

**EFFECTS OF INFLATION AND INTEREST  
RATES ON LAND PRICING**

by

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## **ABSTRACT**

Land is typically the highest value category of assets that farmers and ranchers have on their balance sheets. The value of land is affected by inflation. Understanding the effect of inflation on the land market helps farmers make better land pricing decisions and better asset management decisions. Using Treasury Bills and Farm Credit Bonds, future inflation expectations and agricultural risk premiums can be estimated. With the recent government stimulation of the economy and the resulting large amount of money infused into the economy, inflation is becoming an increasing concern with investors. Economic theory suggests that this infusion of money will affect future interest rates and ultimately the value of land given the inverse relationship between interest rates and the value of land.

These lingering affects occur with the rise and fall of yield rates for Treasury Bills and Farm Credit bonds. Farm Credit bonds are sold at a premium over Treasury Bills. This premium indicates the market-assessed additional risk that farmers have to pay for their operating loans and other mortgages.

Even though land values are affected by inflation, other things affect land values such as recreational use, development, and natural resource exploration. A combination of inflation and these other affects can greatly affect land prices.

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## CHAPTER I: INTRODUCTION

Many factors affect land values, most revolving around supply and demand. Inflation can also influence land values. An increase in expected inflation will increase interest rates and cash rents. When interest rates go up, land values go down because land will support a smaller loan. Bond values can be used to estimate expected inflation that ultimately affects land values.

Inflation is a basic rise in general prices over time and indicates how much a dollar will buy compared to the time period before. As the general price levels rise, the currency buys fewer goods. In reality, inflation is a loss of purchasing power for that particular currency. There are other important concepts such as stagflation and deflation that have more troubling effects on an economy than inflation. Deflation occurs when products and services lose value whereas stagflation occurs when the economy has slowed and unemployment is high.

A low level of inflation is normal for an economy showing modest economic growth. To control inflation, the Federal Reserve can adjust the Federal Funds rate; the rate at which banks are able to borrow capital from the Federal Reserve. When this rate increases, the Federal Reserve may be trying to reduce or keep inflation subdued by increasing interest rates. The opposite occurs when the rate decreases as the Federal Reserve may be trying to spur lending by lowering the Federal Funds Rate.

The crisis of the last half of 2008 may have been exacerbated by low interest rates for several years that helped deepen the financial and housing crisis. To try and lessen the

impact of the crisis, the federal government passed several stimulus bills to attempt to get the economy growing. With the large infusion of stimulus money, there are concerns that this may create future inflation. High amounts of money available in the market can cause inflation to increase, similar to what happened back in the 1980s from an oversupply of money.

Before Congress passed the stimulus bill, the Federal government passed the Troubled Asset Relief Program (TARP). This was designed to give banks equity needed to start lending again to consumers and businesses. Even with TARP, banks must be able to loan to each other to balance their books on a daily basis. The rate at which banks borrow from each other is known as the LIBOR (London Inter Bank Offered Rate). The LIBOR is the interest rate at which banks borrow unsecured funds from other banks in the London wholesale money market (Wikipedia n.d.). They can borrow for a day up to a year. LIBOR is calculated for ten currencies from around the world<sup>1</sup> (Wikipedia n.d.). The LIBOR is usually a few points above the Federal Funds rate, but in April of 2008 the 3-month LIBOR rose to the same level as the Federal Reserve dropped its rate. In February 2010, the Federal Reserve raised the discount rate signaling that there may be some optimism about the economy. With the Federal Funds rate and LIBOR spread increasing, bankers became more hesitant to lend to each other for fear of obtaining substandard collateral consisting of sub-prime mortgages. The increase in the difference between the two rates is one of many reasons that the cost of borrowing temporarily increased for consumers and businesses.

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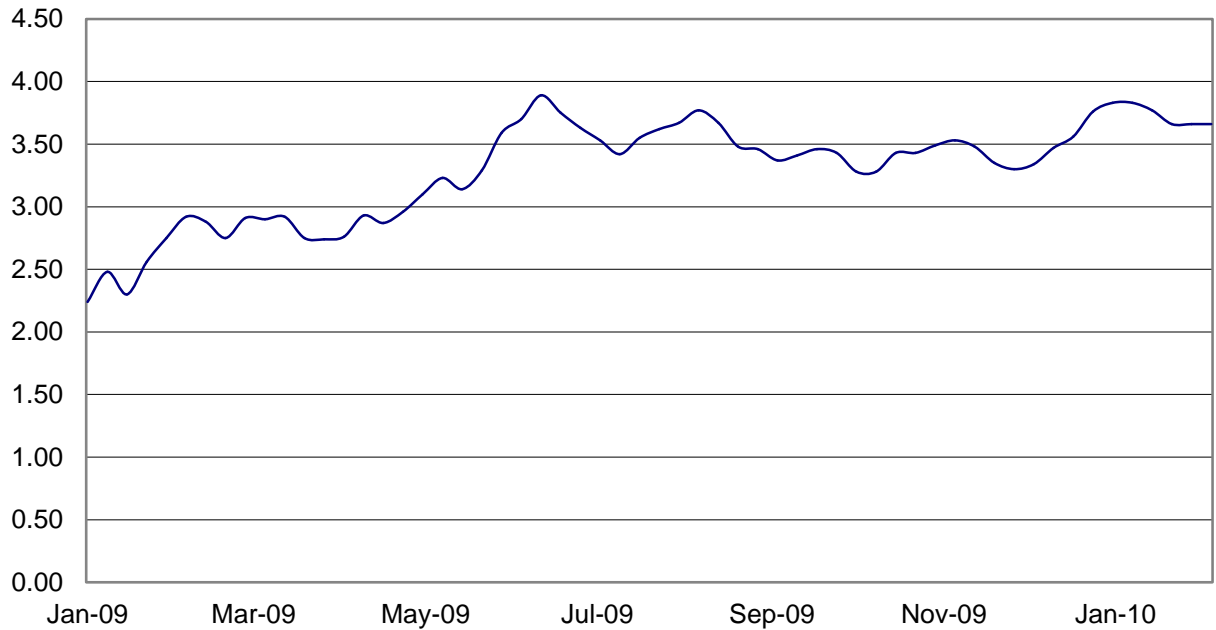
<sup>1</sup> LIBOR is calculated for the Pound Sterling, US dollar, Euro, Japanese Yen, Swiss Franc, Canadian dollar, Australian Dollar, Swedish Krona, Danish Drone and New Zealand dollar.



In the depths of the 2008 financial crisis, banks stopped loaning to each other because they were concerned about other banks not being able to repay the loans. To make up for lost capital by not loaning to other banks, consumers were charged higher rates and new fees. For example, one of the largest banks in the U.S. that received TARP funds started charging fees for things that would normally be free, such as account balance inquiries. With this decrease in lending, people worried about the health of banks and ultimately the health of the U.S. economy. This could have led to a run on deposits. To finance TARP and other stimulus, the Treasury held bond and T-Bill auctions.

The large amount of stimulus added to the economy has fueled concern about inflation. Future inflation expectations can be estimated by Treasury Bills and Bonds. Since June 2009, long term bond rates have been increasing relative to short term rates because of investor's fear of inflation due to the stimulus bill and government spending. During January 2009, Treasury bills were trading around a yield of 2.3% (Figure 1.1). As inflation became more of a concern, Treasury Bills increased in yield to 3.6%, a jump of over 1%. This may be a sign that the government may have to pay higher rates to get people to purchase Treasury bills.

**Figure 1.1: 10 Year weekly constant maturity treasury rates from January 2009 to January 2010**

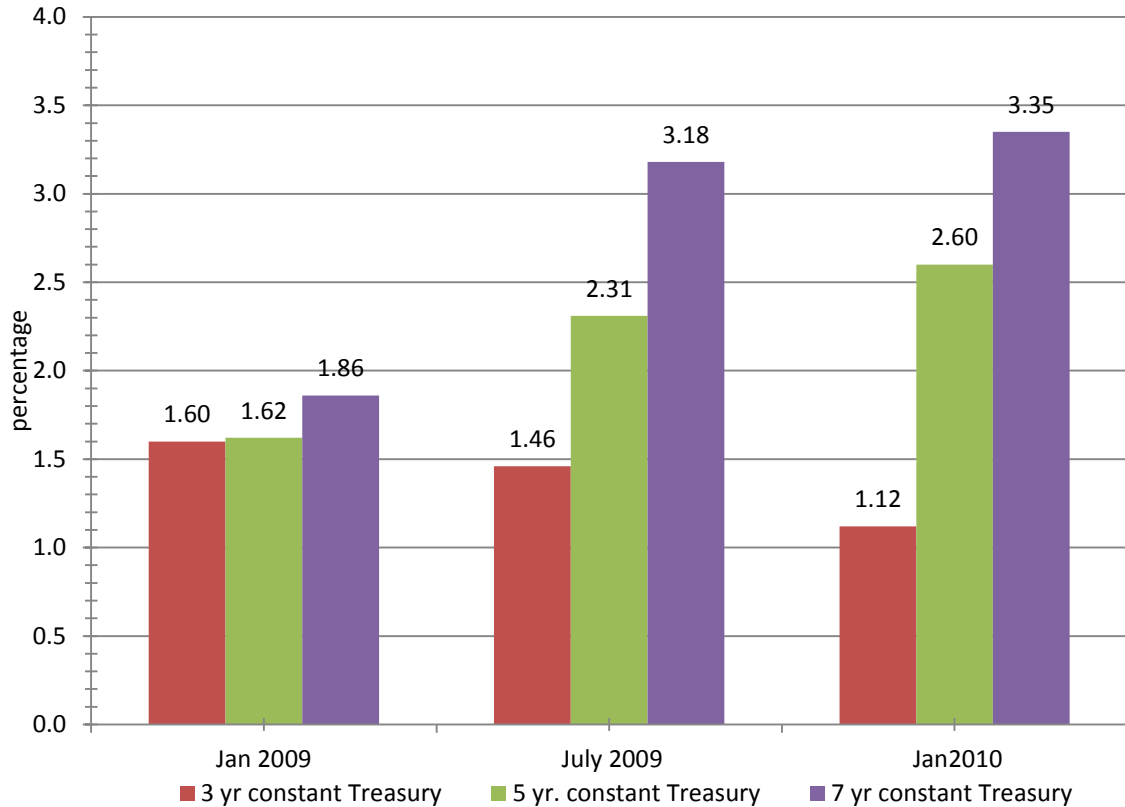


With cash flooding into the economy, some have expressed a future concern of hyperinflation. Hyperinflation is an accelerated form of inflation where the currency is being devalued so fast that the government has trouble stabilizing inflation to normal levels.

