INTEREST RATE AND COMMODITY PRICE IMPACTS ON FARM-LEVEL FINANCIALS

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ABSTRACT

The agriculture industry has been around for hundreds of years. Although farmers and ranchers work every day to put food on the tables of billions of people from all around the world, most agricultural producers require assistance to finance their operations and continue production. This research is motivated by recent changes in interest rates and the downturn in agricultural commodity prices. This study examines how farm-level financial statements are impacted by changes in interest rates and agricultural commodity market prices. A Monte Carlo simulation is used to model several stochastic variables and derive key financial calculations. This study shows how the financial statements of different agricultural operations change due to factors that are largely beyond the control of agricultural producers.

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1. INTRODUCTION

1.1. Overview

The agriculture industry is an important part of the United States economy. Farmers and ranchers work every day to put food on the tables of billions of people from all around the world. Recently, a combination of events created a downturn in the agriculture industry. Prices are low for many key commodities and some producers are struggling to make a living farming. Others have decided to exit the agriculture industry and pursue other career endeavors.

Farmers and ranchers who persevere through these difficult times need considerable financial capital to help run their operations and make needed investments. Seeking financial help beyond the farm has benefits and challenges. Borrowing can create new opportunities for farms and ranches. However, borrowing can also lead to headaches when loan repayment is difficult.

The health of the agricultural finance sector is determining multiple critical variables. Variables such as interest rates and commodity prices create uncertainty for all parties involved in agricultural lending. Lenders must charge an interest rate that covers their expenses but is still competitive in the market. From the perspective of a farm or ranch operator, uncertain interest rates can greatly impact cash flows. In addition, increased costs of borrowing reduces profits that could be re-invested in the operation or used to pay down current debt. Increased interest rates can lead to issues in the future, especially if commodity prices continue to be low and costs continue to accumulate.

1.2. Problem Statement

From an agricultural producer's perspective, there are numerous aspects to consider when interest rates increase. With the recent increase in the effective federal funds interest rates and the current downtrend in agricultural commodity prices, these issues have been relevant in recent years. When the cost of borrowing money increases, farmers may have difficulty justifying spending money to expand or do projects to improve facilities. Along with this issue, low commodity prices have significantly influenced the cash flows of farms throughout the U.S. This decrease in prices has pushed farmers to be more efficient in production. Low prices are straining farms and causing many operators to question how long they can continue in the current low-profit environment.

While cash flows and profits are important to consider during tough economic times, the balance sheet is also affected by changes to interest rates and income. Interest rates and land values tend to be inversely related. In other words, as interest rates increase, land values tend to fall. This is an extremely important the equity of an agricultural operation. Land is the chief asset on agricultural balance sheets, so losing value on this asset can lead to more severe financial issues and may decrease the amount of borrowing power the operation has in the future.

1.3. Objectives

In response to the current state of the agricultural economy, it is important to consider future farm finances and potential implications for the wider agricultural industry. The goals of this study are to:

1. Develop a model that represents an average Red River Valley corn and soybean farm's balance and income statement.
2. Determine how repayment capacities of farms have recently been impacted.
3. Examine how price and yield fluctuations influence net income and farm cash flows.

These objectives are meant to provide perspective on the current financial situation of many farmers. The amount of uncertainty in interest rates and commodity prices moving forward makes it difficult for a farm operation to plan the best financials decisions. In addition, trying to survive economically challenging years is a major motivation of many farmers at the moment. A model that brings the balance sheet and income statement of an operation together may help farmers develop effective planning for upcoming expenses and allow them to be more prepared for cash flow issues in the future. Financial awareness should result in better management strategies in which farmers can work to mitigate their risk while pursuing better profits.

1.4. Procedures

In this paper, a balance sheet and income statement are developed. These model financial statements are based on historical financial data available on FINBIN, a University of Minnesota farm statistics database. Next, for the base case, prices and yields are derived. These values carry into the balance sheet and income statement. From here, a stochastic interest rate is used to calculate projected financial statement measures.

The model used here applies the Monte Carlo feature in @Risk. The @Risk program is a Microsoft Excel add-in feature. When the program is "run," 10,000 repetitions of the model occur based on stochastic parameters. The stochastic parameters in this example include several balance sheet and income statement variables, along with the commodity yields and interest rates associated with debt financing. Various scenarios are tested for each of the variables. Sensitivity testing is used to gain a clearer understanding of the model's outputs. The model will be explained in further detail in later chapters.

1.5. Organization

Chapter two provides a literature review. This literature review describes U.S. agricultural history and the agricultural lending system. The chapter then moves on to describe important repayment measurements of farming operations. From here, chapter two shifts to identify the needs of farmers today and different risks in the agriculture industry.

Chapter three introduces and explains the empirical model used in this paper. Here, the base case is explained in detail. Chapter three provides an in-depth look at aspects of the model including: explanations of variables and @Risk functions; sensitivity and correlation analysis; explanations, summaries, and sources of the data; and an overall summary of the significance of the model.

Chapter four provides a detailed explanation of results from the base case, including the sensitivity analysis preformed. This chapter also focuses on why certain sensitivity analyses were performed. Chapter four aims to show the importance of this paper and its implications for the agricultural finance sector. Finally, chapter five provides an overall summary of the paper including the methodology of the model, key findings of the research, and further research opportunities in this area.

2. LITERATURE REVIEW

This section discusses previous research relating to farm-level finance. First, a brief history on U.S. agriculture is presented. Second, the development of the agriculture lending industry is discussed. Next, interest rate information is discussed. After that, repayment capacities are introduced. Finally, the risks involved with production agriculture are presented.

2.1. Brief History of U.S. Agriculture

The United States agricultural industry has experienced significant changes throughout time. At the beginning of the 20^{th} century, agriculture in the U.S. looked much different than it does today. The industry was composed of small, labor-intensive family farms that employed nearly half of the U.S. workforce. Due to the intensity of the work and amount of labor required to operate an agricultural business, the main goal of these operations was producing enough food to meet the needs of their families. International trade was therefore a limited concern (Dimitri, Effland, & Conklin 2005). It is also important to note that most farms were small and self-sufficient, so agricultural financing was relatively underdeveloped at this time.

The early 1930s brought improvements in efficiency and technology to agriculture. Some of these improvements included plant and animal breeding enhancements and better farm management practices (Harl 1998). Along with this, the origination of motorized equipment, such as tractors, presented a new opportunity for producers. For example, from 1900 to 1930 alone, the number of work animals dropped by 2.9 million, while 920,000 tractors were brought into use (Dimitri, Effland, & Conklin 2005). The incorporation of new technologies meant fewer inputs and people were required to grow more goods and feed the growing population (Harl 1998).

Technological progress came at a great expense. Agricultural operations became increasingly reliant on external financing for investing in new technology and expansion. Further advancements in the 1950s lead to a rapid spike in agricultural debt (Harl 1998). While debt levels of farms increased, the agriculture industry was prosperous through the 1970s. Agricultural producers took advantage of the good times and financed significant amounts of debt through loans with local banks or credit unions (Lawton 2016). Increased liabilities combined with reduced commodity prices to create extreme financial stress during the 1980s (Lawton 2016 & Kuhns, Patrick 2018). These farm financial problems were not a result of poor efficiency, but rather extremely large debt loads (Harl 1998).

Over the past century, the agriculture industry has transitioned from small subsistence farming operations to larger farms working to feed the growing population of the world. In 2012, the number of farmers in America was just over 2 million, down from the nearly 7 million in the mid-1930s (Gardner n.d. & United States Department of Agriculture 2016). However, from 1930 to 2000 U.S. agricultural output approximately quadrupled, while the use of inputs such as land, labor, capital, and other material inputs remained nearly constant (Gardner n.d.). The shift from a labor-intensive industry to an extremely capital-reliant industry is noteworthy. Therefore, it is more important than ever for farmers to have access to financial capital.

While the U.S. agriculture industry has changed, one thing has remained, and that is the prominence of family-owned farms. In the 2012 Census of Agriculture, it was found that 97 percent of farms in the U.S. are family-owned. Furthermore, 88 percent of farms were considered "small" farms which generated less than $350,000 in gross cash farm income in a given year ("United States Department of Agriculture"). These statistics illustrate that family farms are still a major part of rural America. Therefore research on navigating trying times is critical.

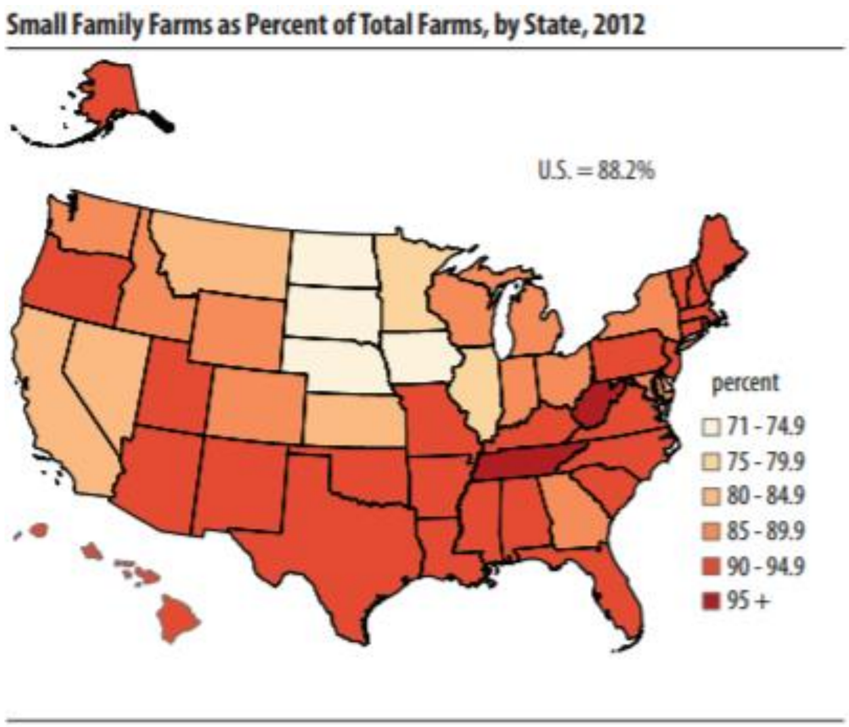

Figure 2.1: United States Department of Agriculture (Courtesy of 2012 Census of Agriculture)

While looking at the industry throughout time is interesting, drawing connections between the different time periods is perhaps more important. One of the most obvious comparisons is between the current state of the U.S. economy and the conditions experienced in the 1980s (Kuhns & Patrick 2018). Currently, the industry is experiencing some circumstances similar to the 1980s (Gardner n.d.). Sharp declines in net farm income and an increase in interest rates are connections between the two trying times in agriculture (Khuns & Patrick 2018). Moreover, like the 1980s, agricultural operations experienced record-high prices prior to the beginning of financial struggles, and as a result, many decided to take the chance to update old equipment, expand their operations, or make improvements they had been putting off.

