Ability to Pay and Agriculture Sector Stability

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Introduction

In the past century the agriculture sector has witnessed three major boom and bust cycles, all following a relatively similar pattern. Profits increase due to a growth in exports and prices received, then with the larger cash flow, deleveraging and an expansion in capital expenditures occurs. Once profits begin to fall, capital expansion tends to continue for a period of time and debt grows to manage the increase leveraged positions.\(^1\) In the recent agriculture boom, various aspects of this pattern have emerged yet again.

Beginning in the late 1990’s, net farm income in U.S. agriculture began to expand from a little over two million dollars in Iowa to over twelve and a half million in 2012, a percent increase of close to 450\%.\(^2\) This increase in net cash farm income is largely due to increases in crop prices during that time (corn, + 300\% and wheat, + 226\%)\(^3\), increases in yield per acre and increases in demand both domestically and internationally. Demand increases have been attributed to several factors. Firstly, the emergence of multiple free trade agreements in the mid to late 1990’s and 2000’s that have made exporting goods to the other countries easier. Secondly, expansions in both the population and income of developing countries have increased demand for U.S. exports; and finally, the boom in biofuels have increased domestic demand for grains.

Comparing the recent boom in agriculture to that of the 1970’s, there are similarities in terms of the expansion of demand due to increases in international trade and higher prices. Farm operators have expanded operations increasing capital expenditures as well as their debt

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\(^1\) Henderson and Kauffman, 2013, “Farm Investment and Leverage Cycles: Will This Time Be Different?”

\(^2\) USDA NASS Data

\(^3\) USDA NASS Data
positions. All cycles have also seen similar rapid increases in farmland prices. The changes in farmland value during these cycles are an important factor as it is the largest use for collateral for these loans. In the 1970’s, the average yearly increase of land in Iowa was 10% and increased overall 178% from 1971 to 1985.\(^4\) Today, there have also been substantial increases in the market prices of farmland with the Midwest witnessing the largest. In 1987, following the downturn in the agriculture sector, farmland prices in Iowa averaged $1,311.42 in real terms. In 2015, farmland prices were $7,463.64—an increase of nearly 500%. In the past decade, farmland prices have increased on average, 128% in Iowa, reaching a maximum of $8,050 per acre.\(^5\) Graph 1\(^6\) shows the historical changes in farmland prices seen in Iowa, a representative state for the Midwest region where farmland prices have been the most affected.

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\(^4\) USDA NASS Data
\(^5\) USDA NASS Data
\(^6\) USDA NASS Data
One of the major differences between previous boom-and-bust cycles and the current boom is the leverage position of the producers. Graph 2\(^7\) shows the evolution of the debt-to-asset ratio overtime. In 1985, the debt-to-asset ratio peaked at 22%. 2015 recorded a sector-wide debt-to-asset ratio of 12%. At face value, this figure indicates a significantly less risky market.

![Graph 2. Debt-to-Asset Ratio](image)

Yet, in previous cycles, debt accumulation continues following signals of downturns in the sector. As seen in Graph 3, capital expenditures tend to continue to increase following repeated decreases in net farm income. Previous busts in the agriculture sector have largely been fueled by the producers’ inability to support their over-leveraged position with cash flow. Yet as the graph shows, as sources of cash flow diminish, the market continues to increase their debt. There are two sides to the debt accumulation of the market. Firstly, the producer is willingly

\(^7\) USDA NASS Data
adding risk to their financial position by continuing to expand their debt positions. On the other hand, lenders are also allowing and possibly encouraging the risky behavior of the borrowers.

Graph 3. Net Farm Income and Capital Expenditures

This paper will serve to model capital expenditures as a way to better understand changes in the risk positions of the market participants and assess whether the credit market is outpacing the borrowers’ ability to repay.