One way to forecast future inflation is by examining long term and short term bonds using the yield curve. Yield curves are used by fixed income analysts to understand economic conditions. Because bonds and treasury bills are used as indicators of future inflation, yield curves can be helpful for investors. Bonds usually rally when the economy is in recession and inflation is subdued. The yield curve provides money managers information to prepare their investors for what lies ahead. Long term bond prices have increased compared to short term bond rates indicating that investors may be concerned about the long term effects of government spending increasing inflation.

The differences between the long and short term Treasury Bills are illustrated in Figure 1.2. The three year bond rate decreased while the five and seven year rates increased from January 2009 to January 2010, perhaps because of a concern with inflation.

**Figure 1.2: 3, 5 and 7- year constant treasuries, January 2009, July 2009, and January 2010**



To examine how bonds can be used to protect investors from inflation, consider the Lord Abbett Bond Debenture Fund (Lord Abbett 2009). Since this fund began operations in April 1971, it has resulted in returns higher than inflation. Investors desire a return above inflation. For example, if inflation is an annual rate of 3.5% and you have your money in a savings account earning only two percent then you are losing roughly 1.5% per year. The Lord Abbett fund invests in high-yield corporate bonds, investment grade bonds and some

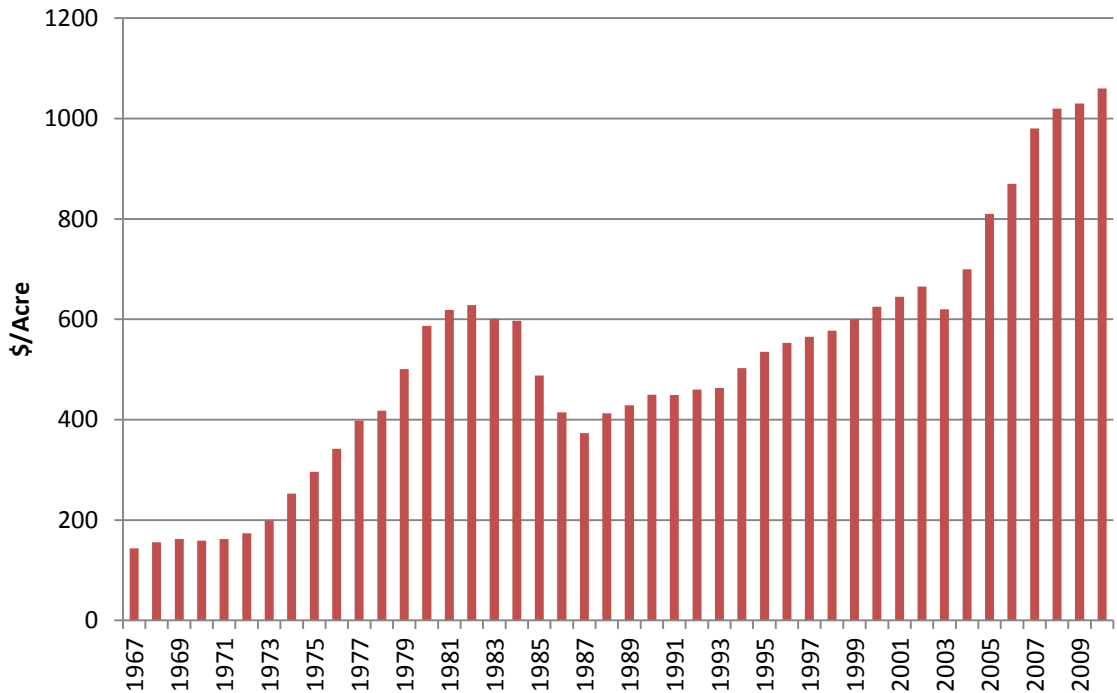
convertible and other equity related securities and typically returns a yield above the inflation rate.

Instead of investing in a fund such as the Lord Abbett fund, you can invest in other bonds such as Farm Credit bonds. Farm Credit bonds pay a premium over Treasury Bills. Farm Credit sells bonds to obtain capital to lend, instead of taking deposits like a bank. Investing in Farm Credit bonds is thought to have more risk than investing in Treasury bills due to possible default. Because the Farm Credit system lends to farmers and ranchers, the market may view this as riskier than lending to the government. With weather, price, and other natural elements that farmers and ranchers face, there is usually a higher risk investing in Farm Credit bonds so a premium is needed to draw people to invest in these financial instruments instead of Treasury Bills.

The cash rental rate from land is often considered the dividend for owning land.

Capitalizing anticipated rents by discounting the cash flow stream for a given investment, can help determine the value of land (Stammers). Other factors that affect the price of land are capital availability (Stammers).

**Figure 1.3: Average Kansas Land Values 1967 to 2010**

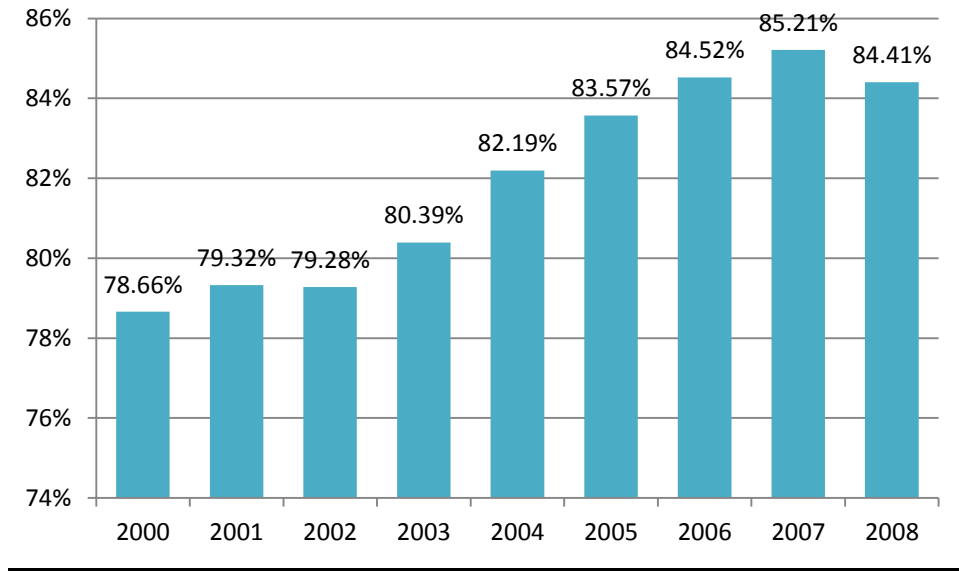


Source: USDA

Average farmland values in Kansas have gone up steadily on average over the last 43 years (Figure 1.3). Even though there were several years that there were declines, land has increased in value over the long term.

Land is the single largest investment made by many farmers or ranchers. Land is also used as collateral for other loans in the agricultural sector for additional land or yearly operating expenses. From 1987 through 2010 (Figure 1.3), the major farm asset value (land) went up steadily. Land in 2008 (Figure 1.4) was 84.41% of farm assets whereas the year before land was 85.51% of farm assets.

**Figure 1.4: U.S. Land as a percent of farm assets, 2000 to 2008**



Source: (USDA n.d.)

Besides crop income, other factors affect the value of land. These include items such as recreation (hunting, trail riding, ATV and UTV trails) and urbanization. Overall, less demand for recreational land may have helped to contribute to the decrease in land values from 2008 to 2009 (UDSA).

In Southeast Kansas, a lot of land had gas wells drilled over the last four years. These wells provide extra sources of income to the mineral right holders and can increase the price of land. Recently, land was bought for mineral rights in anticipation of natural gas opportunities and the land is resold at the original cost. A tract of 140 acres was for sale in Wilson County just East of Neodesha, KS (80 acres farm ground and 60 acres grass). The owner was selling the land at \$1950 per acre without mineral or surface rights. The seller had originally purchased the land for just the mineral rights and was reselling to gain back what they paid for the land. But with the 2008 downturn in the economy and the price of natural gas, new exploration for natural gas has all but ceased in Southeast, Kansas.

## **1.1 Thesis Objectives**

In this thesis, there are three objectives. First expected inflation and interest rates are examined using expectations theory. Next, the risk premium for farm borrowing is estimated using Farm Credit bond rates. Finally, future land prices are examined based on inflation expectations.

In the literature review (Chapter 2) I will briefly discuss TIPS (Treasury Inflation Protected Securities) and Bonds will be discussed. Chapter 3 discusses expectations theory, the growth stock model of valuation and the premium for agricultural lending using Farm Credit Bonds. Finally, the methods (Chapter 4) used to estimate inflation using TIPS and Treasury Bills and how the Farm Credit Bonds risk premium is discussed. Chapter 5 will consist of the results and Chapter 6 will present the conclusions of the thesis.