2.2. Development of the Agricultural Lending Industry in the U.S.

The agricultural lending industry has dramatically changed through time. The Farm Credit System (FCS), a financial system designed to help farmers, was created by congress in

1916. Prior to its creation, financial assistance was often hard to find for agricultural producers due to the riskiness of the industry (Monke 2016). The FCS was created to help farmers seek financial assistance for operating expenses and purchases of land, equipment, and machinery. Today, farmers have more opportunities for where they may choose to finance their debt. Along with the FCS, commercial lenders also provide loans to farmers (Nam, Ellinger, & Katchova 2007). Competition between lenders keeps interest rates affordable and allows farmers to decide where they want to do business. Financing can be the key to survival during difficult times. As in any industry, notable difficulties in agriculture have occurred. As explained in the previous section, one of the worst economic downturns the industry has experienced occurred in the 1980s. During this time, the value of land dropped by 60 percent in some parts of the Midwest. Many farmers were short on cash, and some were unable to make debt payments. As a result, farm foreclosures rose dramatically (Lawton 2016).

The 1980s not only impacted the agricultural industry, but also the lending institutions who loaned money to farmers. Today, the industry is also experiencing an economic downturn. While on the surface it may seem agricultural producers will just have to pay more to service their debt, these payments are only one part of the current puzzle. Along with this, asset prices are negatively impacted by increased interest rates, financial risk accumulates, and other negative consequences can result. Especially during a trying time in agriculture like the industry is currently experiencing, it can be incredibly detrimental to an operation to have excessive interest costs. Beginning in 2014, many key crop prices have been low. While some economists project conditions won't be as severe as the 1980s, many producers are nervous for the future of the industry (Patrick & Kuhns 2018).

Many agricultural economists have examined what happened in the 1980s in the agriculture industry. The 1980s farm crisis impacted farms across the Midwest and nation. The crisis involved debt loads and interest rates upwards of 21 percent (Lawton 2016). There were record yields, which forced prices down and led to a decline in U.S. exports of more than 20 percent. With no money, and nowhere else to turn, many producers were forced into foreclosure. It is estimated that more than 33 percent of farmers were in serious financialtrouble. Many decided to exit the industry, which led to an over-supply of available land and few interested buyers. This situation created a drastic drop in land values, further depressing the agricultural economy (Lawton 2016).

While commodity prices are low right now, it is not expected that the economy will see debts become as troubling as those in the 1980s (Kuhns & Patrick 2018). Kuhns and Patrick also noted that certain farms may be more sensitive to higher interest rates, and specifically mentioned livestock operations. They use little data from the past to draw their conclusions, so there is room for addressing this research area.

2.3. Determining Interest Rates

Another important area in agriculture lending is the determination of interest rates. Walraven and Barry (2012) found "banks consistently charged higher rates of interest for the farm loans that they characterized as riskier, with an average difference in rates between the most-risky and least risky loans of about 1-1/2 percentage points." The results from this study indicated that loans that were less risky were more likely to have collateral associated with them, and in turn received lower interest rates on additional loans received (Walraven & Barry 2004).

Barry and Ellinger (2012) add insight on loan pricing and profitability analysis from the financial institution's perspective. Loan rates differ based on a variety of characteristics, including credit risk, loan size, loan maturity, type of loan (fixed or variable interest), prepayment options, and secured versus unsecured status. Loan pricing systems are a key topic for financial institutions.

Naturally, along with previously discussed research, another key determinant that plays a role in interest rates is the general cost of borrowing money. The effective federal funds rate affects loans with variable interest, such as operating loans (Amadeo 2019). Bankers often make predictions on where the Federal Reserve will move interest rates, and alter base rates according to these predictions. Depending on their confidence in assuming what the rates will be, these bankers may be willing to take on more risk for a higher reward in the future (Covey 1998). The 10-year treasury rate is also a major indicator of where loan rates will settle. These rates are different because they do not tend to follow the federal funds rate closely (Martin 2017). Figure 2.2 compares several key interest rates.

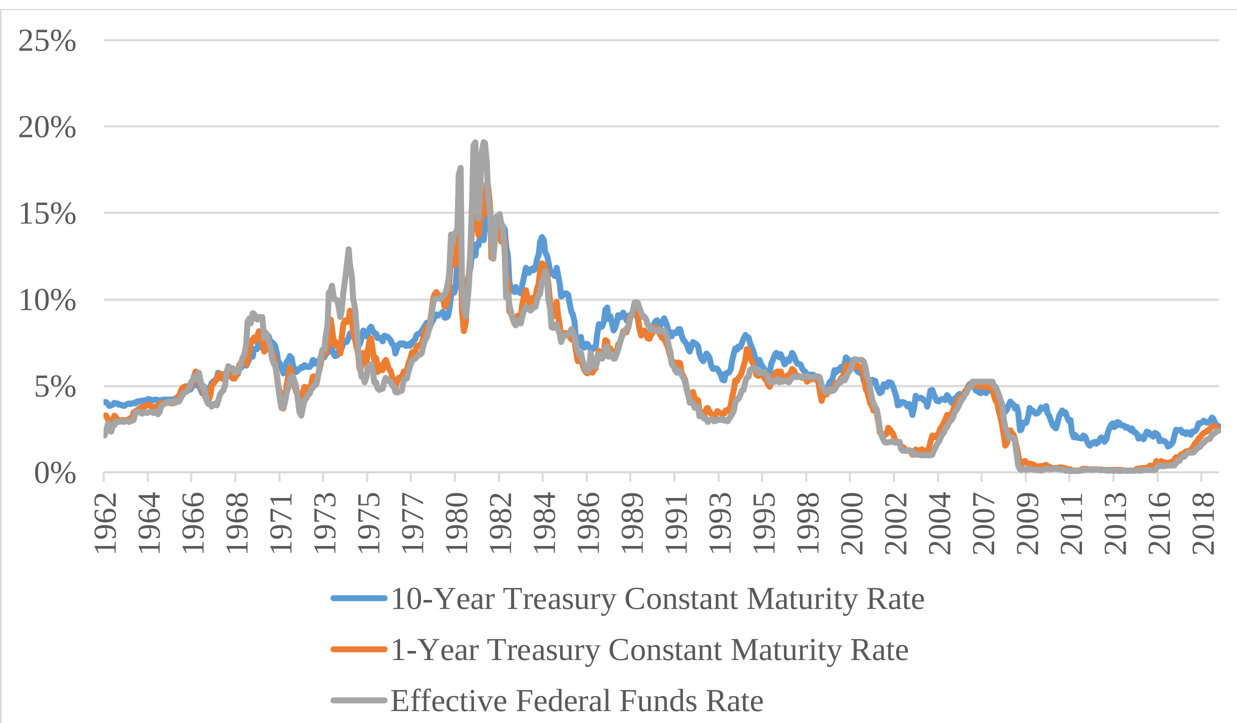

Figure 2.2: Interest Rate Comparisons (Federal Reserve Bank of St. Louis)

As figure 2.3 shows, agricultural loan rates for long-term real estate loans and operating loans tend to closely follow the same pattern as the 10-year treasury notes do. It is important to note that long-term and fixed interest rates are usually more impacted by these rates. For example, if the 10-year treasury rate increases, a bank may decide to change the fixed interest rate for their institution, which in turn would increase the cost of borrowing money for assets, such as land and large capital purchases (Covey 1999).

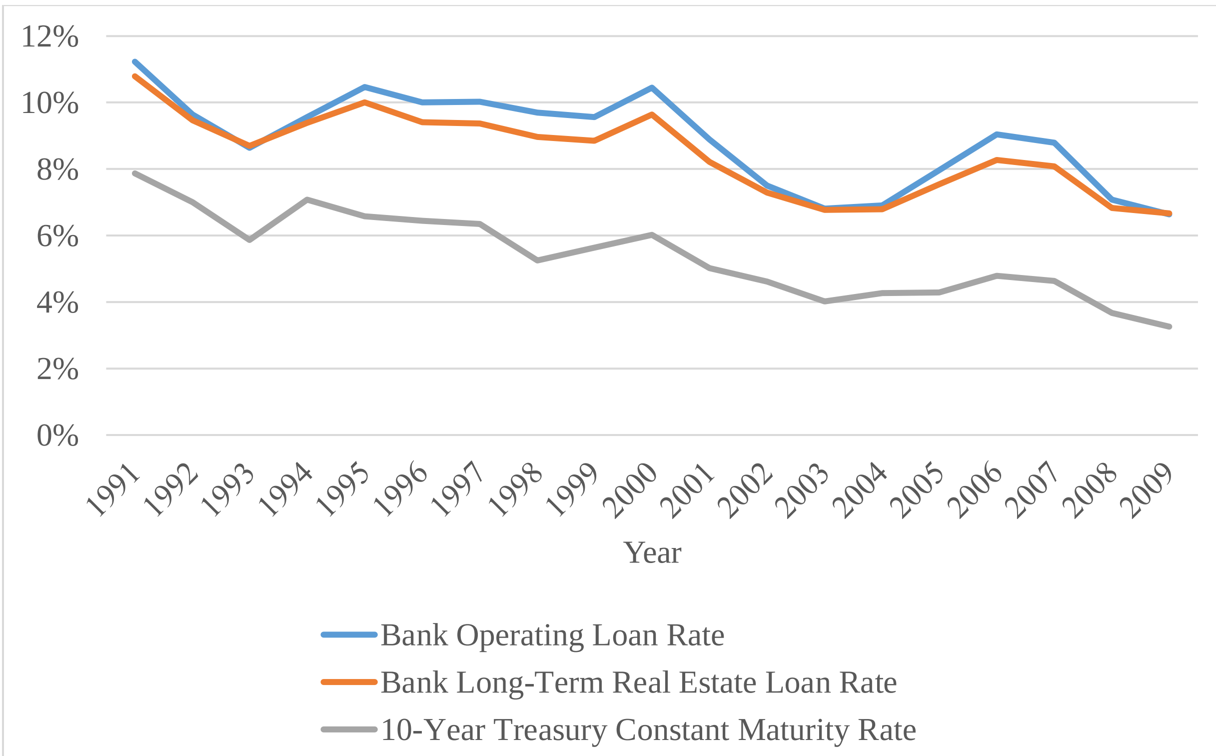

Figure 2.3: Farm Interest Rates (Martin 2017, Federal Reserve Bank of St. Louis)

