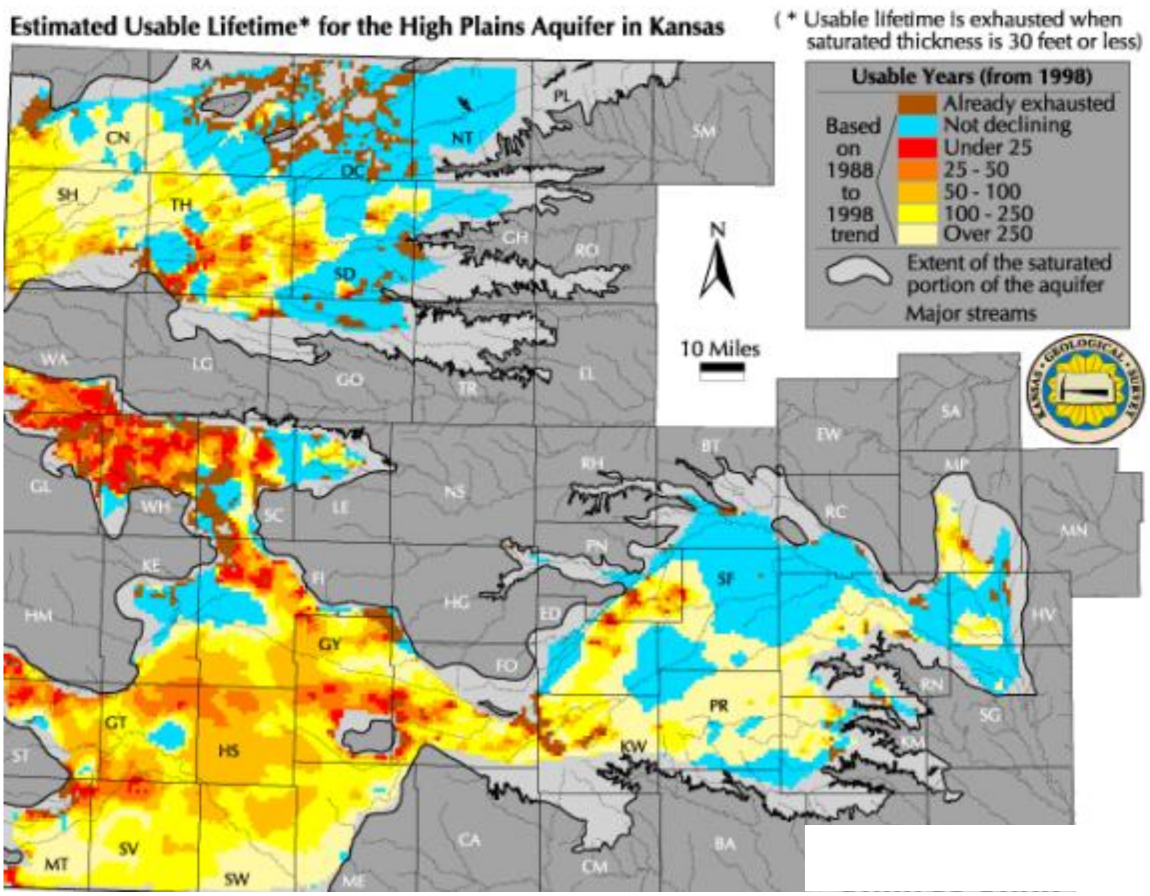

Figure A1: Ogallala Aquifer