What variables have historically impacted Kentucky and Iowa farmland values?

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Abstract

This study evaluates how farmland values and farmland cash rents are affected by cash corn prices, soybean prices, corn yields, soybean yields, the interest rate on a 10 year United States Treasury bond, and the United States Dollar foreign exchange value. Results are significant for these variables. Most importantly, how can farmers reduce portfolio risk?

Introduction

Farmland values across the United States are currently at historically high levels with the rate of change in the past 10 years increasing faster than the long run average. According to the National Agricultural Statistic Service data, from 1924 to 2012 Iowa farmland values have increased at an average rate of 5.01 percent.[1] In the past 10 years from 2002 to 2012 aggregate Iowa farmland values increased from $1,920 to $7,000 per acre, which is an average annual increase of 14.12 percent. This value per acre is the highest level on record. Additionally, corn and soybean prices have followed a similar pattern. From 1925 to 2012, Iowa cash corn prices increased at an average annual rate of 4.92 percent. In the past ten years, this increase has averaged 15.04 percent. Soybean prices over these time periods increased by 4.6 and 12.24 percent.[2] Furthermore, the U.S. dollar and interest rates are near the lowest levels on record. According to the St. Louis Federal Reserve Bank of the United States, in July of 2011, the U.S. Dollar exchange rate set an all-time low value of 68.[3] In August of 2012, the 10 year U.S. Treasury Bond rate hit an all-time low of 1.57 percent.[4]

Past literature and agricultural business intuition suggests that these variables greatly impact farmland values. Lower interest rates should provide lower costs of capital and borrowing for the purchase of farmland and capital expenditures. A weak U.S. Dollar on foreign exchange markets increases the price of commodities in Dollar denominated terms. This is because each U.S. Dollar buys fewer goods as the price of U.S. Dollars declines relative to other currencies of the world on foreign exchange markets. Higher commodity prices increase the returns to farmland values with it being the only production output of the land.

Since 2008, the U.S. Federal Reserve Bank has increased the monetary base by more than four times in roughly the past five years. During September 10, 2008 to September 18, 2013 it increased from $874.826 Billion to $3.545 Trillion, which is

[1] Farmland values per state link: http://quickstats.nass.usda.gov/

[3] U.S. Dollar Index link: http://research.stlouisfed.org/fred2/series/DTWEXM

[4] 10 Year U.S. Treasury Bond Rate link: http://research.stlouisfed.org/fred2/series/DGS10

an average annual increase of roughly 61 percent. From February 1984 to September 2008 the monetary base increased at an annual rate of just 15.73 percent.[5] The monetary base is the money supply that the Federal Reserve controls before it enters the broad money supply in circulation throughout the economy. Never in its history has the Federal Reserve taken such dramatic policy actions. This has caused considerable future inflation speculation priced into the commodity markets. It is highly uncertain how much of this increase in the monetary base will be in broad money circulation at some point in the future. A greater amount of currency in circulation can lead to higher rates of inflation as the entering currency is dilutive. In other words, when the rate of growth in currency exceeds the production of goods and services, this tends to increase prices at a greater rate.

Historically high agricultural commodity prices and rates of return increase the expectations for future farming profitability. This has been capitalized into farmland values in recent history. According to NASS data, five of the 10 highest valuations of farmland relative to rents were recorded from 2000-2011, which is estimated by dividing farmland value by cash rent. As expected, a similar increase has been recorded for agricultural commodity prices. Using boxplots to observe the distribution, it is shown that more than 75 percent of the data observations for corn price per state have annual changes below a 40 percent increase. In 2007, 2008, and 2011 corn prices increased by more than 40 percent.[6]

Fluctuations in farmland values and agricultural commodity prices have strong implications for farmers, agricultural businesses, government workers, land developers, and financial market participants. These groups are most concerned with what impacts farmland prices. There are several crucial decisions throughout the agricultural business community that depend heavily on future prices.

Most importantly, agricultural grain commodities and farmland have been highly inelastic over the last several decades. Small changes in supply and demand cause large price fluctuations. This is due to lack of substitutes between corn, soybeans, and wheat. These staple crops are used in a wide variety of processed foods and other goods. Producers of these products cannot easily substitute to another crop when prices rise dramatically. Furthermore, farmland in isolated geographical areas have limited alternative uses. Therefore, farmland is highly price inelastic.