Another important factor lending institutions must consider when pricing loans is competition. If there is a lot of competition in the market, interest rates will naturally decrease because financial institutions will do what they can to attract customers. Similarly, banks will often increase their rates on money-generating deposits, such as savings accounts, to entice investors to put their money into the bank (Barry & Ellinger 2012). This, in turn, increases the financial institution's lending limits, and leads to more opportunity for profit. The entire farm sector seems to be influenced by changing interest rates, but each individual farm will be impacted differently. Particularly, farms with a large share of variable-interest debt on their balance sheet may already be exhibiting worse debt repayment measures (Takach 2018). To go along with this idea, types of commodities produced on an operation not only impact income, but also debt levels on farms. For example, farmers involved in "livestock production, particularly poultry, tend to finance more capital through debt than similarly sized farms producing other commodities" (Takach 2018). Many livestock producers have lines of credit so they are able purchase animals, feed, and other inputs as needed. These loans often have variable interest rates, meaning that as rates increase, the cost of financing the inputs for their operations also increase. Prices received for the goods raised have remained relatively low compared to rising operating expenses, so increasing costs could result in greater financial stress if their cash flows decline or interest rates rise (Takach 2018).

An important idea to keep in mind is that increasing interest rates may not always lead to more farm debt. Previously acquired debt only increases in cost if the debt was financed with a variable interest rate. Fixed interest rates will not change when rates increase. When taking out loans, farmers often must decide what route they want to take. Typically, "a variable rate loan will often have a lower interest rate than a fixed rate loan with a similar maturity because the borrower is assuming interest rate risk" ("Fixed-Versus Variable-Rate Financing" 2015). In other words, the borrower is willing to risk the rate going up in the future to take advantage of the current low rate. It is up to the borrower to determine if they are willing to take on the additional risk of the interest rate increasing if they decide to go with a variable interest rate (Takach 2018).

Other areas that may impact financing costs and sensitivity to changing rates include the age of the operator and years of experience in farming. The Farm Service Agency's loan program helps young farmers receive loans to start their operations. This program often provides fixed interest rates to farmers. This is most likely one of the reasons young and beginning farmers typically have a smaller percentage of variable-rate interest loans, creating the conclusion that rising rates have a smaller impact on this division of farmers (Takach 2018).

Beyond these immediate impacts, increasing rates can have lasting effects on a farm's balance sheet. For example, the cost of borrowing money and the value of land tend to be negatively correlated. In other words, as banks charge more to borrow money, fewer farmers are willing to finance land though debt. As a result, the law of supply and demand comes into play. If fewer individuals are willing to borrow money to buy land, the value of the land drops, and therefore net equity of an operation is impacted. This aspect is often overlooked but is extremely important as it can result in the loss of valuable equity (Kauffman 2018).

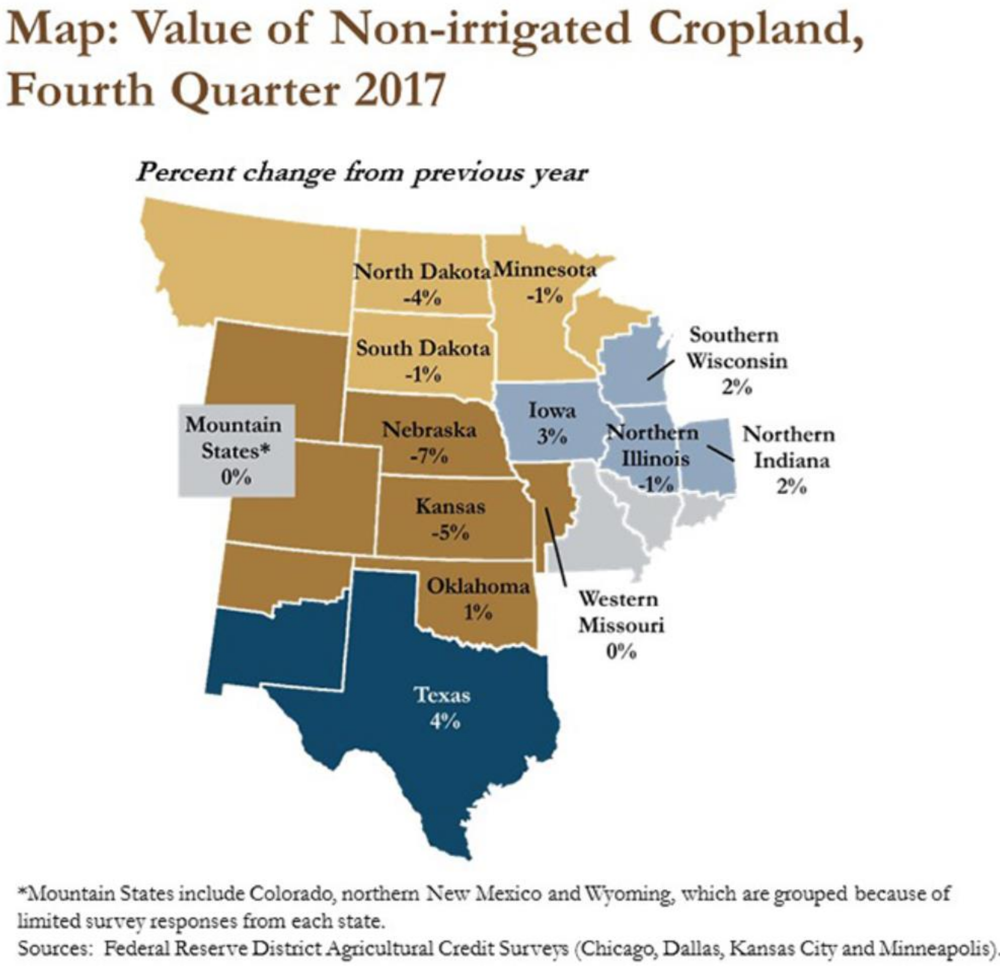

Figure 2.4: Land Valuation (Courtesy of Kauffman 2018)

2.4. Repayment Capacities

While the groups and types of farms that will be the most impacted by rising rates have been discussed, considering actual repayment capacity implications is an important area that needs to be addressed. According to Langemeier (2018), “repayment capacity measures include the capital debt repayment capacity, capital debt repayment margin, replacement margin, term debt and capital lease coverage ratio, and replacement coverage ratio.” A farm’s ability to repay operating loans and cover current principal and interest due on non-current loans like machinery, buildings, or land is determined by capital debt repayment capacity, capital debt repayment margin, and the term debt and capital lease coverage ratio. Evaluating whether a farm has funds to repay term debt and replace assets is done through the replacement margin and replacement margin coverage ratio (Langemeier 2018, "Assessing Financial Management Skills).

To look at these financial measurements more closely, a case study was put together by Langemeier (2018). For the example, a farm with 3,000 acres of corn and soybeans was used. To ensure enough funds were available for long-term capital replacement and expansion, depreciation was multiplied by 1.15 to account for replacement and inflation in prices. Both projected and actual values were used for the study. Therefore, it is easy to determine how different the predictions for the year were versus how the farm performed.

The resulting calculations, pictured in the following figure, yielded interesting results. While the projections for the capital debt repayment capacity was anticipated to be $151,103, the actual numbers told a different story. The capital debt repayment margin ended up being only $56,050, reflecting the idea the farm would be unable to generate enough funds to cover term debt obligations and replace capital in the 2018 crop year.