## CHAPTER II: LITERATURE REVIEW

Inflation enters into many decisions people make including affording a mortgage payment, whether to go on strike for higher wages, or how to invest retirement funds (Haubrich 2009). It also effects daily decisions such as whether to wait and buy milk on sale or buy it before prices go up (Haubrich 2009). Real interest rates play a key role in many economic decisions such as when businesses invest in plant and equipment or when a family buys a new car. People make judgments using the real return on investments and the real cost of borrowing (Haubrich 2009). Investors and policymakers have long hoped that Treasury Inflation Protected Securities (TIPS) would provide an accurate measure of long-term market inflation expectations and the real return on the cost of funds (Shen and Corning). To help make informed decisions, investors need to consider the rate of inflation expected by other market participants (Shen and Corning).

With the introduction of TIPS in 1997, the difference between conventional Treasuries and TIPS provides an estimate of market inflation expectation (Shen and Corning). From 1953 to 2003, U.S Treasuries generally outperformed inflation by about one percent (Brealey, Myers and Allen). It is expected that as inflation rates change, there is a corresponding change in the interest rates (Brealey, Myers and Allen). In a study of the U.S. Treasury bill market between 1959 and 1982, Fama found that a forward premium on average precedes a rise in the spot rate but the rise is less than expectations theory would predict. In October 2010, the Treasury sold \$10 billion of five-year Treasury Inflation Protected Securities at a negative yield for the first time at a U.S. debt auction as investors bet the Federal Reserve would increase inflation (Eddings and Kruger 2010). The securities drew a negative 0.55 percent return (Eddings and Kruger 2010). The negative yield is “a reflection of where the



overall rate environment is, combined with the expectation for the Fed to stoke inflation and get prices rising again, which will ultimately be good for the economy,” said Ian Lyngen (Eddings and Kruger 2010).

Farmland values strengthened with higher land lease revenues from expanded oil and gas activity, especially in Oklahoma and Wyoming (Heschmeyer 2011). With farmland values rising, some lenders have become more active, such as the insurer MetLife Inc., originating nearly \$3 billion in agricultural loans in 2010, double from what the company originated in 2009 (Heschmeyer 2011). At a symposium entitled: “Don’t Bet the Farm: Assessing the Boom in U.S. Farmland Prices”, said the recent run up in farmland values could be attributed to:

- Increasing demand for biofuel energy such as ethanol from corn
  - Strong agricultural product demand from emerging markets and
  - Generally decreasing interest rate environment with rates at 30-year lows
- (Heschmeyer 2011).

Values are dependent upon interest rates remaining low and/or sustained growth in agricultural incomes (Heschmeyer 2011).

Studies have examined and found that the relationship between land buyers and sellers has a significant impact on asset sales prices (Tsoodle, Golden and Featherstone 2006). Results indicated that parent-child relations have a pronounced effect on farmland prices with values being discounted from 31% to 38% (Tsoodle, Golden and Featherstone 2006). Sales between neighbors resulted in discounts 11% to 23% that were slightly higher than other family member’s discounts 7% to 19% (Tsoodle, Golden and Featherstone 2006).

U.S. farm programs are key variables determining farmland values and cash rental rates (Featherstone and Baker 1988). With the federal budget deficit a major policy issue, there is substantial pressure to cut expenditures on agricultural programs (Featherstone and Baker 1988). Because cash rent and land price are dependent on expectations, current outcomes weigh heavily on market behavior (Featherstone and Baker 1988).

Other researchers have found that interest rates play a part in land values but are not the only thing that affects them. Items such that family members and neighbors discount land prices to each other shows a desire to help farms or ranches grow and benefit economically.

### CHAPTER III: THEORY

This thesis uses two main theories to understand and measure the effect of inflation on land values. The first is expectations theory that explains the term structure of interest rates by using a combination of maturities to estimate the yield curve. The second theory is the Gordon growth model of valuation.

Individual bonds measure an investor's perceptions of long term and short term securities yield and determine the slope of the yield curve. A positive yield curve occurs when lenders receive a higher rate for money by committing it for longer periods of time. The opposite results in a negative or inverted yield curve which occurs when the demand for short term credit drives up short term rates. An inverted yield curve occurred in the early 1980s when short term rates went to 20% and long term rates were 16% to 17% (Business Glossary).

The yield curve can be explained by the expectations theory. Brealey, Myers, and Allen state that in equilibrium the forward interest rate,  $f_2$ , must equal the expected one-year spot rate, which is a product of  $(1 + r_1)(1 + r_2)$  where  $r_1$  is the one year spot rate and  $r_2$  is the spot rate for year two. An investor must decide to invest in either two one year notes or a two year note and that in equilibrium; the expected payoffs would be the same. The expectations theory implies that for an upward sloping term structure, investors expect short-term interest rates to rise. Economists suggest that the expectations theory about future interest rates has an important effect on term structure (Brealey, Myers and Allen 2006). The expectations theory also implies that investing in a succession of short term

bonds yields the same return as a long term bond. If short term rates are lower than long term rates then investors must be expecting rates to rise.

Inflation can be measured by using nominal treasuries and Treasury Inflation Protected Securities (TIPS). The return on TIPS adjusts with inflation so they provide a real rate of return on investments unlike normal treasuries or bonds. For example, if you invest in a three percent TIPS and inflation is three percent with normal bonds or treasuries your return would be zero. With TIPS, the rate adjusts above the three percent of inflation to provide an actual three percent return after inflation from this investment. Using the nominal treasury rate TIPS spread allows an estimate of inflation for that time period to be estimated. Estimated inflation is calculated by

$$1) \quad I = (1 + r) / (1 + r^*) - 1$$

where  $r$  is the nominal treasury yield and  $r^*$  is the TIPS return.

The second model used is the capitalization model where cash rent is discounted to estimate land prices. Using Gordon's model, the following equation can value growing perpetuities:

$$2) \quad P_0 = \frac{\text{Div}_1}{(r-g)}$$

In this equation,  $r$  is the opportunity cost of capital or discount rate,  $g$  is the growth rate, and  $\text{Div}_1$  is the dividend expected from the investment. The interest rate ties the expectations theory into the capitalization model since interest rate expectations are key to the valuation of land. Growth can be determined by using expected changes in cash rent

over time and is also related to inflation. This allows the determination of the price of land with regards to current expectations on future inflation and growth in cash rents.  $Div_1$  is the expected amount of income that land will provide in year one (cash rent).

To examine the effect of inflation in the denominator of equation 2, the following equations are needed:

$$3) \quad r = (1 + I)(1 + r^*) - 1$$

$$4) \quad g = (1 + I)(1 + g^*) - 1$$

where  $g$  and  $r$  are the nominal growth rates, respectively,  $I$  is the inflation rate and the asterisk converts the nominal rates to real rates.

Substituting equation 3 and 4 into 2, results in:

$$5) \quad P_0 = \frac{Div_1}{(((1+I)(1+r^*)-1)-((1+I)(1+g^*)-1))}$$

Rearranging 5 results in:

$$6) \quad P_0 = \frac{Div_1}{((1+I)(1+r^*)-(1+I)(1+g^*))}$$

Further rearranging results in:

$$7) \quad P_0 = \frac{Div_1}{((1+I)((1+r^*)-(1+g^*)))}$$

and finally:

$$8) \quad P_0 = \frac{\text{Div1}}{((1+I)(r^*-g^*))}$$

Thus, the denominator is a function of  $1+I$  and  $r^*-g^*$ . Thus, unless inflation ( $I$ ) is large, there is not a large difference in the denominator whether it is the subtraction of nominal rates or real rates. This would suggest that inflation difference may not have a large effect on the capitalization of the expected land return. However, it should be noted the Div, will increase due to inflation so there will be an increase in the land price over-time due to inflation.

A final factor that could affect the land price is the premium for agricultural lending. This would affect  $r^*$  in equation 8 or  $r$  in equation 2. As the premium for agricultural lending increases, the difference between the expected interest rate and the expected growth rate will increase. This premium can be estimated by taking Farm Credit Bonds minus Treasury Bills. This is useful in determining the market's assessment of risk for agricultural lending.

## CHAPTER IV: METHODS

Information on weekly Treasury bill prices and Farm Credit bonds was used to estimate future inflation rates. Bonds can be a good indicator of what inflation may do in the future under the expectations hypothesis. During the week of May 26th, 2009, the yield on bond prices rose drastically as an indicator that inflation may be a concern with investors. This was the same concern that occurred in the early 1980s. Five, seven, and ten year constant maturities were used because they could be matched with TIPS maturities. With constant maturity T-Bills, one, three, and five year terms were able to be matched with Farm Credit Bond maturities to calculate a Farm Credit Premium. In this part of the thesis, the process used to estimate inflation using TIPS, Treasury Bills, and to estimate the risk of Agricultural Lending using Frontier Farm Credit Bonds will be discussed. Regression analysis will also be discussed.

To estimate inflation, TIPS (Treasury Inflation Protected Securities) and the nominal treasury bill of the same maturity were used. The compound expected inflation rate was calculated with the equation  $\left(\frac{(1+\text{nominal T-Bill}/100)}{(1+\text{TIPS}/100)}-1\right)*100$ . Inflation were calculated for terms of five, seven and ten years. The TIPS and the constant maturity Treasury Bills data were from the St. Louis Federal Reserve Bank (<http://research.stlouisfed.org/fred2/categories/115>). These data were reported on a weekly basis.