There is also an interrelationship between commodities. Farmers distribute the supply of farmland production to generate the highest returns. In recent years the increased demand from ethanol production has taken a considerable amount of farmland away from other commodities to be used for corn growing. This has decreased the supply of other commodities, which increases its prices. Therefore, the demand for corn and its inelasticity causes the price of other commodities to increase. Conversely, if the price of corn declines this will cause the price of other commodities to also decline.

Moreover, agricultural commodity production is a relatively competitive market with many buyers and sellers, which limits market power for any particular farmer.

[5] U.S. Federal Reserve Monetary Base link: http://research.stlouisfed.org/fred2/series/BASE
[6] Corn price per state link: http://quickstats.nass.usda.gov/

Therefore, over longer periods of time supply tends to increase which decreases prices. This is because the market responds to higher prices by growing more corn. Also, every farmer is mostly producing the same good.

As such, the recent period of high agricultural commodity prices and farmland values may not be sustainable. The agricultural business community needs to understand that small changes in demand and supply will cause a larger marginal effect on prices. Furthermore, long run prices tend to decline due to increased supply. With no alternative uses for farmland farmers could operate at significantly lower profits or potential net income losses if prices decline.

Literature Review

Past literature is used as a guideline to choosing explanatory variables that have historically influenced farmland values. Henderson (2007) displays several similarities to the booming farmland values of today and the dramatic increases in the 1970's and large crash in the 1980's. A historical trend of farmland values is used to analyze what variables are impacting this significant rise in prices. There are currently lower crop supplies, high demand for corn from ethanol, rapidly growing foreign economies, and a weak U.S. dollar. These are all impacting farmland value appreciation.

A specific study from the historic increase and decline of farmland values in the late 1980s is shown by Barkema (1987). From 1976 to 1981 farmland values increased dramatically and then declined further than the price appreciation by 1986. It displays that the three most significant variables impacting farmland values are returns from farmland, interest rates, and the expected rate of inflation. Over this time period the value of farmland cash rents followed a similar pattern to that of farmland values. Furthermore, a large increase in interest rates corresponded to the decline in farmland values.

Schnepf (2008) shows that corn, barley, sorghum, oats, wheat, rice, and soybeans prices have been extremely volatile over the recent past and currently sit at historically high levels. Explanatory variables examined are crop stocks, currency fluctuations, several macroeconomic variables including interest rates and global economic growth rates, and government/international policies.

Scott (1983) outlined that farmland values increased in 48 of 50 years from roughly 1931 to 1981 providing a stable investment return above the rate of inflation. Following this period a large decline in farmland values occurred in the early 1980's. These variables are used in this study to explain changes in farmland values: rate of return to farmland, inflation (CPI), farmland rents, price to rent ratio, average price of corn, and average yield on corn.

A more recent study by Gloy, et al. (2011) models farmland value as a function of expected farm income or cash rents, interest rates, and expected growth rate of farm income. Farmland values are in the numerator and interest rates and expected growth rate are found in the denominator. Expected farm income or cash rents have grown with large increases in agricultural commodity prices. This has been capitalized into farmland values through expectations of future profitability. The paper also displays that interest rates have declined to historic lows which has dramatically increased farmland values as well. A specific example in the study shows that a decline in interest rates from eight percent to four percent doubles farmland value per acre. Intuitively, lower borrowing costs and greater growth rates increase profitability in the denominator. Therefore, a decline in the 10 year Treasury rate from the 15 percent peak in the 1980's to roughly three percent today can explain a great deal of farmland value appreciation.

Ahrendsen, Bandlerová, and Majerhoferová (2013) uses agricultural profitability, productivity, and interest rates to model farmland values in an OLS framework with data from 2000 to 2009. Farmland is broken out into pasture, crop, and agricultural land. The greatest contribution of the study was the findings with interest rates. For the U.S. interest rates are highly significant in all models with negative coefficients on crop and agricultural land with the corresponding inelasticities, -0.40 and -0.20.

Moss (1997) provides a capitalization model of farmland values as a function of returns or farm income divided by the discount rate. Results found that inflation had the largest impact on farmland values. Klinefelter (1973) used net farmland rents, average farm size, amount of voluntary transfers of farmland, and expected capital gains as a function of farmland values. It was found that 97.3 percent of the changes in the deflated index of Illinois farmland values over time was explained by these four variables.