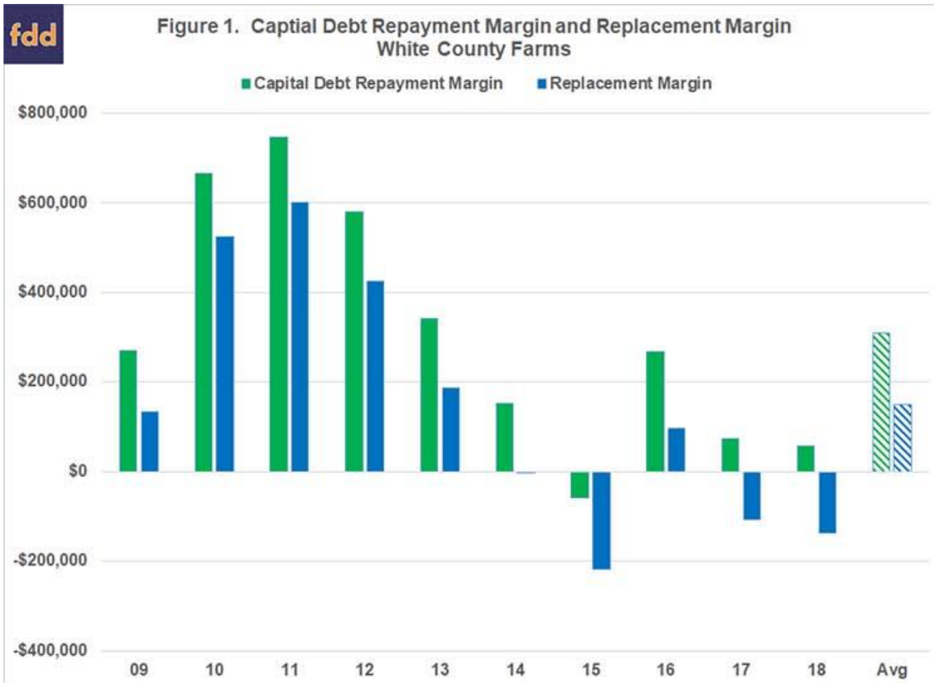

Figure 2.5: Capital Debt Repayment Margin and Replacement Margin (Courtesy of Langemeier 2018, "Assessing Financial Management Skills")
Note: Figure above shows the Capital Debt Repayment Margin and Replacement Margin for White County in $.

The study went a step further and looked at the replacement margin coverage ratio calculations from 2009 to 2018. In those years, the only time a negative margin resulted was 2015. This was a positive sign that the farm should be adequately positioned financially to make it through the tough times. However, if the negative replacement margin and below-average replacement margin coverage ratio continue for years down the road, it could become a major financial concern for the operation.

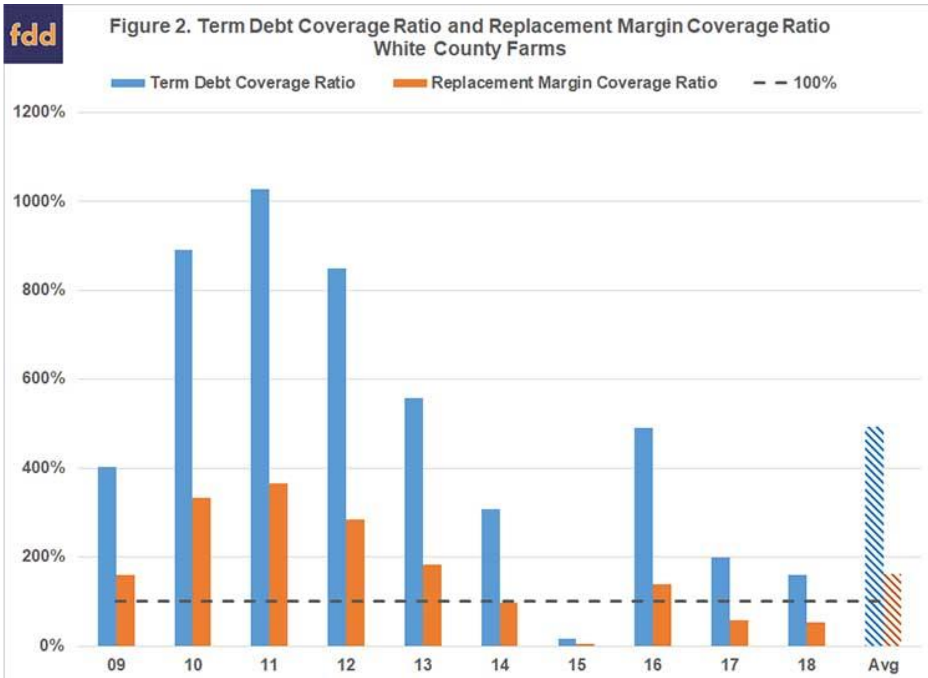

Figure 2.6: Term Debt Coverage Ratio and Replacement Margin Coverage Ratio (Courtesy of Langemeier 2018, "Assessing Financial Management Skills")

Note: Figure above shows the Capital Debt Repayment Margin and Replacement Margin for White County as trends.

2.5. Market Risk Management

While the previous sections have discussed the trends that agriculture has experienced over the years, it is also important to note the different types of risks that exist in agriculture. According to "Risk in Agriculture" (2018), the agriculture industry, risk is typically pooled into five different categories:

1. Production risk
2. Price or market risk
3. Financial risk
4. Institutional risk
5. Human or personal risk

Production risks involve yields or overall production being lower than anticipated (Sciabrrasi). This type of risk could result from weather, disease, pests, delayed planting or harvest, equipment failures, or issues with machinery and equipment (Sciabrrasi & “Risk in Agriculture” 2018). While there isn’t a lot you can do once the crop is lost, there are steps to take to protect against these risks. One available option is crop insurance (Sciabrrasi). This is a federally subsidized program created to help farmers protect against loss. Since it is subsidized, it may be an affordable option for producers. Along with this, diversifying, following recommended production policies, and maintaining equipment and facilities are other ways to reduce production risks (Sciabrrasi).

Commodity price or marketing risk relates to the uncertainty in the price the farmer will receive for their crop (“Risk in Agriculture” 2018). Market forces drive the prices of agricultural commodities and farmers are forced to be price-takers, so they have very little influence on the price they will receive. However, farmers can use marketing plans to decide on target prices and sales forecasts. When the market hits a certain level, they may decide to sell a set portion of their grain (Sciabrrasi). Crop insurance also plays a role in marketing risk for farmers. Producers may choose to market up to the level of crop insurance coverage they have to ensure they are covered if something happens to their crop.

Financial risk involves not having enough cash to pay for operating expenses and losing equity in the farm. This may also involve increasing interest rates (“Risk in Agriculture” 2018). For these reasons, financial risk is a major concern at the moment. As industry prices continue to be below the cost of production, many farms have lost equity in hopes prices will rise soon. There are some options to help reduce the financial burden, including developing a business plan, monitoring financial ratios, having open conversations with the corresponding lending institution, and finding off-farm income for a family member (Sciabrrasi). These options are only some sources of risk minimization that can help an operation through tough times.

Institutional risks involve the actions of surrounding government (“Risk in Agriculture” 2018). These risks involve state and federal regulations of chemical use, waste disposal, tax laws, and other conservational matters. Choosing the proper business structure for a farm and developing good agricultural practices to maintain sustainability are two main ways to reduce institutional risks (Sciabrrasi).

The final area of risk in the agricultural industry is human or personal risk. Unfortunately, this type of risk involves issues that can greatly impact a family farm, including divorce, accident, death, and illness, (“Risk in Agriculture” 2018). Life insurance policies and well-organized wills, trusts, and power of attorneys can help reduce the stress and risk if serious circumstances develop on a farm. Seeking advice from a succession or estate planner is typically very helpful (Sciabrrasi). Having an open line of communication is important on every operation to ensure all family members are aware of what is happening with the operation in the event of such a risk developing.

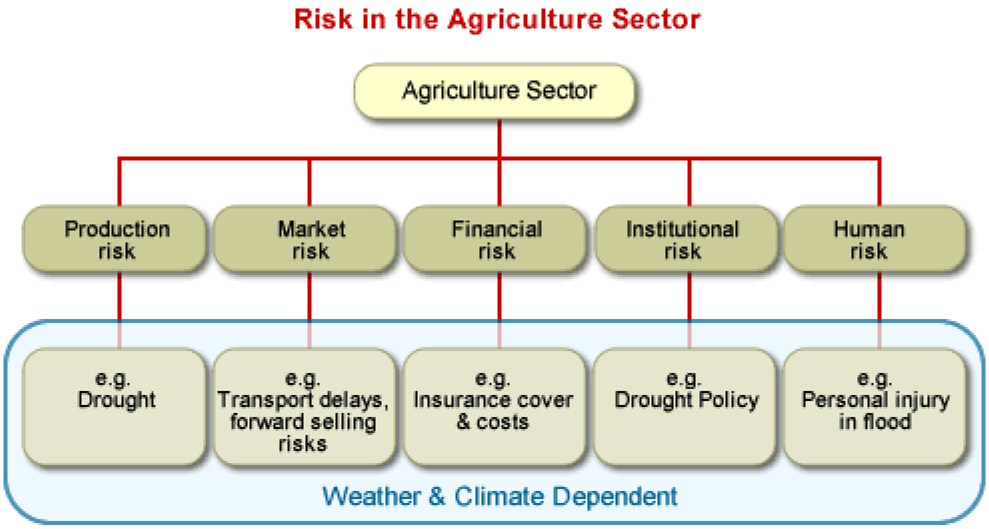

Figure 2.7: Risk in the Agriculture Sector (Courtesy of "Weather and Climate Risk in Agriculture")

Although it is apparent that farming is a risky business, it is also clear there are many tools available to U.S. farmers to help avoid significant impacts from risk exposure. Moving forward, it is important to keep these risks in mind, and consider how they are impacting farmers today. Price and financial risks are of particular interest for the model discussed in the next chapter.

3. EMPIRICAL MODEL

3.1. Introduction

This model was designed to replicate a farm's balance sheet and income statement. Specifically, the model is built to demonstrate the effects of changing interest rates, corn and soybean cash prices, and corn and soybean yields. A base farm type and area of operation was developed for the purposes of this study. Sensitivity analysis on crop prices and yields was performed to show the impact of these variables on overall farm financial health. This risk feeds directly into the interest rate banks charge to the customer.

The two crops considered in the model are corn and soybeans. These crops are analyzed because they are the primary crops grown in the Red River Valley, and adequate data was available on farms of similar practice and size. Since there is very little livestock production in the Red River Valley, data on the small number of farms that do raise livestock was omitted, leading to the most accurate representation of an average farm in the Red River Valley.

As previously mentioned, farmers in western Minnesota are primarily involved in crop production. This is an important production characteristic that will be discussed further in this chapter, as most operations sell all corn and soybeans raised to a direct market. These goods are then shipped out for further export or use in other areas of the United States or world. This reliance on highly competitive markets is noteworthy, especially when commodity prices are low, as they have been in the past few years. Very few farms in the area have other enterprises (e.g. livestock feeding), so they are sometimes restricted in risk-management options. More on this topic will be discussed later in this paper.