**Background**

In 2013, Henderson and Kauffman of the Federal Reserve Bank of Kansas City wrote a paper, “Farm Investment and Leverage Cycles: Will This Time Be Different?” addressing a pattern that has arisen in the past three expansion and contraction periods. The three periods addressed are 1910-1940, 1940-1960 and 1970-1980. The progression of events begins with an expansion in profits, caused by varying factors related usually to increases in trade, exports and prices
received. As cash flow increases, producers decrease their leveraged positions and the debt-to-asset decreases. As less cash flow is required for debt services, the wealth of farmers increases. Following the increase in wealth, capital expenditures increase. A downturn in the agriculture economy causes profits to decrease, reducing their cash flow to cover the debt positions created from the capital expansion yet capital expansion tends to continue to grow. Finally, farm operators are forced to expand or restructure their debt positions to manage their inability to service their debt positions. 8

1910-1940

The 1910’s were already experiencing increases in food demand. As World War I occurred, demand for US agricultural exports doubled. As a result, crop and livestock prices also increased causing large upward movements in profits for the US agriculture sector. 9 This time period was also a time of mechanization of farming. Producers were adopting the use of tractors and other farm machinery equipment leading to surges in the level of yield produced. In 1917, farm spending on vehicles, machinery and equipment increased 33% and continued to expand through the decade. 10 By 1921, exports had decreased and the onset of a recession suppressed prices and profits. Real net returns to operators decreased 53% therefore as a way to provide liquidity to their operations, farmers expanded and restructured their debt positions. By 1923 farm bankruptcies began to increase. Following the initial recessionary period, the onset of the Depression in the 1930’s caused farm profits to collapse again, creating another series of farm bankruptcies. 11

8 Henderson and Kauffman, 2013, “Farm Investment and Leverage Cycles: Will This Time Be Different?”
9 Henderson and Kauffman, 2013, “Farm Investment and Leverage Cycles: Will This Time Be Different?”
10 Henderson and Kauffman, 2013, “Farm Investment and Leverage Cycles: Will This Time Be Different?”
11 Henderson and Kauffman, 2013, “Farm Investment and Leverage Cycles: Will This Time Be Different?”
1940-1960

As for the economy, overall, World War II spurred an increase in prices and demand for US agricultural exports and brought the sector out of the recession it had been in. Net farm income for the sector more than doubled from 1940 to 1943. Following the increase in income, capital expenditures from 1943 to 1949 increase more than 3 times. By 1947 non-real estate investment increased by 73%. From 1950 to 1956, profits were suppressed and debt was expanded to finance previous capital expenditures. Between 1950 and 1960, average farm debt rose close to 10% each year for both real estate and non-real estate transactions. Debt levels, overall, remained below historical averages and therefore, the sector avoided a bust following the expansion in the 1940’s.

1970-1980

The boom in the 1970’s was largely a result of an increase in exports and prices following a trade agreement with the Soviet Union in 1972. The year following the trade deal, U.S. agricultural exports and net farm income nearly doubled. Profits returned to near previous levels following that initial spike in returns but remained 44% higher than the previous decade. The substantial increase in profits caused an expansion in both non-real estate investments and land improvements. Capital spending began to rise faster than incomes increasing debt levels by about 5% per year. The substantial leveraged positions and decreases in farm profits lead to the development of the second financial crisis.

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12 USDA NASS Data
13 USDA NASS Data
14 Henderson and Kauffman, 2013, “Farm Investment and Leverage Cycles: Will This Time Be Different?”
15 Henderson and Kauffman, 2013, “Farm Investment and Leverage Cycles: Will This Time Be Different?”
16 Henderson and Kauffman, 2013, “Farm Investment and Leverage Cycles: Will This Time Be Different?”
17 USDA NASS Data
18 USDA NASS Data
In the beginning of 1980, farm exports and price declines lead to a collapse in farm profits. Net farm income decreased from about $67 billion to $36 billion in 1980. All capital expansion was halted to minimize the accumulation of more debt but the over-leveraged positions of the market had already been realized. The sector witnessed another decrease in profit in 1983 to $26.5 billion. The massive decline in cash flow coupled with increasing interest rates made servicing debt even more difficult for farmers. By the mid-1980’s the sector witnessed 2.3 bankruptcies per 1000 farms and 30 bank closings on average, per year. Between 1985 and 1988, debt per farm decreased 10% annually as lenders wrote off existing debt. The crashing of the sector reverberated throughout the agriculture sector causing massive declines for all including local economies and input suppliers such as John Deere.