Given this evidence of variables that impact farmland values, the Capital Asset Pricing Model can be used to estimate reduced portfolio risk for farmers. Barry (1980) shows that the expected return of an asset is the rate of return above the risk free rate and then divided by the variance of the asset. This can be used in a portfolio context by estimating the expected returns and variances on each asset to measure a weighted average, which is based on the value in each asset relative to the total assets of the farmer. Adding farmland related assets to a portfolio with less variance can reduce overall portfolio risk to the farmer.

Data and Methods

The 10 year government bond interest rates and U.S. Dollar Foreign Exchange Index are provided by the St. Louis Federal Reserve Bank of the United States. Farmland values per acre, cash rents, corn/soybean yields and prices in U.S. Dollar nominal terms are taken from the National Agricultural Statistics Service. All variables are in annual frequency.

Based on the literature, the following framework is used: farmland values can be given by the following equation:

$$\begin{aligned} &Farmland\ value\ per\ acre \\ &\quad = expectations\ (Cash\ rents \\ &\quad + 10YrGovBond + corn\ price \\ &\quad + soybean\ price + corn\ yield \\ &\quad + soybean\ yield \\ &\quad + U.S.Dollar\ Exchange\ Rate) + \ \varepsilon \end{aligned}$$

where farmland value per acre in each state = expectations (cash rents, 10 year government bond interest rate, corn price, soybean price, corn yield, soybean yield, and the U.S. Dollar Exchange Rate). Cash rents, corn price, soybean price, corn yield, and soybean yield provide an empirical representation of returns to farmland. The 10 year government bond interest rate provides a variable to account for the fluctuation of interest rates. To provide a measure of foreign exchange the U.S. Dollar value is used. The hypothesis is that farmland value per acre is a function of these variables. Using a dataset for Kentucky and Iowa, an Ordinary Least Squares, OLS, model with robust standard errors is generated for preliminary econometric results.

Results

Displayed in Table 1, for Iowa farmland, from 1924 to 2012, the results display significance at the 1% level for cash rents and soybean yield. Soybean price is significant at the 5% level. All other variables are insignificant. The variance inflation factors reveal that there is multicollinearity among the variables with a mean VIF value of 23.13, displayed in Table 2. This is well above 10 for all variables. The U.S. Dollar index is omitted due to no data available until 1973. With the U.S. Dollar included the frequency is reduced to 1973 to 2012. The result of this regression shows that the U.S. Dollar has a significant effect on Iowa farmland values at the 5% level, shown in Table 3.

The data for Kentucky ranges from 1940 to 2012. OLS models for Kentucky farmland provides a significant relationship at the 1% level for corn yield and the 10 year Treasury bond rate, shown in Table 4. As is the case with Iowa farmland, the Kentucky model has multicollinearity among the variables, which is displayed in Table 5 under the VIF results.

Due to the multicollinearity, the variables are differenced until stationary, which is verified through the Augmented Dickey Fuller Test. All variables are stationary in the first difference with each observation representing the current value subtracted by the previous year value. This removes the time trend of the data and measures the variation around the trend. With stationary variables, the model shows significance in only Iowa farmland cash rent and it is significant at the 1% level, displayed in Table 6. The mean VIF between the variables of 1.79 shows no evidence of multicollinearity, shown in Table 7. Therefore, when comparing the model without differenced variables to the model with them it is shown that the significance of the variables is greatly reduced when the trend is removed from the data.

Also, a granger causality model is constructed with 3 lags of each independent variable. The results from Table 6 show that there is evidence that past values of Iowa farmland, corn and soybean prices, yields, and cash rents granger cause farmland values. Two lags of Iowa farmland values, two lags of corn prices, two lags of corn yield, and two lags of cash rents are significant at the 1% level. These results are exhibited in Table 8.

With these relationships, there are several financial tools that have been introduced in recent history which are currently being underutilized by farmers. These include Real Estate Investment Trusts, known as REIT's and Exchange Traded Funds, or ETF's. A REIT represents farmland and an ETF predominantly consists of commodity futures contracts. REIT's and ETF's provide a more cost efficient way to take advantage of the relationships between the explanatory variables and farmland values.

What is a Real Estate Investment Trust (REIT) and How Can It Be Used?