In this chapter the empirical model is explained in detail. The overall setup of the model is discussed along with further analysis of the base case. correlation matrix regarding prices and yields of corn and soybeans will also be discussed. Finally, the source and background information on the data will be covered, along with any alterations or accommodations made.

3.2. Base Case

The purpose of a base case scenario is to provide a model of a typical farming operation in a given area. This example can then be used to compare with other operation types or areas of production. Finding an area with similar farming practices, crops, soil types, topography, and overall production standards is important to providing an accurate representation of a given area and offering more credibility for the research in general. Therefore, farms in the Red River Valley serve as the typical "base case" scenario.

The Red River Valley is an area in western Minnesota and eastern North Dakota that neighbors the Red River. For the sake of this paper and availability of data, six counties in Minnesota were used. Those counties are listed in table 3.1.

Table 3.1: Base Case Counties

Red River Valley Counties
Minnesota
Clay
Kittson
Marshall
Norman
Polk
Wilkin

There were many reasons why these counties were selected to represent the Red River Valley region and serve as the base case. To begin, the farming in this area is relatively consistent, with corn and soybeans being the primary crops grown. This made data on average yields and cash prices received readily available and easily collectable. More details about the data sources will be discussed later in this chapter.

The average farm size in the Red River Valley is 1,900 acres and the average age of farm operator is 48 years old, which is slightly lower than the U.S. average of 58.3 according to the 2012 Census of Agriculture (Agweek Wire Reports 2018 & Kurtzleben 2014). The land in this area is extremely flat and uniform in terms of types of soil and farming practices. Soils are typically of the Aquolls family, which are deep and provide a prosperous environment for growing crops ("Soil Information for Environmental Modeling and Ecosystem Management" 2018). For this reason, most farming in the region is conventional, or non-irrigated. While having soil that holds water is beneficial during dry seasons, it can cause issues in times of extremely wet springs or general weather. The Aquolls soil is poorly-draining soil, therefore some farms in this area have issues with drainage. Some farms invest money in drainage systems to help avoid prevented planting or drowned crops ("Soil Information for Environmental Modeling and Ecosystem Management" 2018).

To determine the crops grown in the Red River Valley, USDA production maps were analyzed. The maps revealed the primary crop rotation in the valley is a corn and soybean rotation. Wheat was not used in the model as it has become less commonly grown in the area and tends to only be used in rotation as it is needed.

3.2.1. Model Layout

This model mimics the appearance of financial statements agricultural lending institutions use to determine credit worthiness of farmers. A Monte Carlo simulation determines realistic financial projections of income statement and balance sheet values. Ten years of financial information, from 2008 to 2017, is collected and used in the model. The 10-year look-back is implemented to provide an overall big picture of how farm financials would appear. While banks may only look back three to five years, 10 years was selected for this model for a few reasons. First, agriculture is a cyclical industry. By choosing to look-back 10 years, patterns from the industry can be seen and more accurate financial projections could be made. Looking at 10 years of hard records can also unveil any financial issues in the operation that may need to be addressed to avoid extreme financial consequences in the future. The data used in the model were analyzed to look for any trends. No significant trends were found, and therefore no further actions were required.

3.2.2. Corn/Soybean Prices and Yields

The first components of the model are the price and yield tables for corn and soybeans. These tables were created to derive gross farm income calculations. For the commodity prices, deterministic monthly cash price averages from 2015 to 2018 were collected for the six Minnesota counties, to represent the Red River Valley area. A 12-month moving average of 2018 values was included in the model to determine the starting cash price for each commodity in the model. Since 2018 price data were available, actual prices were used for projections. Individual tables for corn and soybeans were then created.

For the yield corn and soybean yield tables, deterministic yearly averages from 2012 to 2017 were collected for the six Minnesota and counties to account for the Red River Valley area. Data from 2018 were not yet available for use, so the @RiskLogNormal function was used. The average and standard deviation from 2012 to 2017 for the Red River Valley counties were calculated and incorporated into the @RiskLogNormal function. This function was used to consider yield fluctuations from the mean. From here, the gross revenue per acre was calculated for each individual commodity.

Table 3.2: Red River Valley Corn Yields (USDA NASS 2019)

Corn Yields										
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Clay	147	130	147	114	148	138	131	157	182	166
Kittson	115	-	-	-	-	-	-	-	144	133
Marshall	109	115	130	114	147	131	119	141	141	123
Norman	136	121	142	118	128	120	125	161	167	157
Polk	-	105	143	125	115	120	127	161	166	-
Wilkin	-	119	154	121	166	134	136	168	184	182
Total Average	127	119	140	108	135	126	128	152	161	155

Table 3.3: Red River Valley Soybean Yields (USDA NASS 2019)

Soybean Yields										
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Clay	35.5	29	36	33.5	37	36.1	35.2	40.6	44	40.7
Kittson	32.5	27.5	34.1	29.1	36.1	40.1	29.5	31.8	33.9	34.8
Marshall	27	26.5	31.7	31.9	36.2	35.5	28.9	32.4	35.9	29.4
Norman	29	28.5	33.9	31.3	32.7	32.8	35.7	40	41.4	36.2
Polk	28.5	29	34.4	33.7	35.7	36.6	36.3	35.6	43.6	38
Wilkin	32	29	36.7	31	41.7	32.2	37	40.2	44.1	38.9
Total Average	29.8	28.6	34.6	30.1	36.6	34.2	34.1	36.4	41.4	36.4

The sole input variable in the corn and soybean tables was the total acreage of each crop. As mentioned before, the average farm in the Red River Valley is 1,900 acres. Since most farms follow a similar rotation of corn and soybeans, 950 acres of each was used for the base case. Having this input was important as the model would allow individual farms to enter personal acreage and get a better representation of their operation's total revenue from each commodity raised. The model also allowed for easy alteration if crop rotations varied from year to year. From the given stochastic and deterministic inputs, the total gross income was calculated.

Table 3.4: Corn Revenue

Corn	
Starting Price	$3.28
Average Yield	146
Gross Revenue Per Acre	$481.60
Total Acres	950
Total Gross Revenue from Corn	$457,517

(USDA NASS 2019)

Table 3.5: Soybean Revenue

Soybeans	
Starting Price	$9.00
Average Yield	37
Gross Revenue Per Acre	$329.77
Total Acres	950
Total Gross Revenue from Soybeans	$313,284

(USDA NASS 2019)

3.2.3. Interest Rate Determination

Interest rates are an important variable in the model. Interest rates are the price farmers must pay to service debt through a lending institution. This stochastic value was developed similarly to the price and yield variables. Data on average interest rates Midwestern banks charged to farmers for agricultural loans were collected from 2013 to 2017 from the Kansas City Federal Reserve database. The @RiskNormal function was utilized to account for the average interest rate charged and included a standard deviation add-in. A truncation of the minimum interest rate from the last five years was used as a minimum as the cost of borrowing money cannot be negative. No upper-bound truncation was implemented, as one of the intentions of the model was to determine how rising interest rates impact farms. The resulting output from the @RiskNormal function provided a starting interest rate for the model.

As with prices and yields, a volatility option was added-in, ranging from five to 20 percent, again with five percent increases. It was important to include this volatility because as previously discussed, interest rates have increased in recent years. As the market is unpredictable, including volatility to account for some movement is important. This volatility also accounts for the fact that not all producers receive the same interest rate when they walk into a bank. The factors listed during the review section all play a role in determining the price farmers are charged for borrowing.

3.2.4. The Income Statement

Following the completion of price, yield, and interest rate tables, an income statement was developed. The income statement lays out all incomes and expenses an operation incurs in a given year and calculates the net farm income. For the sake of this model, the income statement represents the calendar year from January 1st to December 31st, which is common among farmers. The income statement includes several random variables that were simulated via the @RiskPert function. Specifically, the @RiskPert function determined 2018 projections for the following variables:

1. Total sales
2. Government payments
3. Other farm income
4. Accounts receivable
5. Gains or losses in hedging accounts
6. Change in assets

7. Cost of production
8. Depreciation
9. Interest expense
10. Tax paid

The @RiskPert distribution is appropriate for all but one of the variables described above when considering historical financial data. The purpose of this function is to develop projections based on previous data. To do so, the @RiskPert function requires the input of the minimum, maximum, and most-likely value the projected estimate could take on. These numbers were taken from the previous years of data in the model. Through running the simulation, a random number within the range of minimum, average, and maximum values is generated. The results of the simulation create a prediction based on previous years' trends and were used as the 2018 projection results.

An important exception to the use of the @RiskPert function is the total sales projection. For the revenue portion of the income statement, the total sales category is generated based off the value of crops produced for sale in a given year. To make accurate projections for this variable, the previously calculated projected corn and soybean revenues were utilized. These values, along with an average of previous data, were important to include to provide the most accurate prediction for 2018. The result provides a standard distribution of the expected value of crops that will be held for sale. This is an extremely important projection because almost all the income of crop farms comes from the sale of commodities. Being able to project expected values of crops and income from production helps provide farmers with a better idea of where they need to be for break-even prices. This, in turn, can aid in making marketing decisions and push a producer to sell if they are able to lock in prices at a profit to the operation.

It is important to discuss the remaining model variables in-depth. Government payments are income provided by the federal government, including crop insurance loss payments and payments from programs such as the conservation reserve program (CRP). Other farm income includes the sale of general farm machinery and miscellaneous equipment. Accounts receivable income accounts for products that have been sold, but for which cash income has yet to be collected. For example, a farmer may decide to sell corn on December 31st of a year but payment may not be received until the following tax year. Another example of accounts receivable could be custom work a farmer provided for a neighbor but has yet to receive payment on. Gains or losses in hedging accounts is money a farmer gains or loses through hedging activities in the futures market. Finally, change in assets is the difference in the value of goods a farm owns, which may change throughout the year.