Today

Exports and prices rebounded in the 1990’s and early 2000’s from the bust of the 1970’s and 1980’s bubble. This recent boom saw two major drivers of demand—exports and biofuels. International demand has been supported by growing populations and rising incomes in developing countries such as China. In 2011, China was 20% of U.S. exports. Secondly, the demand garnered from The Renewable Fuel Standard established in 2005 has driven demand for grains and oilseed domestically. Crop prices have also been increasing reaching all-time highs in 2012. Corn reached its highest price in 2012 at $6.92. In 1999, the price of corn was $1.72. Soybeans increased from $4.35 to $14.40 from 2001 to 2012. Wheat was $2.15 in 2000 and increased to $7 in 2012. Net farm income reached a peak of $116 billion in 2013, an increase of 60% from 2002 levels. The market is saturated with product and as a result, beginning in 2014,

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19 Henderson and Kauffman, 2013, “Farm Investment and Leverage Cycles: Will This Time Be Different?”
20 Henderson, Gloy and Boehlje, 2011, “Agriculture’s Boom and Bust Cycles: Is This Time Different?”
prices have started to decline. Corn, soybean and wheat prices are currently at $3.50, $8.65 and $3.70, respectively. Additionally, net farm income has declined for the third year in a row.

One of the primary differences constantly noted in this time period from others, is the lack of debt accumulation and the over-leveraged positions of the entire agriculture sector. In the early part of the decade, 2000-2005, debt levels remained stable and accumulation was minimal. During that time, the average debt accumulation year over year was about 1.5%. In 2007 and 2008, debt levels increased 9% and 6%, respectively. Recently, debt levels have seen larger percentage increases. In 2013 and 2014, debt increased 4.5% and 8%, respectively. The average debt-to-asset ratio has also remained around 12% with a maximum for the decade being in 2002 at 15%. While these lower levels of the debt ratio prove promising, previous cycles have shown that capital expenditures increase well past decreases in net farm income which have just begun. If this cycle is consistent with past ones, the debt accumulation stage may just be beginning.

Data

Data used are largely from the USDA Economic Research Service (ERS), Farm Income and Wealth Statistics (FIWS) and the USDA National Agricultural Statistics Service (NASS). The FIWS data source accumulates data observations on income and balance sheet measure for individual states and the United States as a whole. Data is collected and released in February, August and November. Historical data included is annual and spans from 1974 to 2015. All values are deflated using the same method implemented by USDA NASS. The deflator is the GDP chain-type price index published by FRED. All data is deflated to comparable 2009 levels.
Several data were used for the development of the regressions used. Capital expenditures (CE) and the return on investments (ROI) were obtained from the USDA FIWS. The regression estimations were divided into four measures of CE: real estate CE, non-real estate CE, CE on tractors and CE on machinery and equipment. The various CE measures are from the “Gross Capital Expenditure” data release. The FIWS data series provides a breakdown of each of these expenditure measures. Real estate capital expenditures include expenditures on buildings, land improvements and include operator dwellings. Non-real estate CE includes those on vehicles, tractors, machinery and equipment.

The return to investment explanatory variable is calculated as revenue divided by total operating cost plus capital consumption. The revenue value is obtained from the “Return to Operator” data from the USDA FIWS data file identified as “Gross Receipts of Farms.” The total operating costs is available as “Farm Production Expenses” from the same source and includes capital consumption value.

Methodologies

Five models were developed to explain changes in capital expenditures. CE were broken down into real estate and non-real estate transactions. Further, non-real estate transactions were separated into expenditures on tractors, and expenditures on machinery and equipment. Two explanatory variables were used in each equation. Total ROI was included in every equation as an indicator of expected return to the investment in the varying capital expansions. Additionally, the lagged value of the CE associated with each dependent variable was also included as an explanatory variable. Initially, an ordinary least squares regression was used to estimate the
relationship between the total real estate, total non-real estate, tractor, and machinery and equipment variables and the independent variables:

\[ CE_{Total\ Real\ Estate,t} = f(ROI_t, CE_{total\ RE,t-1}) \]

\[ CE_{Total\ Non-Rea\ Real\ Estate,t} = f(ROI_t, CE_{Total\ Non-RE,t-1}) \]

\[ CE_{Tractors,t} = f(ROI_t, CE_{Tractors,t-1}) \]

\[ CE_{Machinery\ &\ Equipment,t} = f(ROI_t, CE_{Machinery\ &\ Equipment,t-1}) \]

In addition, a seemingly unrelated regression equation was also run to determine if more information would be gained if it was assumed that the errors of the equations were contemporaneously correlated. Intuitively, it is likely that these equations’ errors would have some correlation.