To estimate the inflation rates between years 5 to 7, the following equation is used  $I_{5-7} = \left[\frac{(1+I_7)^7}{(1+I_5)^5}\right]^{1/2}-1$ \* 100. To estimate inflation between year 7 and 10,  $I_{7-10} = \left[\frac{(1+I_{10})^{10}}{(1+I_7)^7}\right]^{1/3}-1$ \* 100.

To estimate the risk premium for agricultural lending, the Farm Credit bond minus the Treasury bill rates were subtracted for one, three, and five year terms. The one, three and five year Farm Credit bond values came from Federal Farm Credit Banks Funding Corporation ([www.farmcredit-ffcb.com/farmcredit/index.jsp](http://www.farmcredit-ffcb.com/farmcredit/index.jsp)).

Regression analysis is a statistical technique that attempts to “explain” movements in one variable, the dependent variable, as a function of movements in a set of other variables, independent variables, through the quantification of a single equation (Studenmund 2006). This procedure allows one to examine how changes in independent variables cause a change in the dependent variables. There are a couple of key statistics to look at that tell you if the analysis is significant or not. R-Squared estimates the insample predictive power. As R-squared is closer to one, the predictive power is higher. The t-stat is another important measure, the larger in absolute value the t-value is, the greater the likelihood that the estimated regression coefficient is statistically different from zero (Studenmund 2006). Another important set of statistics to examine are the estimated coefficients. If these numbers are positive then they have a positive correlation with the dependent variable. If they are a negative number then they have a negative correlation with the dependent variable. The magnitude of the coefficient provides a quantitative estimate of the economic importance.

A final measure of analysis is simple correlation between variables. This indicates how statistically significantly close each variable moves with one another. That is, correlation analysis measures how closely two variables move together. The closer to one, the closer they move in the same direction. The closer to zero, the more the series are unrelated. The



closer to -1, the closer the series move in opposite directions. This is a simple but useful analysis.

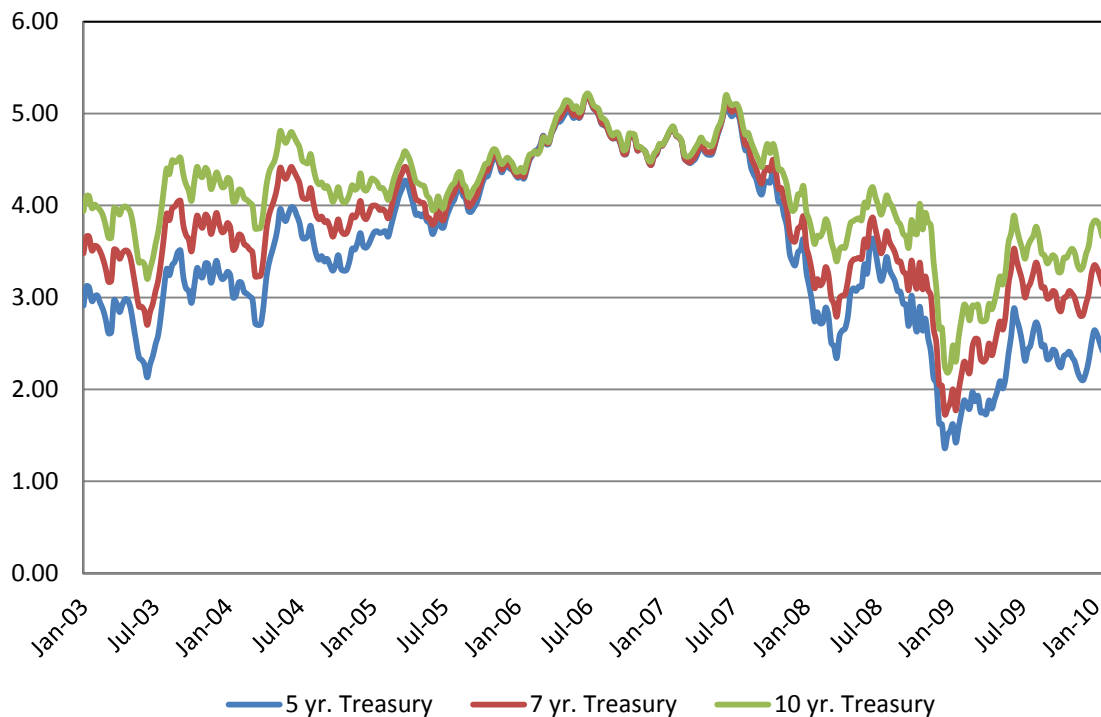
## CHAPTER V: INFLATION AND RISK PREMIUM

In this chapter, expected inflation and the risk premium of farm borrowing is presented.

First, Treasury Bills and TIPS rates are examined to illustrate the patterns that each security followed since January 2003. Next the spot rates for Treasury Bills, TIPS and spot expected inflation are discussed.

### Measuring Inflation

**Figure 5.1: Five, Seven and Ten year Treasury Bills for January 2003 to January 2010**



The five, seven, and ten year Treasuries all follow roughly the same pattern (Figure 5.1)

The longer the term of the treasury the higher the interest rate for most periods. Between May 2006 to July 2007 the rates for the 5, 7, and 10 year bonds were about the same. This was the time period leading to the financial crisis. When the stock market fell, people moved money to treasuries for security. Supply and demand provides an explanation of

why the drop in short-term yield occurred. The high demand for a short term securities caused short term rates to fall.

**Figure 5.2: Five, Seven and Ten year TIPS from January 2003 to January 2010**

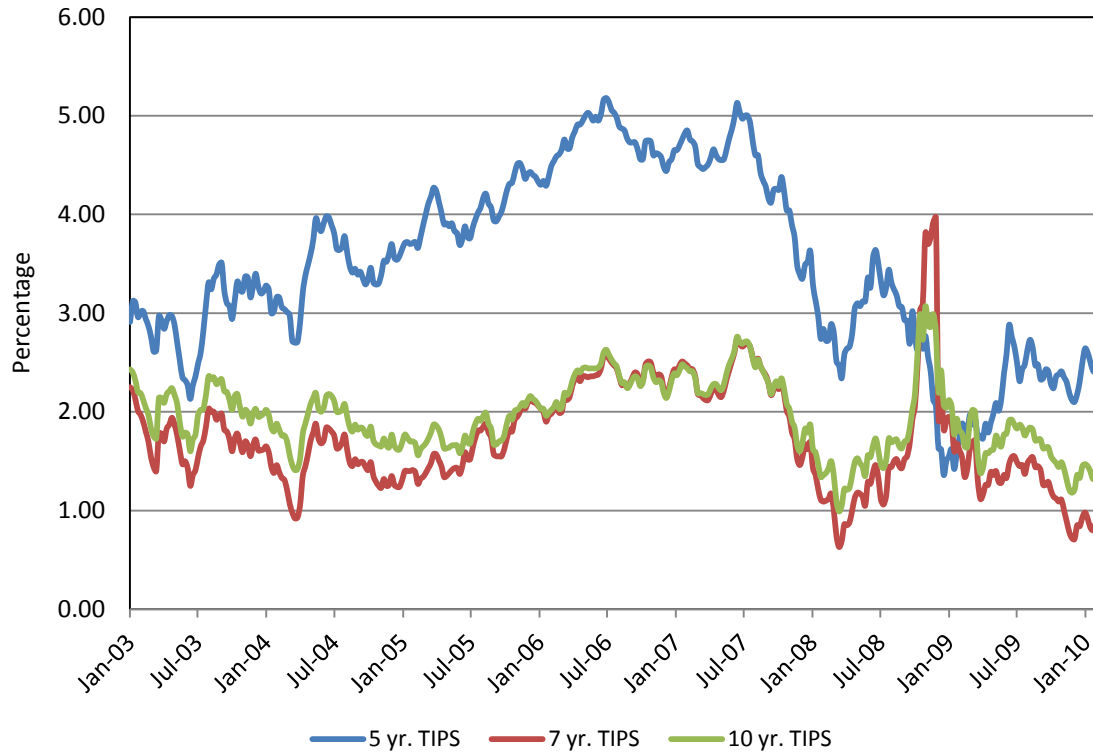
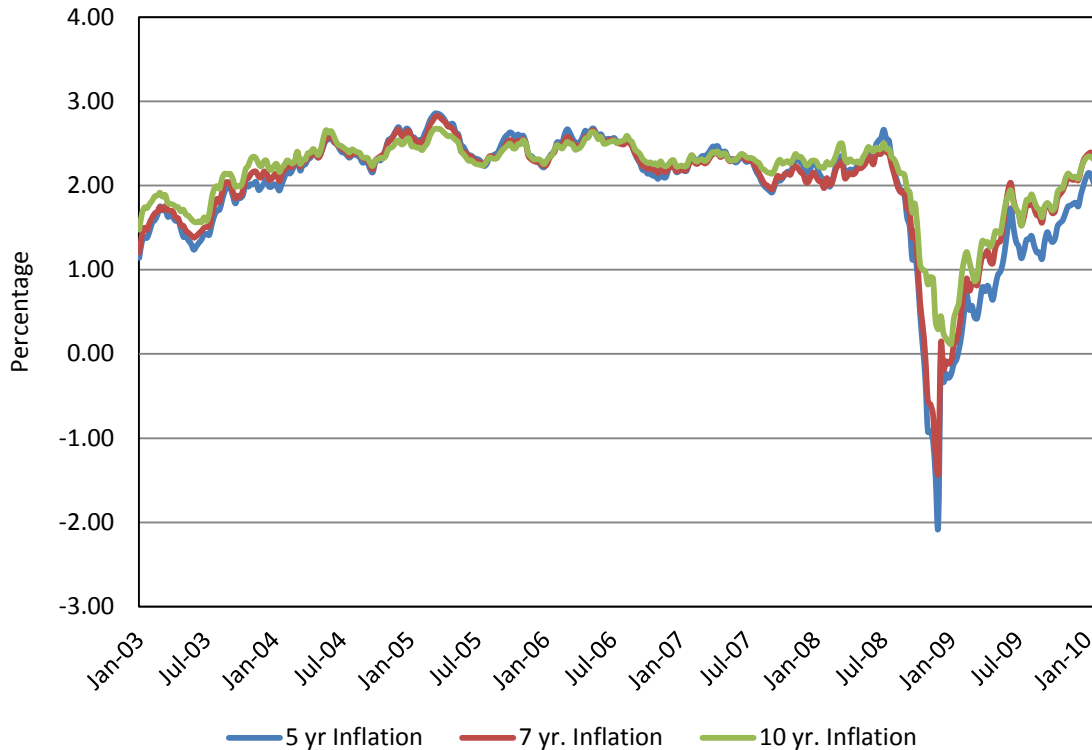