The expense categories included in the model income statement are the cost of production, depreciation, interest expense, and taxes. Cost of production is the money a farmer must spend to produce a crop. This includes the cost of seed, fertilizer, chemicals, fuel, equipment, and various other supplies. Depreciation is defined as the loss of value materials, equipment, and buildings endure through use. As equipment ages and has more hours of use, the value of the equipment decreases. The difference between the value paid for items and the current value makes up economic depreciation. In farming, most depreciation comes from intermediate assets, such as machinery, equipment, and titled vehicles. The interest expense category is the cost a farm endures to finance debt with a lending institution. Finally, the tax category includes all income tax a farm must pay in a given year. As one would expect, an increase in earnings results in a higher tax expense.

Now that the variables comprising the income statement have been described in detail, it is important to note an important alteration to one of the projections. For the cost of production projection, only data from 2013 to 2017 was used to determine the minimum, maximum, and most-likely value for the @RiskPert function. This is because, while the agriculture industry has observed a decrease in commodity prices, the industry has seen the cost of production increase or level off in recent years. For this reason, considering values back to 2008 would not result in an accurate representation of the cost of production for a farm in the base case.

Following the simulation of the model, results are used to calculate two key farm financial measurements. First, operating profit is calculated by adding gross crop sales, government payments, other farm income, accounts receivable, gains or losses in hedging accounts, and changes in assets together and subtracting the cost of production and depreciation costs. This results in the amount of operating profit the farm generated for the production year. Second, following this calculation, net farm income was determined by subtracting interest and tax expenses from operating profit. This overall calculation results in the net farm income projection for 2018. Further analysis of income statement results and comparisons will be covered later in this paper.

Table 3.6: Base Case Income Statement Variables

Income Statement Variables	Minimum	Average	Maximum
Government Payments	$ 14,489	$ 29,994	$ 38,636
Other Farm Income	$ 61,714	$ 75,729	$ 97,524
Accounts Receivable	$ -13,868	$ 3,769	$ 97,524
Gain or loss in hedging accounts	$ -12,459	$ 455	$ 6,280
Change in Assets	$ 3,372	$ 7,581	$ 13,625
Cost of Production	$ 702,448	$ 732,282	$ 769,241
Depreciation	$ 42,364	$ 63,614	$ 78,685
Interest Expense	$ 32,017	$ 35,739	$ 39,760
Tax Expense	$ 14,653	$ 23,422	$ 38,921

3.2.5. The Balance Sheet

The balance sheet, as with every portion of the model, was set up to replicate a typical Red River Valley farm's actual balance sheet. On a balance sheet, assets and liabilities are divided into categories. Current assets are defined as cash or assets expected to be converted into cash within a year. Intermediate assets are noncurrent assets expected to retain value for less than seven years. Examples of this type of asset are machinery or equipment. Long-term assets are farm properties that are expected to be a part of the farm for a long period of time, in most cases buildings and farmland.

Liabilities follow a similar pattern to assets. Short-term, or current liabilities, are debts expected to be paid back within a year's time. Intermediate liabilities mature in under seven years, which typically are payments on machinery or equipment loans. Long-term liabilities are debts with longer payment terms. These types of investments may include the purchase of farm land or the construction of buildings.

3.2.5.1. Assets

The stochastic variables for the balance sheet exceed those from the income statement due to the number of inputs on the balance sheet. As previously mentioned, the balance sheet breaks down assets and liabilities into time-based categories. The current assets included in the balance sheet are:

1. Cash
2. Prepaid expenses and supplies
3. Growing crops
4. Accounts receivable
5. Crops held for sale

6. Crops under government loan
7. Other current assets

Cash includes farm savings and checking account balances, as well as any physical cash held in hand by the operation. Prepaid expenses and supplies include any inputs a farmer has purchased with the intention of using the products for production. This may include prepaid seed, chemicals, and fertilizer. Farmers will often take advantage of purchasing these goods early when companies provide discount incentives. Growing crops includes the value of unharvested crops in the field. It is important to note a balance sheet provides a snap-shot in time, so this value is very low in the model because the balance sheet data are from December of each production year. By this time most farmers have harvested their corn and soybeans for the year. Accounts receivable represents revenue farmers have earned but not yet been paid for. This may include commodities that have been contracted but not yet sold for cash, or goods that have been sold, but money has yet to be received. Hedging accounts represent a type of risk mitigation farmers can use for marketing crops. Crops held for sale include all raised commodities being stored prior to sale. Farmers may choose to store grain and hold off selling the commodity until market prices increase. Crops produced under government loan include planted acres financed through government-issued loans. Finally, other current assets include miscellaneous current assets that can be converted to cash in less than a year’s time.

All 2018 current asset projections were calculated using the @RiskPert function, the same function that was used for most of the income statement inputs. Since this function considers the ten years of previous data, it is good indication of how the farm has performed financially. In doing so, the @RiskPert function considers the minimum value, maximum value, and most-likely value the number could take on. Again, as a simulation is run, a random number for each corresponding field is generated to become part of the 2018 projections.

Intermediate assets include assets intended to be used in the operation for seven years. The variables included in this balance sheet are:

1. Machinery and equipment
2. Titled vehicles
3. Other intermediate assets

Machinery and equipment includes all the tractors, planters, fertilizers, sprayers, combines, and other equipment farms used to plant, take care of, and harvest their crops. Titled vehicles include all the semis and other registered vehicles used in an operation. Other intermediate assets may include miscellaneous pieces of equipment used for production on the operation. The @RiskPert function was again implemented for these variables to find 2018 projections. A five-year look back period was used to determine the minimum, maximum, and average values for the @RiskPert calculation. Only five years were used because, over time, technologies change and the cost of purchasing equipment and machinery fluctuates to meet the new demands of purchasing new equipment.

Long-term assets in the base case balance sheet include assets intended to be used in an operation for long periods of time. These variables are:

1. Farm land
2. Buildings and improvements
3. Other long-term assets

Farm land includes all real estate an operation owns. This is a chief asset of a farm and is very important in balance sheet calculations. Buildings and improvements include all storage an agriculture operation owns, and any enhancements made. Other long-term assets include anything owned by the farm and intended to use in the operation for more than ten years. As with all other projections, the @RiskPert function was used. Ten years of previous data were used to estimate these values for the balance sheet.

Following the determination of current, intermediate, and long-term assets, simulating the model resulted in stochastic projections for the 2018 production year. Adding together all the variables results in the total farm assets for the base case. Further analysis of these results will be covered in the next chapter.

3.2.5.2. Liabilities

As with assets, current liabilities included in the base case were listed separately. These variables include:

1. Accrued interest
2. Accounts payable
3. Current notes
4. Government crop loans
5. Principal due on term debt

Accrued interest includes all interest due in a given years' time from all short, intermediate, and long-term loans. Accounts payable includes debt owed to another business or operation. For example, the unpaid cost of hiring someone to help with harvesting of a commodity would be included in this expense category. Current notes, on the other hand, include a promissory note and are typically loans provided through banks or other financial institutions. Government crop loans include money owed to the federal government. Principal due on term debt includes all payments on intermediate and long-term debt that is due within the year. This is important because a farm business must have enough cash available to make these yearly payments. For all current liabilities' projections, 2013 through 2017 estimates were used. Again, the @RiskPert function and five years of data were used to project these expenses because the average cost of inputs and financing has increased, so considering values from 10 years ago would not provide an accurate representation of farm financials today.

Intermediate and long-term liabilities were determined a bit differently than other values in the balance sheet. Due to a lack of data on individual categories, these groups were represented in one lump-sum in the base case balance sheet. The intermediate category included machinery and equipment, titled vehicles, and other intermediate debts. The long-term liabilities included farm land, buildings and improvements, and other long-term liabilities. Projections for these values were simulated through the @RiskPert application, and again five years of data was used.

Following the determination of current, intermediate, and long-term liabilities, simulating the model resulted in stochastic projections for the 2018 production year. Adding together the three categories resulted in the total farm liabilities for the base case. Further analysis of these results will be covered in the next chapter.

The last important data used in the base model are net non-farm income and family living projections. Data were collected on these variables and averages were used. Projections were based off of minimum, maximum, and average values derived from the @RiskPert function.

Following the simulation of the model, the projected net equity of the base case was calculated by taking the total farm assets, minus total farm liabilities, plus off-farm income, minus family living costs. This calculation results in the equity of an average Red River Valley farm. More on trends and results will also be discussed later.

3.3. Correlation Matrix

A correlation matrix was incorporated in the model to consider the relationship between corn and soybeans. Prices and yields of both commodities were arranged in a table to display how strongly the variables were correlated. The @RiskCorrelations function was used to derive the table. After gathering the data, a Spearman Rank correlation assessment was constructed. The purpose of this table was to see if crop rotations followed any type of trend based on the relationship between prices and yields of corn and soybeans.

3.4. Data Sources

The data for this paper was extracted from various sites. Model financial statements are based on historical financial data from Minnesota farms available on FINBIN, a University of Minnesota farm statistics database. This data source collects financial information of farms and combines the results into the FINBIN site. For the base case, information from the six counties was used. Averages from 2008 to 2017 were derived and used in the model.

Interest rate data was collected from the Kansas City Federal Reserve. The average interest rate charged to farmers by Midwestern lenders was collected from 1993 to 2017. Then, as previously discussed, the @RiskNormal function was utilized to derive a starting interest rate that could accurately represent what farmers were charged for financing in 2018.

Price and yield information for corn and soybeans were derived from the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) website. Price-level data was available at the state level, so Minnesota commodity cash prices were collected. From here, averages of the prices were calculated, and a 12-month moving average was used to determine a starting price for the 2018 projections. Yield data was available at the county level, so data for six counties in the Red River Valley was used. Averages of 2017 production were then used to determine the estimated yields for the 2018 crop season.