More specifically, a REIT is a real estate company or business trust who owns and purchases real estate. Today, REIT's invest in a diverse mix of commercial and residential real estate. REIT's receive income by leasing property to tenants. Almost all lease income passes through the REIT to investors in the form of dividend payments. The REIT company creates common stock shares, which list on stock exchanges. Investors who buy REIT shares receive the income generated from leasing the property which are paid in the form of dividends. Also, they realize gains or losses from changes in stock value. REIT share price is a function of buyer and seller expectations stemming from rental income and real estate value, but income is the primary driver of REIT share price, Walters and Barnhart (2013).[7]

Currently there is not a REIT that owns farmland. Such a REIT would allow investors the opportunity to participate in returns generated from farmland. Investors would receive dividend payments that originate from farmland rent. Investors would also benefit from increases in farmland REIT stock price, which would be driven by increases in either farmland capital appreciation and/or farmland rent. Speculators and hedgers could both be market participants interested in acquiring returns from investing in farmland by taking buy a long or short position. Hedgers, specifically holders of farmland, would view the REIT the same way they look at commodity futures. Cash grain prices are equal to futures prices plus basis. For farmland, the cash market would be the physical farmland market, futures prices would be the farmland REIT and basis would represent the difference between both markets. The relationship between cash and futures would provide hedgers the opportunity to hedge their farmland value through the REIT price. The holder of farmland can then hedge the REIT value by taking an opposite position.

In addition to purchasing a REIT, an investor can also short sell a REIT on a stock exchange. The ability to short sell provides the opportunity for investors to benefit as real estate asset prices decrease. Short sellers pay the dividends while short the REIT. This is because a short seller borrows the shares from another investor before selling them. The owner of the REIT is entitled to the dividends paid which is why the short seller is liable for dividend payments.

Creating a Hypothetical REIT

Due to no farmland REIT's currently in existence, hypothetical farmland REIT's are created for analysis. REIT's are formed by using the aggregate average farmland value per acre and cash rents for Iowa, Kentucky, and the United States. For simplicity, farmland value per acre is divided by 100 shares to represent a REIT value for U.S. farmland of $0.34, Iowa at $0.79, and Kentucky at $0.38 per share in 1940. At the end of 2012 these values were $24.50 for the U.S., $70 for Iowa, and $35 per share for Kentucky. REITs can have any number of shares determined by the shareholders. The farmland value per acre measures the REIT price per share while cash rents per acre are considered investor dividend.

Therefore, returns to investors are estimated by the annual change in farmland values which correspond to the price appreciation of the REIT. Additionally, investors realize a dividend yield that is the annual cash rents divided by the farmland value per acre or the REIT price per share in that year. For simplicity, the dividends are equal to 100% of rental income in this example. Adding both the price appreciation of farmland and dividend yield from cash rents together provide the return in each year. There is an average return of 15.65% for Iowa and 17.85% for Kentucky from 1940 to 2012.

There have been several extreme price increases and declines over the time series. In 1977 Iowa had a REIT value increase of 36.85%. This was followed by a price appreciation of 28.13% in 1985. Over

[7] Inserted from the article titled, *What is a Real Estate Investment Trust?,* by Cory Walters and John Barnhart

the past three years Iowa REIT value has increased 16.88% in 2010, 26.67% in 2011, and 22.81% in 2012. Kentucky REIT values have been slightly less volatile. The largest price increases were in 1977 with 20.43% and in 1979 with 20.42%. However, declines were more modest with the largest being in 1985 at only 7.64%. Furthermore, from 2010 to 2012 Kentucky REIT prices have increased far less than Iowa with annual increases of 1.05%, 0.69%, and 5.17%. The largest increase for Kentucky over the time series was in 2005 at 23.74%. In the same year Iowa REIT values increased 20%, respectively.

With aggregation of the data into a statewide farmland value and rents per acre average there is basis risk incurred by individual farmers when investing or hedging through a hypothetical REIT. This occurs from differences between each individual observation and the average values. Therefore, the fluctuation and actual values in the REIT price and dividend yields will vary from each individual farmer's farmland value and cash rents. This is known as basis risk. For example, the basis risk that the average Kentucky farmer faces against the average Iowa farmland value and rents per acre is shown through the time series.

The average total return basis between Iowa and Kentucky is 2.21%. Kentucky REIT value increased on average by 2.69% more and had a dividend yield of 0.48% greater than Iowa. Furthermore, there was less risk involved with Kentucky returns. Total standard deviation of returns for Iowa was 14.06% while Kentucky was 12.34%. In the recent past there has also been considerable basis risk for Kentucky. On average from 2007 through 2012 Iowa REIT value increased by 13.88% annually more than Kentucky. This disparity was largest in 2011 with a 25.97% increase of Iowa above Kentucky.