Figure 5.2 graphs the rates of Treasury Inflation Protected Securities (TIPS) from January 2003 to 2010. The five year TIPS has carried a premium compared to the longer term seven and ten year TIPS. The TIPS rates fell during the financial crisis indicating a preference for safety even with a lower rate of return. The seven and ten year TIPS yields increased in value for a short period of time. The average for the five year TIPS during the period of January 2003 to December of 2009 is 1.52 percent compared to the average for 2009 of 1.07 percent. The average for the seven year TIPS during the entire time period was 1.76 percent and 1.33 percent for 2009. The average for the ten year TIPS is 1.96

percent compared to the 2009 average of 1.66 percent. Thus, the TIPS rate has fallen from previous years.

**Figure 5.3: Five, Seven and Ten year Inflation from January 2003 to January 2010**



The inflation rate was estimated using 5, 7, and 10 year Treasury Bills and TIPS rates (Figure 5.3). Between July 2005 and July 2006 estimated inflation varied little regardless of the length of the term inflation was estimated. This indicates stable long-term inflationary estimates. At the height of the financial crisis, estimated inflation dropped rapidly. Five and seven year inflation estimates suggested a negative inflation rate or deflation but the ten year estimation never fell below zero. As the economic recovery began, inflation expectations began to rise. Over the entire time period, the 5 year average inflation is 1.97 percent, the 7 year average inflation is 2.04 percent and the ten year inflation is 2.13 percent.

**Figure 5.4: One to Five, Five to Seven, and Seven to Ten Year Treasury Spot Rates from January 2003 to January 2009**

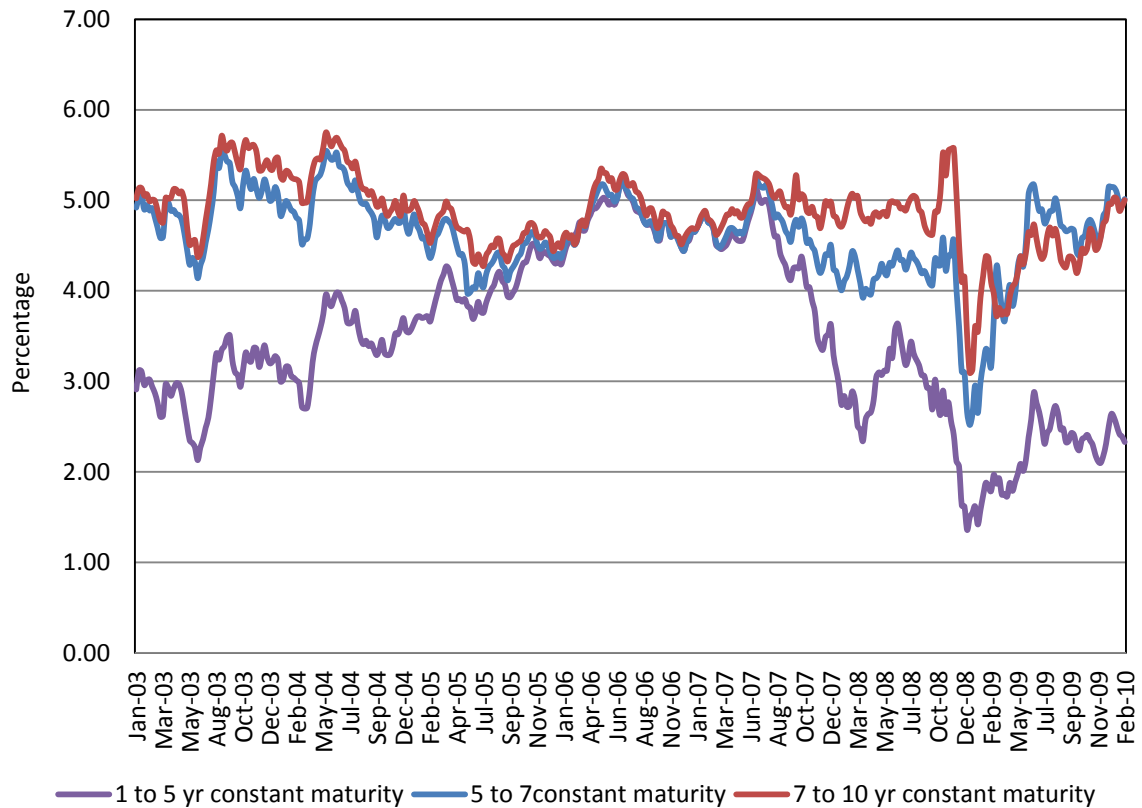
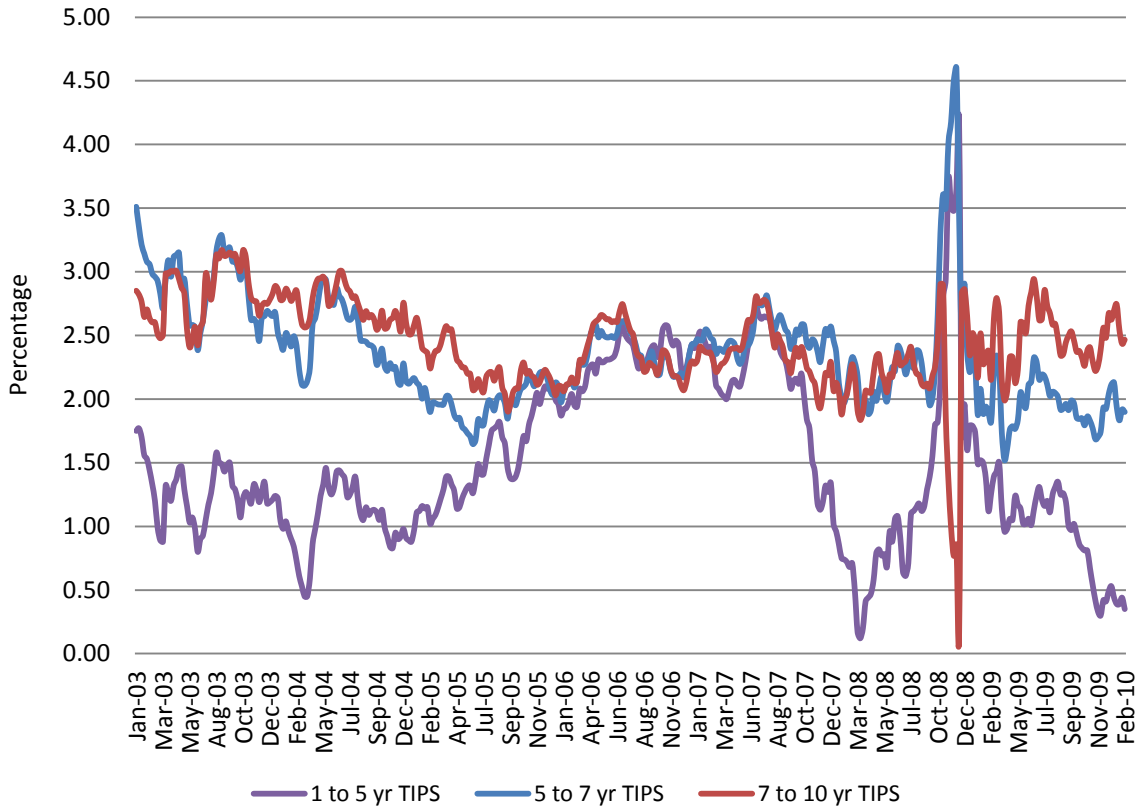