Table 3.7: Base Case Balance Sheet Variables

Balance Sheet Variables	Minimum	Average	Maximum
Cash	$ 46,426	$ 54,600	$ 65,889
Prepaid Expenses and Supplies	$ 86,066	$ 102,283	$ 120,894
Accounts Receivable	$ 51,233	$ 60,017	$ 68,793
Hedging Accounts	$ 5,239	$ 8,113	$ 9,463
Crops Held for Sale	$ 487,210	$ 555.378	$ 609,188
Crops Under Government Loan	$ 0	$ 16,676	$ 47,804
Other Current Assets	$ 371	$ 892	$ 1,474
Machinery and Equipment	$ 851,217	$ 857,488	$ 917,984
Titled Vehicles	$ 52,854	$ 53,368	$ 55,128
Other Intermediate Assets	$ 246,916	$ 269,472	$ 296,882
Farm Land	$ 508,708	$ 941,515	$ 1,293,525
Buildings and Improvements	$ 94,232	$ 184,312	$ 265,491
Other Long-term Assets	$ 33,496	$ 66,736	$ 98,345
Accrued Interest	$ 15,109	$ 17,019	$ 18,400
Accounts Payable	$ 23,715	$ 27,892	$ 32,854
Current Notes	$ 291,070	$ 305,046	$ 335,730
Government Crop Loans	$ 9,076	$ 15,766	$ 27,951
Principal Due on Term Debt	$ 74,158	$ 82,419	$ 89,350
Total Inter. Farm Liabilities	$ 154,764	$ 178,702	$ 210,217
Total Long-Term Farm Liabilities	$ 378,238	$ 417,015	$ 468,554
Net Non-Farm Income	$ 18,061	$ 22,100	$ 25,226
Family Living	$ 53,580	$ 73,748	$ 85,127

4. RESULTS

Results for the model were simulated for the base case and a comparison case using data from Minnesota farms. It is necessary to remember that previous financial data were used with @Risk functions to obtain the most accurate projections for the 2018 crop year. The focus of this chapter will be on stochastic projections from the model, along with some significant financial calculations and findings. First, the results from the base case will be discussed with noteworthy findings. Next, the comparative, south-western Minnesota case will be compared against the base case to determine similarities and differences between the corn and soybean producing farms.

4.1. Base Case Results

After the base case was simulated, the results from the model generated projections for expected farm financials of the base case farm. While all the financial information is used in the income statement and balance sheet for the base case, some values were of more importance than others. For this reason, a few key financial ratios were calculated to show changes over time and ultimately provide projections for 2018. These results are organized in tables and can be found throughout this section.

The first financial calculation considered is capital debt repayment capacity (CDRC). This ratio is an important measurement banks and lending institutions consider when deciding if lending to a farmer would be a good investment for their company. Arguably, this is the most important calculation to consider, as it provides the repayment capacity of a farm and its ability to repay debt. The table below shows how CDRC is calculated.

Table 4.1: Capital Debt Repayment Capacity Calculation

Net Farm Income
+ Non-Farm income
+ Depreciation
+ Term debt interest expense
- Family living costs
= CDRC

As anticipated, the data show that the CDRC of farms in the Red River Valley experienced a significant down-trend from 2012. This was expected because in 2012 the industry experienced record-high corn and soybean prices. However, something interesting and not anticipated was the model projections for a higher CDRC for the 2018 year than was seen in 2017. This is interesting as prices have continued to be in a downward trend.

Possible explanations for the increase in the CDRC is the drastic increase in the cost of production from 2016 to 2017. The expenses associated with producing a crop for the year increased, on average, by nearly $40,000. With a significant jump in the cost of production, the net farm income for 2017 significantly impacted the CDRC. The projected cost of production is not expected to exhibit such a dramatic increase from 2017 to 2018, which could be one explanation of why the CDRC is higher in the 2018 projections. Other possibilities for why 2018 projections suggest a higher CDRC could result from operations attempting to cut costs by not replacing equipment as often as they maybe would in financially sound times.

Along with these assumptions, sensitivity testing was performed to determine other impacts of the changing CDRC. Through analysis in @Risk, it was determined total sales, or revenue generated from selling corn and soybeans, was the dominant factor that determined CDRC calculations. Other inputs, such as government payments and gains or losses in hedging accounts, resulted in minimal overall impacts. This testing validates model accuracy and results.

Table 4.2: Base Case CDRC

	Net Farm Income	Depreciation	Net Non-Farm Income	Family Living	Interest Expense on Term Loans	CDRC
2008	$ 222,113	$ 42,364	$ 18,061	$ 53,580	$ 37,357	$ 266,315
2009	$ 74,268	$ 43,205	$ 19,966	$ 62,287	$ 32,308	$ 107,460
2010	$ 306,310	$ 54,013	$ 21,808	$ 75,078	$ 35,491	$ 342,544
2011	$ 237,605	$ 58,973	$ 23,595	$ 73,865	$ 32,017	$ 278,325
2012	$ 426,709	$ 69,613	$ 20,565	$ 85,127	$ 33,357	$ 465,117
2013	$ 64,918	$ 69,613	$ 22,487	$ 76,146	$ 33,906	$ 114,778
2014	$ 14,095	$ 73,529	$ 22,981	$ 76,797	$ 34,600	$ 68,408
2015	$ (8,943)	$ 78,753	$ 27,154	$ 75,987	$ 39,020	$ 156,723
2016	$ 156,873	$ 78,685	$ 24,018	$ 74,978	$ 39,390	$ 223,988
2017	$ 118,363	$ 71,715	$ 22,290	$ 77,104	$ 39,200	$ 174,464
2018	$ 162,044	$ 62,584	$ 21,948	$ 72,283	$ 35,789	$ 210,081

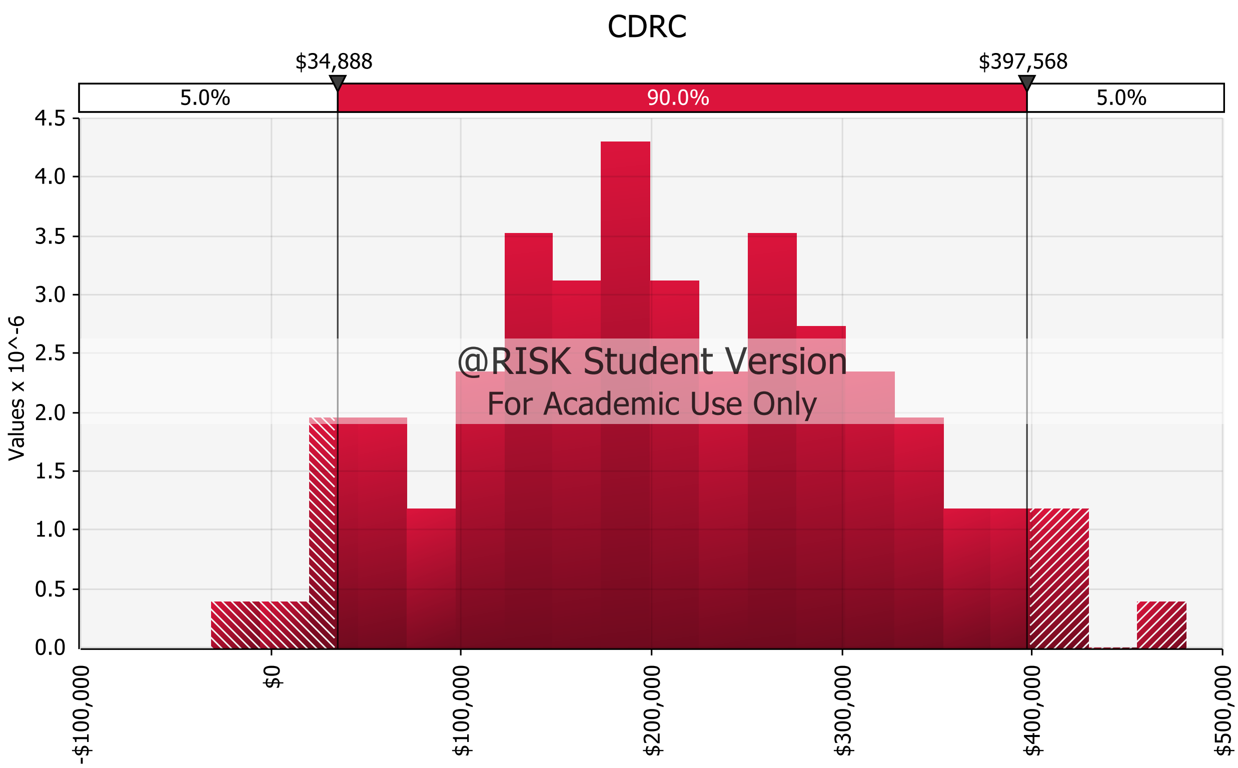

Figure 4.1: Base Case CDRC

The second financial calculation to consider is the liquidity of the base case farm. To do this, the current ratio was calculated by dividing the current assets by the current liabilities of the operation. This financial measurement is a measure of the ability of a farm to pay off current debts using current assets. Like the CDRC calculations, current ratio has exhibited a downward trend since the record-high prices of 2012. In other words, data show that farms have experienced a decrease in current assets, like cash, and an increase in current liabilities, like costs of supplies, materials, and inputs. There was a marginal negative change in the current ratio between 2017 and 2018. While this ratio is currently not as strong as lending institutions typically prefer when making loans, small improvements in the cash available to cover current debts could result in upward progress in this ratio measurement. With current markets, farmers may be more willing to take advantage of small market swings and contract commodities to lock in the prices, and therefore ensure a current cash inflow into the operation.