Hedging Farmland with REIT's

To hedge farmland an investor can sell short a REIT that has strong positive correlation to farmland. In other words, as farmland values decline so does the REIT stock value. Short selling profits offset declines in farmland values. Also, a farmland owner can purchase a put option on the same REIT which also provides counteracting profits from declines in farmland values. In other words, it is a type of insurance that will increase in value as the price of farmland decreases.

REIT's offer option trading against the share price value. A call option can be purchased which gives the owner of the option the right to buy 100 shares of the REIT at a specified price before a future date. All option contracts represent 100 share increments enforced by the exchange as a required regulation. The owner of a call option will profit from the REIT's share price increasing beyond its specified purchase price. As such, the investor will benefit from the REIT's real estate portfolio increasing in value. Conversely, a put option provides the owner the right to sell 100 shares of the REIT at a specified price before a future date. The owner of a put profits when the price declines past the specified selling price or strike price. Thus, the investor benefits when the real estate portfolio in the REIT declines in value. Option owners do not receive or are liable for any dividend payments. The values of options are derived by the price change in the REIT.

Here is a specific example of hedging through an options contract. For simplicity, assume that the investor owns 100 shares of the Iowa REIT. This is equivalent to one option contract. Also assume that the Iowa REIT value was $70 per share which is the ending value for 2012. An investor purchases a put option for $3.50 per share with a strike price of $70, expiring on December 21, 2013. This represents a roughly six month option to sell 100 shares of the Iowa REIT for $3.50 per share. Until expiration of the contract, an investor is protected from losses below $70 per share but must incur the cost of the put option which reduces the gain from future price appreciation. As a result, maximum protection is at $66.50 per share or a 5% loss over the six month period.

An investor can also hedge through a short sale. An Iowa REIT owner can sell a Kentucky REIT that they do not own. Future losses from Iowa REIT value declines are offset by decreases in Kentucky values. However, future gains from Iowa REIT value increases are not fully realized with an appreciation in Kentucky values. Furthermore, the cost to investors executing a short sale is the dividend yield. This must be paid by short sellers. The Kentucky REIT had a dividend yield of 5.84% for 2012. Therefore, an investor has a one year cost of 5.84% in a short sale scenario.

There are several differences between these two strategies for investors to consider. Options provide leverage which allows for greater realization of price appreciation. However, as shown in the example, on a percentage basis over time there are greater costs associated with options. Conversely, a short sale has less cost but future price appreciation is greatly limited. On the other hand, a short sale has no time period restriction and options have clearly outlined expiration dates in the contracts. Both option contracts and short sales have several positives and negatives that investors must determine the suitability for their own financial situation.

From 1940 to 2012 Iowa and Kentucky REIT values have experienced several extreme price increases and declines. In 1977 Iowa had a REIT value increase of 36.85%. Using the previous example of hedging costs, options and short sales, these products would have reduced these losses by 25 to 30%. With the use of put options, a great amount of the price appreciation of 28.13% in 1985 would have still been realized. The timing of execution with these hedging strategies greatly impacts gains and losses.

Kentucky REIT values have been slightly less volatile which can reduce the potential benefits of hedging if costs remain high. The largest price increases for Kentucky were in 1977 with 20.43% and in 1979 at 20.42%. Conversely, the largest price decline was in 1985 at only 7.64%. Therefore, there was less benefit to hedging. However, in most cases the price of options decline due to the market anticipating lower future volatility.

What Is an Exchange Traded Fund (ETF)

The second financial instrument that can be extremely useful in agriculture is an exchange traded fund or ETF. The first ETF was created and listed in 1993. Since then the total amount of assets in ETF's has increased rapidly to over $1 trillion today. It provides investors increased liquidity, reduced transaction costs, less collateral requirements, and improved overall access to capital markets. Specifically to agriculture, market participants have greater access to commodity futures through the stock market.

Creating a Hypothetical ETF

For empirical analysis, hypothetical ETF's are created due to the limited data available. Mostly all agricultural related ETF's have been in existence for less than 5 years. The hypothetical ETF's are constructed with annual cash price data for each state with an evenly divided mixture of corn and soybean prices. From 1924 through 2011, the Kentucky and Iowa ETF's averaged a 4.81% and 4.4% annual increase. The wider standard deviation was from Iowa at 22.3% and Kentucky with 16.89%.