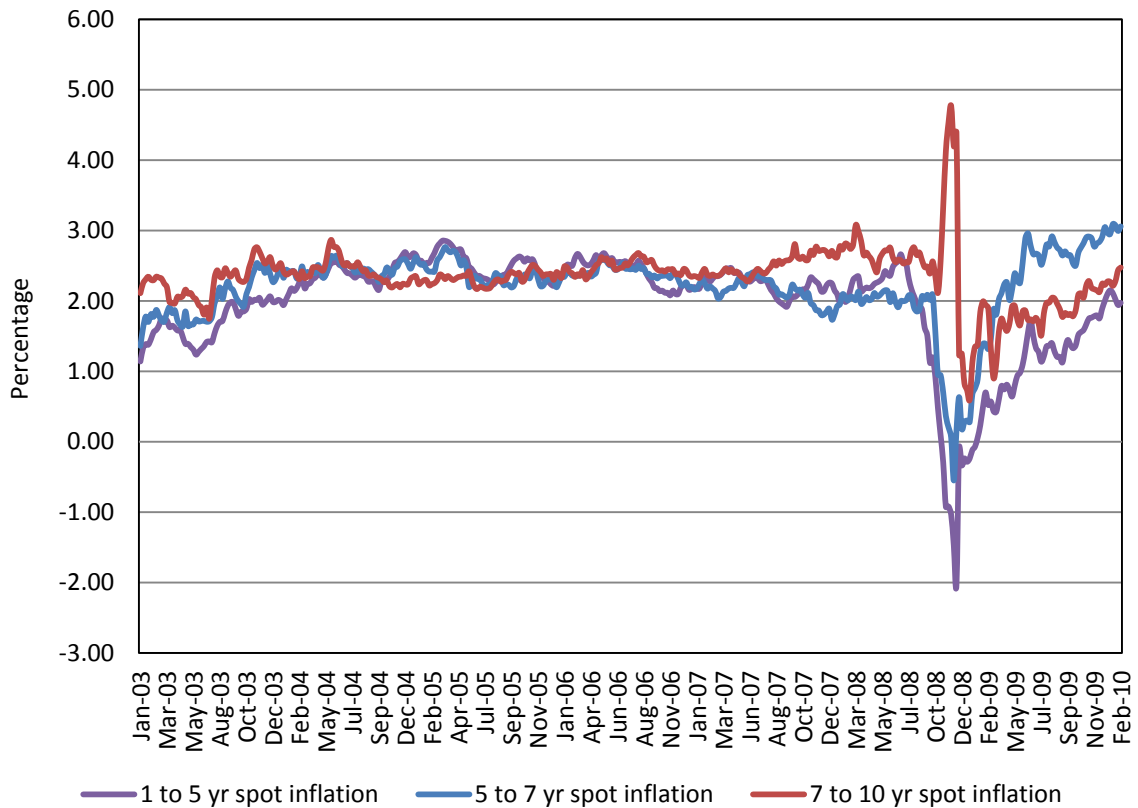
Figure 5.4 reports the 1 to 5 year rate, the 5 to 7 year rate and the 7 to 10 year rate for Treasuries. The spot rates for seven to ten year constant maturities have stayed fairly constant without much change except for around November 2008 with a two percent drop. The longer term five to seven year and Seven to Ten spot rates have been fairly stable. However, the one to five year spot rates are more volatile than the longer term rates. Instability caused by the financial crisis has not affected the 5 to 10 year horizon, but has affected the shorter time horizon.

**Figure 5.5: One to Five, Five to Seven and seven to Ten Year TIPS Spot Rate from January 2003 to January 2009**



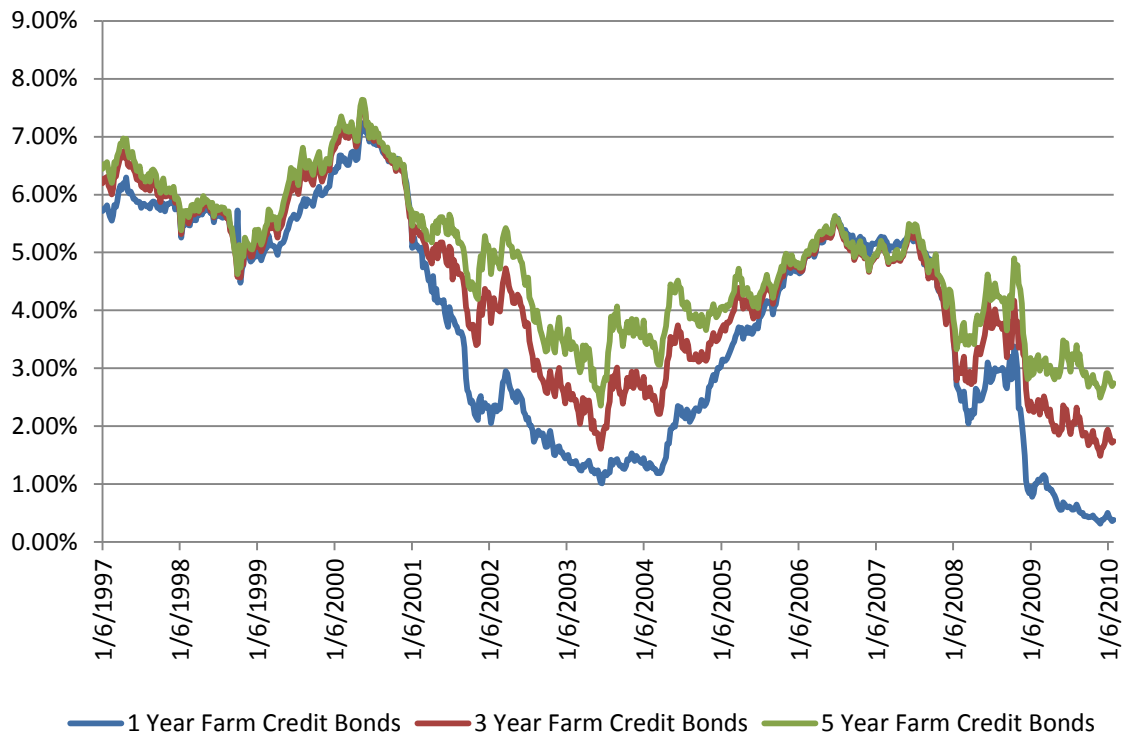
As the recession began, the short term TIPS dropped dramatically because people were worried about instability. As the Financial Crisis deepened, longer term TIPS were not as popular as the investor put money into shorter term TIPS to not tie up their money long term. But as the recession and financial crisis began to ease, TIPS have begun to return to a normal level. Of course longer term TIPS carry a higher rate than shorter term TIPS. Longer term rates are higher because investors tie up their money for a longer period of time. From October 31, 2008 to November 21, 2008 the five to seven year rates were averaging 4.32%. But the seven to ten year rates were averaging 0.99% during this time frame.

**Figure 5.6: One to Five, Five to Seven and Seven to Ten Year Spot Inflation Rates from January 2003 to January 2009**



Spot inflation rates leading up to the financial crisis for all periods remain relatively the same except for the spike or drop in late 2008 (Figure 5.6). In November 2008, the short term expected inflation rates dropped drastically showing possible signs of short term deflation. The long term inflation rate spiked showing possible signs of inflation in the long term. But as the financial crisis began to ease, the spot rates of inflation for all terms began to return to normal levels.

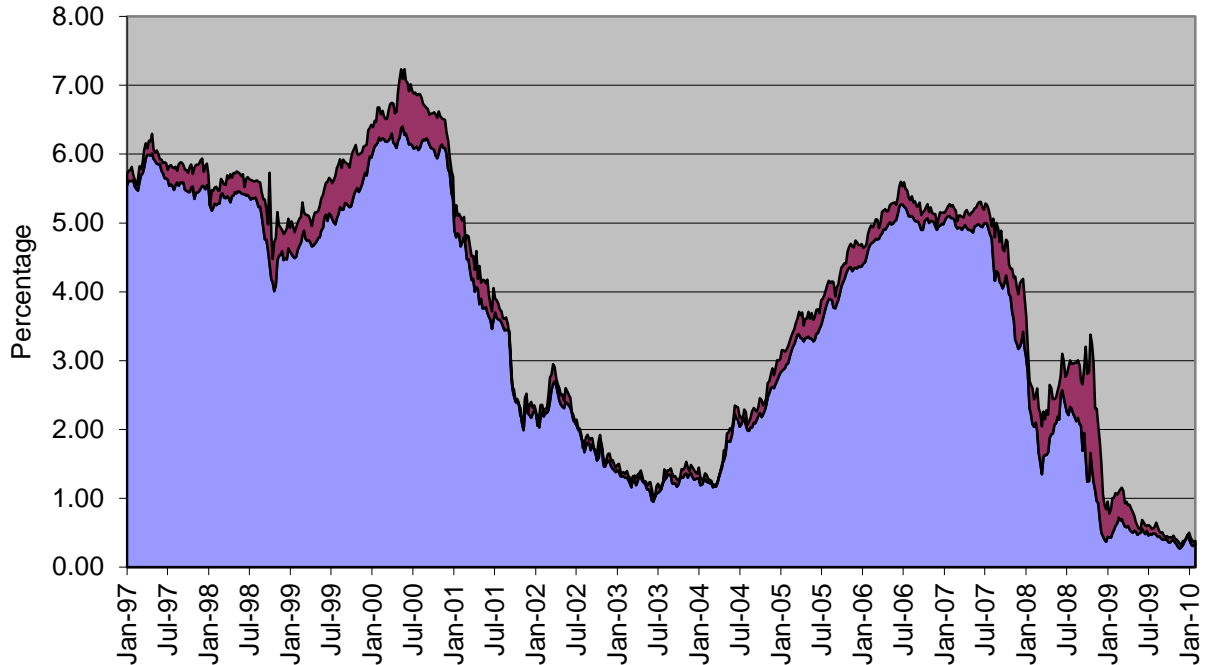
**Figure 5.7: One, Three and Five Year Farm Credit Bonds from January 1997 to January 2010**



Farm Credit bonds are not immune to the spikes and dips that other security's can experience (Figure 5.7). Since Farm Credit derives its capital from bonds, rates follow the national market. The Farm Credit bond rate leading up to the financial crisis (January 2005 to January 2008) were all averaging about the same yield but as the financial crisis began, the yield curve widened and rates began to fall. Short term rates began to drop and the intermediate and longer term bonds began to increase.