Following all estimations, several tests were implemented to ensure the robustness of each regression. The Bruesch-Godfrey test was used to test for serial correlation, White’s general test for heteroscedasticity was used and the variance inflation factor was calculated to determine the existence of multicollinearity between exogenous variables. All tests show no signs of time-series related issues for any of the final regressions.

Two years of ex-post forecasts were estimated for each dependent variable. The in-sample forecast period for calibrating the models were from 1975 to 2013. The CE measures were forecasted for the years 2014 and 2015. Two forecast evaluation measures were considered to evaluate the strength of the model and its ability to forecast the out-of-sample observations of the forecast objects. These evaluations primarily measure the ability capture magnitude changes. Both measures weight the forecast observations equally and the objective of each calculation is to minimize the outputs.
The root mean squared error (RMSE) is the average unit amount the forecast is incorrect over the entire forecast period. The equation for calculating the RMSE is as follows:

\[
RMSE = \left[ \frac{1}{M} \sum_{t=1}^{M} (F_t - A_t)^2 \right]^{1/2}
\]

where M is the number of periods included in the forecast; \( F_t \) is the forecasted value and \( A_t \) is the actual value.

The second measure of forecast accuracy is the mean absolute percent error (MAPE) which is the average percentage error the out-of-sample forecast is from the actual observed values or the average percent that the forecast is incorrect. The following equation is used to calculate the MAPE of a forecasted series:

\[
MAPE = \frac{1}{M} \sum_{t=1}^{M} \left| \frac{F_t - A_t}{A_t} \right| * 100
\]

**Empirical Results**

The regression results proved promising in terms of statistical significance as well as each model’s ability to capture the dependent variables’ variation. The Table 1 shows the results for the in-sample OLS and SUR models.
In all models, the adjusted $r$-squares are greater than 0.80 meaning the models explain at least 80% of the variation in the dependent variables. Additionally, all variables except for the ROI measure in the SUR modeling of the total real estate CE model were significant at the 5% level and most were significant at the 1% level. The SUR model, overall, performed better in terms of the adjusted $R^2$. The signs of the coefficients are also as expected. As an investment becomes more profitable, or as the ROI increases, it is expected that the amount invested will
increase. Therefore, the positive coefficients associated with ROI are as expected. Additionally, it is expected that the capital expenditure in time \((t - 1)\) have some effect on the capital expenditure in the next time period. As seen from the results, this is the case with the positive and near one coefficient associated with the lagged dependent variables.

The forecasts each model yielded were also promising in terms of the forecast evaluations used to measure the models’ ability to forecast the changes in magnitude. Table 2 shows the RMSE and MAPE of each forecast. In all cases except forecasting CE for tractors, the SUR model outperformed the individual OLS estimations. All MAPEs were less than 24% meaning that the models, on average, were incorrect by less than 24%. The MAPEs associated with the total real estate CE were the lowest at 11.51% and 11.31% for the OLS and SUR models, respectively. This is intuitively straight forward as these two variables have far less variation than the CE on non-real estate assets.
## Conclusions

The timeline of events for the previous boom and bust cycles in agriculture are more alike than different. The series of events show that despite signals from the market that the sector may no longer be in a period of growth, expansion of capital expenditures is not impeded. The risk associated with continued growth in capital expenditures lies in the use of debt to finance these asset purchases. As the markets become tighter, cash flows will diminish and the ability to repay
debt requirements will become more difficult. The other side of this transaction, not developed in this paper, is the behavior and actions of the lenders. It is a question of whether they are not only allowing but encouraging this risky behavior. Future research will focus on better understanding and mapping the behavior of lenders in the expansion of capital expenditures and debt into riskier market periods. The Federal Reserve Banks of Chicago and Kansas City survey regional bankers about current lending conditions and their sentiments towards the future of the market. If it can be shown that they are in fact a driver of this risky behavior, there are policy implications or merely educational options for mitigating risk through focusing the attention of lenders on not only the past performance of a borrower but more importantly on macro factors that will affect the borrower in the future. The additional focus on future performance will hopefully prevent or mitigate crises in the future.


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