Basis risk in ETF's consists of the differences between each individual observation and the average values from Kentucky compared to Iowa. This can also be risk through various commodity contracts with varying time expectations. For example, price disparities between June and January not being equal across states. The basis risk between the Iowa ETF price and the U.S. average annual cash price with the same commodity mix was $0.0019. Therefore, the price of the Iowa ETF was $0.001 higher than the U.S. average which is fairly close. This shows little basis risk between Iowa and the U.S. average in an annual time frequency from 1924 to 2012. Kentucky had a much greater basis with the U.S. of $0.0982. Both states with positive basis showing a larger average price of these commodities when compared to the U.S. average. The ETF basis risk between Kentucky and Iowa was 0.095 for Kentucky and a -0.095 for Iowa. This represents a higher average price of $0.095 for Kentucky.

Results from using ETF's and REIT's

An OLS regression with robust standard errors displays that the hypothetical ETF for both states is highly significant with positive coefficients when regressed on the hypothetical REIT and dividend yield values. The following elasticities are observed through the corresponding coefficients. In Iowa, when the ETF increases by one percent, the REIT value increases by 1.69 percent and dividend yield, (rents/farmland value), 1.13 percent, displayed in Tables 9 and 10. Kentucky has greater marginal effects with a 2.22 percent increase in the REIT value and 1.56 percent in the ETF from a one percent increase in the ETF, exhibited in Tables 11 and 12. When regressing these variables across states the results are the same. A one percent increase in the Iowa ETF causes a 2.18 percent increase in the Kentucky REIT, displayed in Table 13. This provides empirical evidence that ETF's and REIT's have a positive relationship over time. Therefore, farmers can successfully hedge across states with these financial instruments.

Using the capital asset pricing model of a farmer's portfolio, the average annual return from farmland can be maximized using these financial instruments. The standard deviation defines the risk or uncertainty of the average annual return. This is graphed with return on the Y-axis and standard deviation on the X-axis. The combination of points plotting the return relative to risk is known as the efficient frontier. It is optimal to maximize the portfolio rate of return with a mixture of asset weightings through long, ownership, and short, opposite, positions. The portfolio return relative to the standard deviation provides a benchmark for an optimal level of return relative to risk.

For Kentucky farmer's the annual average rate of return from the farmland REIT is 17.94 percent with a standard deviation of 6.36. The corn and soybean ETF had a 4.81 percent return with a standard deviation of 16.89 percent. Therefore, a short position in the ETF will most effectively hedge farmland values with a much lower return and higher standard deviation. In other words, there is much greater uncertainty of price with the ETF and a lower price increase. A short position equal to 10 percent of farmland values will reduce the standard deviation of the farmer's portfolio to 4.67 percent while only decreasing the portfolio return to 17.46 percent. Dividing these two numbers provides the amount of return for every one percent of standard deviation or risk. This number is 3.73 percent with a 10 percent short position in the ETF. If the farmer increased the short position to 20 percent it would reduce the portfolio standard deviation by more than half to 3 percent while decreasing the overall return to 16.97%. This provides a relative value of 5.685 or 5.865 percent for every one percent of risk. The short position can also be executed through a put option on the ETF for a fraction of the cost expiring during a certain time period specified by the contract. A 37.7 percent short position provides the mathematically optimal return to risk to return ratio with a portfolio return of 16.12 percent and a standard deviation of 0%.

Similar results are possible for Iowa farmers. The portfolio with only farmland provides a rate of return of 12.35 percent and a standard deviation of 15.57 percent. A 10 percent short position in the ETF provides portfolio returns of 11.91 percent and reduces standard deviation to 13.31 percent. The 20 percent ETF short position provides returns of 11.47 percent with a standard deviation of 11.05 percent. Other combinations can be tailored to the farmer's financial preferences. The optimal portfolio return with respect to minimizing standard deviation is best done through a short position in an ETF because of the much higher standard deviation relative to expected return. A short position in a farmland REIT can reduce portfolio risk through lower standard deviation. However, this is done at the expense of lower portfolio return.

Farmers must also be aware that these optimal results when solved mathematically do not always provide the best asset mix under a practical situation. There are significant capital requirements and percentage costs with large short positions in ETF's or option contracts. Also, low probability outcomes can occur which are largely not accounted for in these models. However, this capital asset pricing model does provide helpful intuition for reducing risk relative to return. Given the data, the best way to accomplish this is with a short position in an ETF of corn and soybean futures contracts.