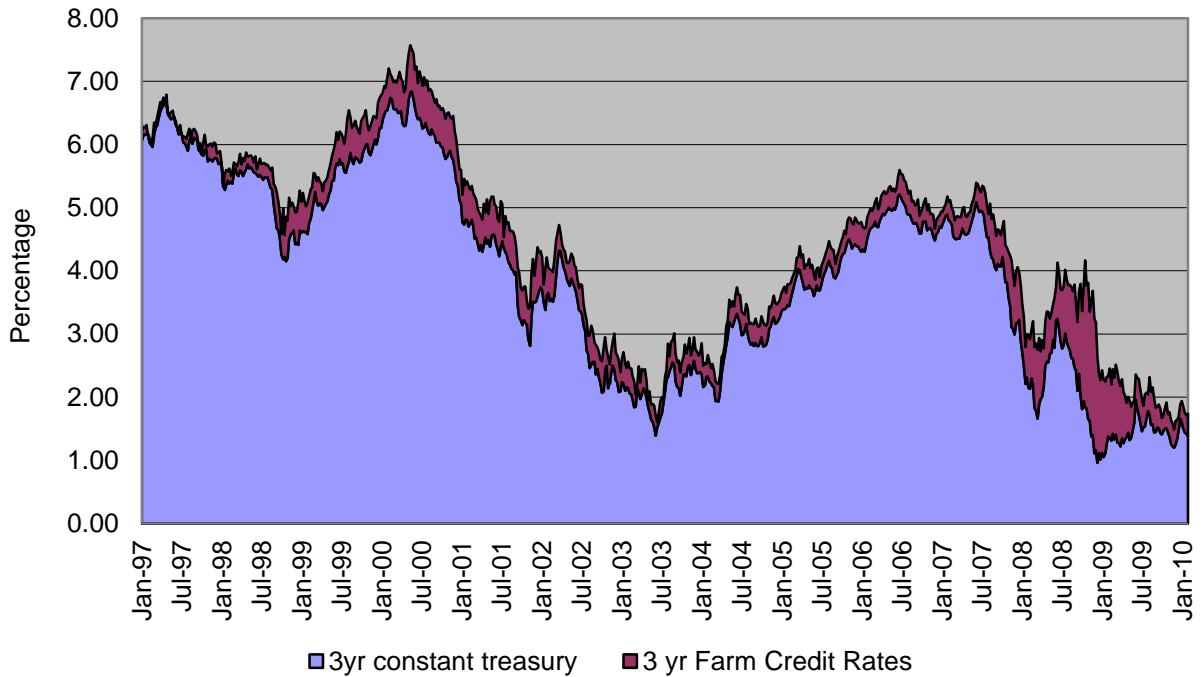


**Figure 5.8: One Year Farm Credit Premium from January 1997 to January 2010**



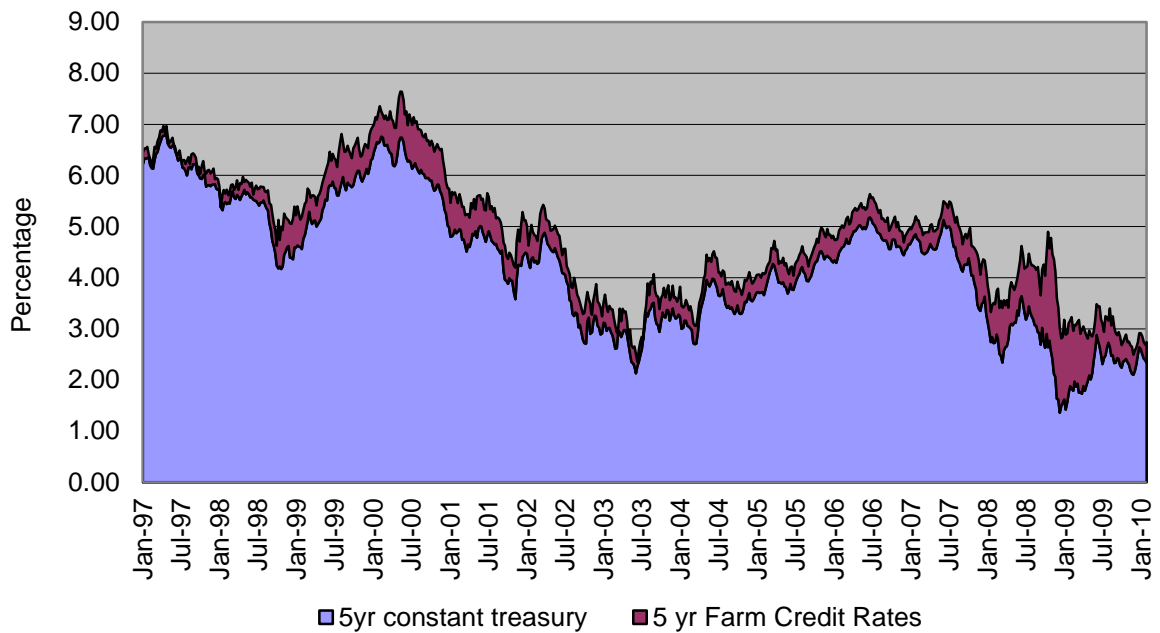
Farm Credit Bonds have paid a premium over Treasury bills for an extensive amount of time (Figure 5.8). Leading up to the financial crisis farm credit bonds paid healthy premiums but as the crisis began, the rates began to drop. For example, the week of June 11, 2007 Farm Credit paid 5.31% for their bonds. Then during the week of January 18, 2010 rates had decreased to 0.39% and were almost even with Treasury Bills that were at 0.31% for the same week.

**Figure 5.9: Three Year Farm Credit Premium from January 1997 to January 2010**



As the recession began to end, Farm Credit Rates began to pay a larger premium than the constant treasuries. An example of the difference between the two securities is the amount Farm Credit bonds pay for a premium. In October of 2008, the premium went over 2 percent (Figure 5.9). Except for two weeks, the premium stayed above 2 percent until the beginning of December 2008 and then the premium went below 2 percent and slowly the premium kept getting smaller. The premium spiked due to the negative press associated with Fannie Mae and Freddie Mac. Because the Farm Credit Bond is a Government Sponsored Entity (GSE), investors initially did not differentiate between farm bonds and Fannie Mae and Freddie Mac until they were able to understand the differences between the home loan market and the farm loan market.

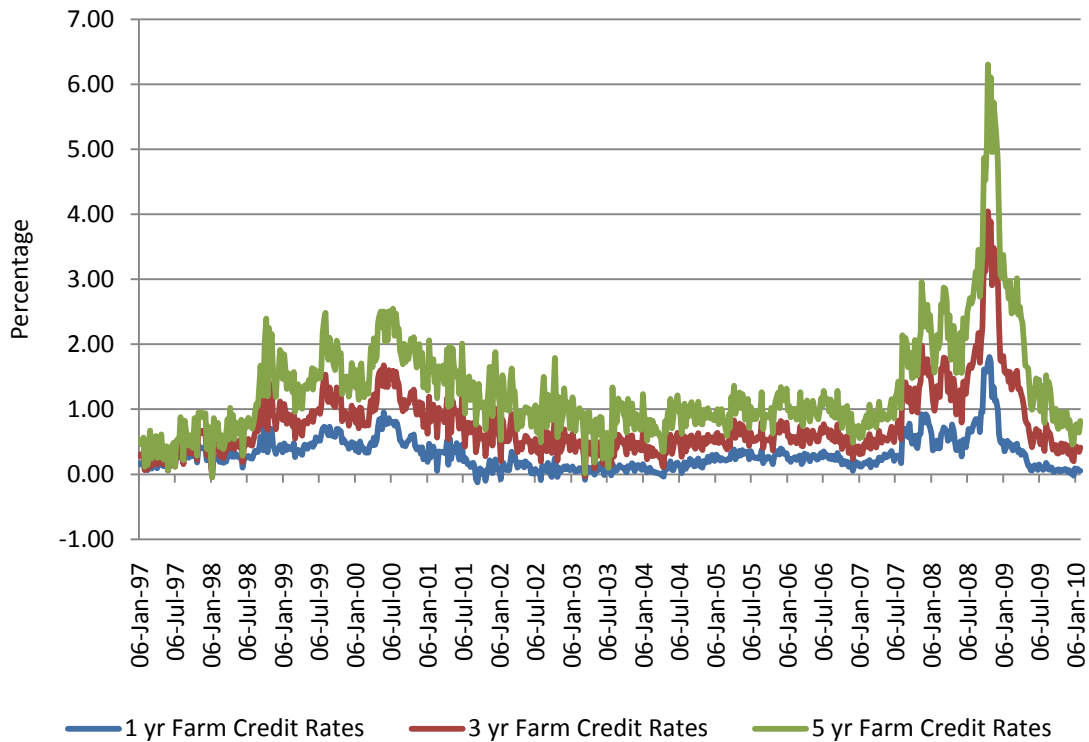
**Figure 5.10: Five Year Farm Credit Premium January 1997 to January 2010**



The five year Farm Credit premium increased from October 2008 to November 2008 where the premium average 2.10% (Figure 5.10). After that time period, the premium began to narrow.

The longer Farm Credit Bond term has more stable rates. The one year bond is more volatile than the five year bond. Looking at Figure 5.11 the one year bond over the Treasury bill does not have much of a premium but as you go up in bond length the farm credit bond premiums increase. This may indicate that the current profitability in agriculture is not expected to last indefinitely into the future.

**Figure 5.11: Farm Credit Premium Comparison from January 1997 to January 2010**



The longer term you invest, the more premium you should gain from that investment. The three and five year Farm Credit Bond premium rates illustrate this theory. The smaller term bond has a more volatile yield than the longer bonds. This also is expected in the bond market (Brealey, Myers, and Allen).