Conclusions

Given the historic increases in farmland values and commodity prices it would be prudent for farmers to manage the potential risk of future declines through hedging strategies. For Iowa, the worst annual rate of return to farmland was in 1985 with a negative 20.94 percent. Therefore, in an extremely bad outcome, a farmer with $1,000,000 in farmland has possible value at risk of $209,400 in total capital loss. Several other years in the early 1980's experienced large negative returns to Iowa farmers. In 1986 returns were a negative 12.37 percent, 1983 a negative 5.39 percent, and 1984 a negative 4.66 percent. This was after historically high returns for Iowa farmland in the 1970's with the largest return of 41.93 percent in 1977, 39.83 percent in 1974, and 35.46 percent in 1976. During the farmland value declining time periods the U.S. Dollar foreign exchange value increased by roughly 40 percent and interest rates increased substantially with the 10 year government bond rate roughly doubling from 7.5 percent to 15 percent. With both near historic lows, it is likely that an increasing interest rate environment with a strengthening U.S. Dollar is imminent at some point in the future. Therefore, farmers should be aware of the potential losses that could occur if the farming sector experiences a similar 1980's like scenario.

Future extensions of this research could include the creation of these and other financial products in agriculture. Aside from ETF's and REIT's, the financial industry could also provide farmland value products. Farmland value swaps could be structured in a similar way to the newly created credit default swaps, which act as an insurance product paying the holder of the swap in full given losses on a mortgage or bond default. In the case of farmland, a swap would pay the holder if the farmer defaulted on their loan. Farmers could purchase this to hedge against potential declines in farmland value stemming from bad outcomes in the agriculture sector. Another financial instrument that could apply to agriculture is a collateralized debt obligation, or cdo. These are pools or groups of bonds and credit obligations bundled into one asset that pay an interest rate to the owner of the cdo. Farmland loans could be structured into a cdo and provide several areas of diversification to farmers and the investment community. These financial products could also trade on exchanges to provide greater liquidity and pricing to market participants.

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Tables of Results

Table 1. OLS for Iowa farmland value per acre

Iowa Farmland Value Per Acre	Coefficient
Iowa Farmland Rents	25.81***
	(4.02)
Iowa Corn Yield	6.28
	(3.87)
Iowa Corn Price	161.44
	(233.91)
Iowa Soybean Price	-136.36
	(60.176)
Iowa Soybean Yield	-35.50
	(12.86)
10 Year Treasury Rate	-824.05
	(2146.27)
Constant	278.94
	(152.61)
Number of Observations	89
F-statistic	163.83
R-squared	0.9423

Significance Level, ***1%, **5%, *10%

Table 2. Variance Inflation Factor- OLS Iowa farmland value per acre

Variable	VIF
Iowa Farmland Rent	38.87
Iowa Corn Price	26.80
Iowa Corn Yield	25.91

Iowa Soybean Price	24.90
Iowa Soybean Yield	20.26
10 Year Treasury Rate	2.02
Mean VIF	23.13

Table 3. OLS Iowa farmland value per acre, U.S. Dollar included reducing frequency to 1973 to 2012

Iowa Farmland Value Per Acre	Coefficient
Iowa Farmland Rents	-10.49
	(16.63)
Iowa Corn Price	21.93**
	(10.00)
Iowa Corn Yield	962.52*
	(532.67)
Iowa Soybean Price	238.52
	(158.51)
Iowa Soybean Yield	20.92
	(30.31)
10 Year Treasury Rate	-3446.21
	(4369.73)
U.S. Exchange Rate	14.41**
	(6.16)
Constant	-6071.35**
	(2474.82)
Number of Observations	40
F-statistic	66.09
R-squared	0.9203

Significance Level, ***1%, **5%, *10%

Table 4. OLS Kentucky Farmland Value per acre

Kentucky Farmland Value	Coefficient
Kentucky Farmland Rent	3.25
	(4.97)
Kentucky Corn Price	242.71
	(161.39)
Kentucky Corn Yield	10.99***
	(3.48)

Kentucky Soybean Price	33.31
	(62.94)
Kentucky Soybean Yield	1.91
	(10.22)
10 Year Treasury Rate	-5880.17***
	(1720.79)
Constant	-667.57**
	(260.22)
Number of Observations	73
F-statistic	97.47
R-squared	0.8986

Significance Level, ***1%, **5%, *10%

Table 5. Variance Inflation Factor OLS Kentucky Farmland Value per acre

Variable	VIF
Kentucky Farmland Rent	46.75
Kentucky Corn Price	29.96
Kentucky Soybean Price	26.54
Kentucky Corn Yield	14.72
Kentucky Soybean Yield	6.65
10 Year Treasury Rate	2.05
Mean VIF	21.11