## CHAPTER VI: LAND VALUE ANALYSIS

First, the data used in the land value analysis are discussed. Next, the correlation between real interest rates, nominal cash rent, nominal land values and inflation are discussed. Then the correlation between real interest rates, real cash rents, real land values and inflation rates are discussed.

The source of the data used in the land value analysis (1967 - 2010) were obtained from various sources and then adjusted for the analysis (Table 6.1). The land prices and cash rent data were obtained from the USDA NASS website and are for Kansas. The PCE index (obtained from the St. Louis Federal Reserve Bank) was used to determine the annual inflation rate by dividing adjacent indices and subtracting one to convert to a percentage.

The nominal interest rate was the non-real estate effective rate on new loans from the Agricultural Finance Databook. The real rate was determined by taking 1 plus the nominal rate and dividing by 1 plus the inflation rate calculated above. The real land price and cash rents are in 2010 constant dollars. These are obtained by taking the nominal price times the 2010 PCE index divided by the PCE index for the nominal price for each year. The average and standard deviations along with the actual numbers are found in Table 6.1.

**Table 6.1: Land Value Information**

Year	Real Land Values	Real Cash Rents	Inflation Rate	Real Interest Rates	Nominal land values	Nominal cash rent
1967	774.82	69.95	2.685%	4.202%	144	13
1968	812.19	73.41	3.348%	3.824%	156	14.1
1969	809.35	69.44	4.211%	3.444%	162	13.9
1970	757.15	68.57	4.915%	3.036%	159	14.4
1971	738.94	71.16	4.397%	3.356%	162	15.6
1972	764.20	69.39	3.858%	3.796%	174	15.8
1973	844.24	70.85	3.525%	4.709%	199	16.7
1974	984.18	84.02	9.059%	0.130%	253	21.6
1975	1043.51	88.49	10.344%	-1.399%	296	25.1
1976	1137.24	77.48	6.018%	2.719%	342	23.3
1977	1250.42	77.92	5.841%	2.796%	398	24.8
1978	1233.41	74.95	6.473%	2.937%	418	25.4
1979	1371.28	76.36	7.807%	3.797%	501	27.9
1980	1447.03	75.43	11.032%	3.754%	587	30.6
1981	1384.56	70.91	10.209%	7.523%	619	31.7
1982	1322.33	71.59	6.228%	9.858%	628	34
1983	1210.04	68.45	4.581%	8.528%	601	34
1984	1155.34	65.99	4.038%	9.672%	597	34.1
1985	912.67	60.60	3.476%	9.011%	488	32.4
1986	754.08	55.06	2.926%	8.330%	415	30.3
1987	659.64	50.58	2.748%	7.642%	373	28.6
1988	704.43	52.19	3.684%	7.249%	413	30.6
1989	699.70	49.26	4.577%	7.576%	429	30.2
1990	704.12	51.79	4.236%	6.873%	450	33.1
1991	673.01	48.71	4.391%	5.182%	449	32.5
1992	669.58	46.43	2.975%	4.686%	460	31.9
1993	657.73	46.60	2.465%	4.914%	463	32.8
1994	701.46	45.46	1.866%	5.825%	503	32.6
1995	728.69	48.35	2.388%	6.946%	535	35.5
1996	738.16	43.65	2.039%	6.234%	553	32.7
1997	736.94	45.00	2.339%	6.705%	565	34.5
1998	745.41	45.86	0.963%	7.960%	577	35.5
1999	765.93	44.68	1.200%	7.411%	600	35
2000	777.93	44.19	2.560%	6.962%	625	35.5
2001	784.83	43.80	2.293%	5.384%	645	36
2002	802.89	43.46	0.782%	5.078%	665	36
2003	730.30	42.40	2.500%	2.830%	620	36
2004	808.08	43.29	2.036%	3.297%	700	37.5
2005	909.63	43.24	2.796%	3.798%	810	38.5
2006	947.75	42.49	3.087%	4.959%	870	39
2007	1041.91	43.59	2.464%	5.696%	980	41
2008	1047.84	43.66	3.492%	2.036%	1020	42.5
2009	1054.83	44.55	0.311%	4.475%	1030	43.5
2010	1060.00	43.50	2.411%	2.430%	1060	43.5
Average	905.86	57.65	3.990%	5.140%	515.77	30.30
Std Dev	226.36	14.28	2.510%	2.459%	240.79	8.37

**Table 6.2: Nominal Land Value Correlation**

	<i>Nominal Land Values</i>	<i>Nominal Cash Rent</i>	<i>Inflation Rate</i>	<i>Real Interest Rate</i>
<b>Nominal land values</b>	1.0000			
<b>Nominal cash rent</b>	0.9292	1.0000		
<b>Inflation Rate</b>	-0.2981	-0.3413	1.0000	
<b>Real interest rate</b>	0.1450	0.3054	-0.3260	1.0000

**Table 6.3: Real Land Value Correlation**

	<i>Inflation Adjusted Land Values</i>	<i>Inflation Adjusted Cash Rents</i>	<i>Inflation Rate</i>	<i>Real Interest Rates</i>
<b>Inflation Adjusted Land Values</b>	1.0000			
<b>Inflation Adjusted Cash Rents</b>	0.5397	1.0000		
<b>Inflation Rate</b>	0.6577	0.7860	1.0000	
<b>Real Interest Rates</b>	-0.1125	-0.3307	-0.3260	1.0000

Table 6.2 illustrates the correlation among variables in the land value model. The nominal land value is highly correlated with nominal cash rent (.9292). Nominal land values are less correlated with the inflation rate (-.2981) indicating inflation rates move opposite land values as suggested by equation 8 in Chapter 3. The inflation rate has a stronger effect on cash rent (-.3413) than on the value of land.

In Table 6.3, the real land value has strong correlation with real cash rent (.5397) and a strong correlation with inflation (.6577).

**Table 6.4: Real Land Price Regression Model**

<b>R Square</b>	<b>0.45</b>			
<b>Adjusted R Square</b>	0.41			
<b>Standard Error</b>	174.56			
<b>Observations</b>	44			
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
<b>Intercept</b>	545.41	157.79	3.46	0.00
<b>Inflation adjusted cash rent</b>	1.32	3.04	0.43	0.67
<b>Inflation rate</b>	5697.55	1726.17	3.30	0.00
<b>Real interest rate</b>	1113.11	1154.32	0.96	0.34

**Table 6.5: Nominal Land Price Regression Model**

<b>R Square</b>	<b>0.88</b>			
<b>Adjusted R Square</b>	0.88			
<b>Standard Error</b>	<b>84.71</b>			
<b>Observations</b>	<b>44</b>			
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
<b>Intercept</b>	<b>-244.27</b>	66.46	-3.68	0.00
<b>Cash Rent</b>	<b>27.93</b>	1.68	16.60	0.00
<b>Inflation rate</b>	<b>-171.83</b>	565.06	-0.30	0.76
<b>Real interest rate</b>	<b>-1541.46</b>	569.36	-2.71	0.01

The regression model predicting real land values as a function of real cash rent, real interest rates, and inflation has an R-squared of 0.45 (Table 6.4). An R-squared closer to one means the regression is more accurate. With a t-stat of 0.96, there is a strong probability that interest rates do not affect land values. As cash rent goes up by one dollar then the value of land increases by 1.32. As inflation increases by 1%, the price of land increases by 56.98. As the real interest rate goes up by one point then the price goes up by 11.13.

The land analysis using the real land values instead of the nominal land values (Table 6.5) is a better observation. The Real Land prices forecast model is adjusted for inflation and in current dollar amounts helps to better illustrate the affects that interest rates, cash rent, and



inflation rates have on land values. The Nominal Land prices forecast model has not been adjusted for inflation and put into real terms.

## CHAPTER VII: CONCLUSIONS

In this thesis, projected inflation was estimated using similar maturity Treasury Bills and Treasury Inflation Protected Securities (TIPS). In addition, historical premiums for agricultural lending were estimated using Farm Credit bond rates and Treasury Bills. Finally the effect that inflation and interest rates have on agricultural land price was examined.

Inflation was estimated using Nominal Treasury Bills and TIPS. This provided the estimated forward inflation rate on a weekly basis. The longer the time period, the higher expected inflation was indicating an upward sloping inflation yield curve. Depending on market conditions, near term inflation was usually lower than the longer term estimates, but the estimates seemed to move in the same direction. So when one term estimate went down the other seemed to follow in that same week or the near future.

The risk premium estimated using the Farm Credit Bonds follow the constant maturity securities pretty close. There are a couple times when the one, three, and five year agricultural lending risk premium widens by a larger margin. This occurred during the Dot com bubble of 1999 and when the financial crisis started in October of 2008.

Land pricing was examined based on inflation. Land pricing is more affected by cash rent than by interest rates. But with interest rates and inflation affecting cash rent then land prices are indirectly affected. Cash rent payments have more of an effect on land values. Nominal land prices correlate to nominal cash rent at 0.93 and real interest rates correlate to nominal land prices are 0.15. Inflation correlates to real cash rent at 0.79 and real interest rates correlate to real land values at -0.11.

Future research could look more closely at the premium that recreational use and oil/natural gas development has more directly on property values. Also, with the amount of wind farms that are starting to show up in Kansas, it is natural to examine the effect wind rights have on land values. Also I would have liked to go farther back in time on everything. Being able to build TIPS data back into the 1970s and 1980s would have been good to show what land prices did during high levels of inflation. Since TIPS started trading in 2003 that is all the data there is for calculating inflation. I would also look at the affect commodity prices have on land values. How do land values change as commodity prices go up or down?

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