Table 6. OLS Farmland Value per acre, stationary data-each variable differenced once

D1 Iowa Farmland Value Per Acre	Coefficient
D1 Iowa Farmland Rents	0.37***
	(0.08)
D1 Iowa Corn Price	2.08
	(28.22)
D1 Iowa Corn Yield	0.74
	(0.59)
D1 Iowa Soybean Price	-0.04
	(0.06)
D1 Iowa Soybean Yield	0.04
	(0.08)
D1 10 Year Treasury Rate	461.69
	(905.63)
Constant	9.24
	(9.47)
Number of Observations	87
F-statistic	5.76

R-squared	0.3016

Significance Level, ***1%, **5%, *10%

Table 7. Variance Inflation Factor OLS Iowa Farmland Value per acre, stationary data

Variable	VIF
D1 Iowa Farmland Rent	2.57
D1 Iowa Corn Price	1.98
D1 Iowa Corn Yield	1.95
D1 Iowa Soybean Price	1.75
D1 Iowa Soybean Yield	1.45
D1 10 Year Treasury Rate	1.02
Mean VIF	1.79

Table 8. Iowa Farmland Value per acre granger causality, 3 lags of each independent variable

Iowa farmland value	Coefficient
Iowa farm value 1 lag	1.75***
	(0.10)
Iowa farm value 2 lags	-0.91***
	(0.16)
Iowa farm value 3 lags	0.05
	(0.10)
Iowa corn price	20.08
	(62.32)
Iowa corn price 1 lag	-181.07**
	(89.64)
Iowa corn price 2 lags	333.84***
	(92.98)
Iowa corn price 3 lags	-263.64***
	(72.19)
Iowa soybean price	-27.75
	(21.81)
Iowa soybean price 1 lag	45.57*
	(24.22)
Iowa soybean price 2 lags	-3.53
	(2.07)
Iowa soybean price 3 lags	-41.72*
	(21.22)
Iowa corn yield	-1.65
	(1.39)
Iowa corn yield 1 lag	-1.67
	(1.97)
Iowa corn yield 2 lags	8.67***
	(2.07)

Iowa corn yield 3 lags	-7.97***
	(1.70)
Iowa farmland rent	4.19**
	(1.83)
Iowa rent 1 lag	5.24*
	(2.85)
Iowa rent 2 lags	-16.37***
	(2.98)
Iowa rent 3 lags	15.43***
	(2.61)
Constant	158.69***
	(55.62)
Number of Observations	86
F-statistic	961.31
R-squared	0.9964

Significance Level, ***1%, **5%, **10%

Table 9. OLS Ln of Iowa REIT value regressed on Ln Iowa ETF

Ln Iowa Farmland REIT	Coefficient
Ln Iowa ETF	1.69***
	(0.10)
Constant	4.63
	(0.12)
Number of Observations	89
F-statistic	282.90
R-squared	0.8304

Significance Level, ***1%, **5%, *1%

Table 10. OLS Ln of Iowa REIT value regressed on Ln of Iowa farmland cash rents

Ln Iowa Farmland REIT	Coefficient
Ln Iowa Farmland Rent	1.13
	(0.05)
Constant	2.08
	(0.19)
Number of Observations	89
F-statistic	577.09
R-squared	0.9164

Significance Level, ***1%, **5%, *10%

Table 11. OLS Ln of Kentucky REIT regressed on Ln Kentucky ETF

Ln Kentucky REIT	Coefficient
Ln Kentucky ETF	2.23
	(0.10)
Constant	3.53
	(0.13)
Number of Observations	73
F-statistic	450.65
R-squared	0.8155

Significance Level, ***1%, **5%, *10%

Table 12. OLS Ln of Kentucky REIT regressed on Ln of Kentucky farmland cash rents

Ln Kentucky REIT	Coefficient
Ln Kentucky Rent	1.46
	(0.40)
Constant	0.59
	(0.15)
Number of Observations	73
F-statistic	1298.94
R-squared	0.9365

Significance Level, ***1%, **5%, *10%

Table 13. OLS Ln of Kentucky REIT regressed on Ln of Iowa ETF

Ln Kentucky REIT	Coefficient
Ln Iowa ETF	2.18
	(0.11)
Constant	3.65
	(0.13)
Number of Observations	73
F-statistic	410.04
R-squared	0.7994

Significance Level, ***1%, **5%, *10%