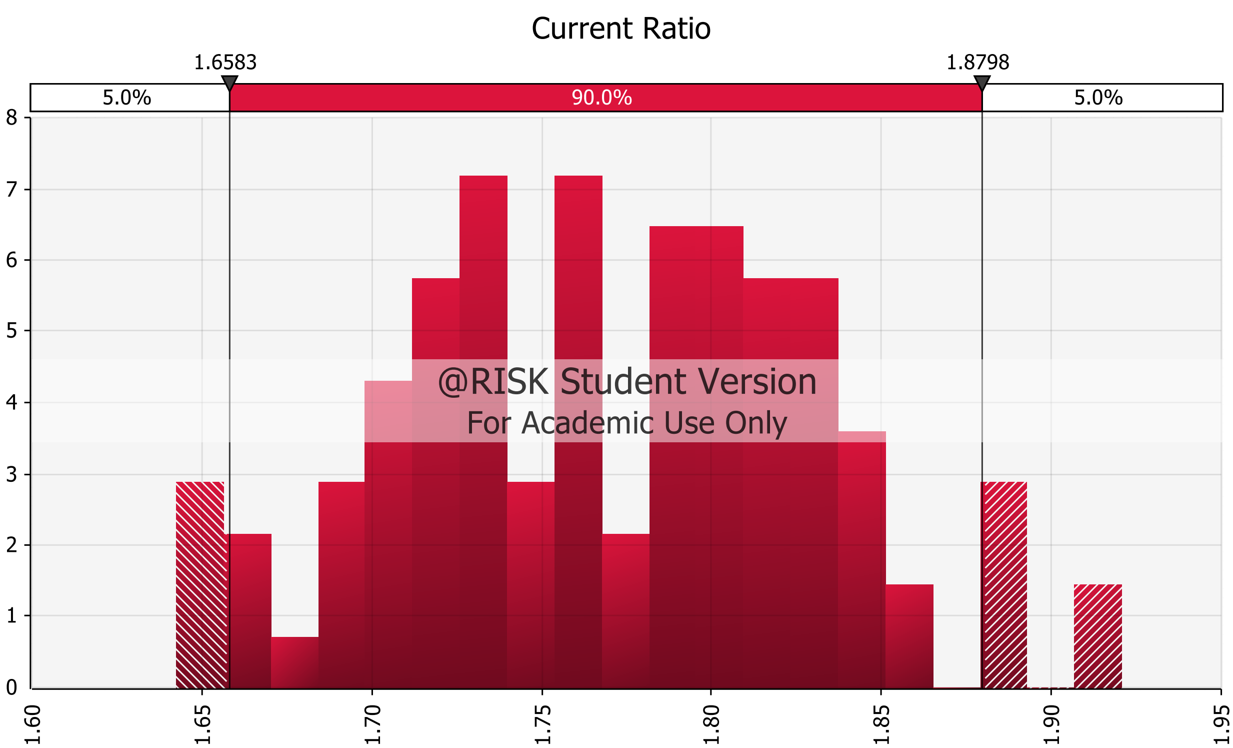

Figure 4.2: Current Ratio

To test for sensitivity, the Spearman Rank of the correlation coefficients was performed on current ratio inputs. The results indicated current ratio has numerous inputs that determine the overall measurement of a farm. The largest impact on the measure was crops held for sale but other inputs such as family living expenses and prepaid expenses and supplies also had a significant impact on the current ratio projection for 2018. Figure 4.3 describes the sensitivity of the current ratio to various inputs.

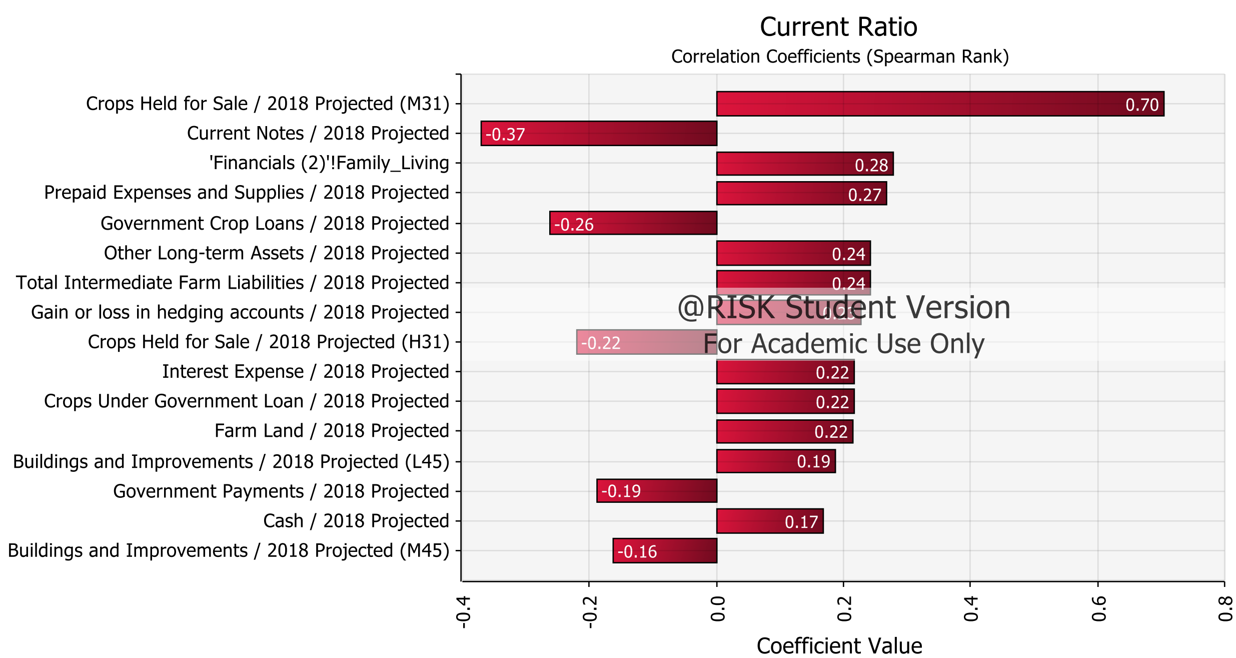

Figure 4.3: Current Ratio Sensitivity Analysis

The third important calculation derived from the results of the base case was the farm debt-to-asset ratio. This ratio is found by dividing total liabilities of a farm by total assets. Being it is a measure of solvency, the debt-to-asset ratio is an important reflection of a business' overall financial position and indicates how much equity a farmer would be left with if everything were sold tomorrow. Surprisingly, the projections for this calculation show an improvement from the previous years' findings. This was an unexpected result from the model. As one would expect, as interest rates increase, the costs of borrowing money goes up, and one would tend to believe a farm would exhibit some stress in solvency. Since this is not the outcome for the base case, it draws back to the idea that farms are not financing as much debt and are getting by with the equipment and land they have until higher commodity prices yield more optimistic financial returns. Figure 4.4 illustrates debt-to-asset projections for 2018.

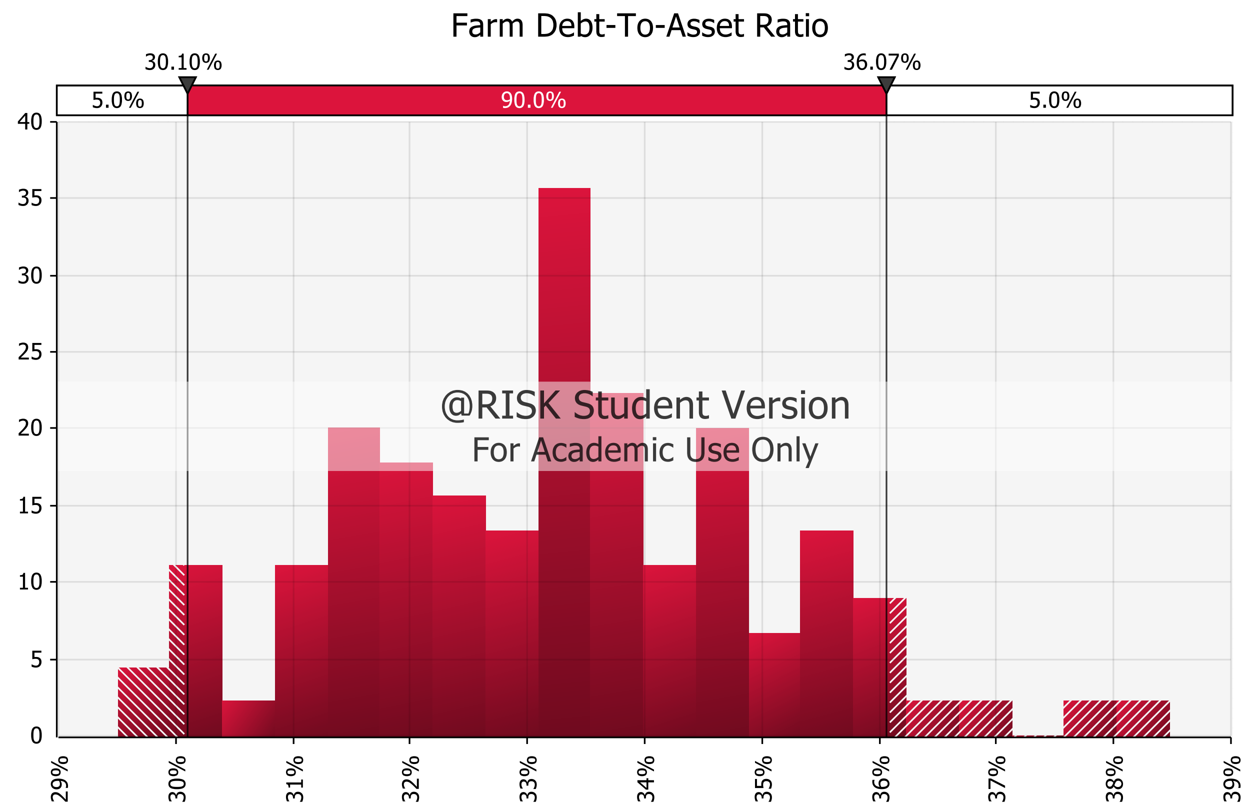

Figure 4.4: Debt-to-Asset Ratio

To test for sensitivity, Spearman Rank of the correlation coefficients was performed on debt-to-asset inputs. The results indicated numerous inputs determine the overall debt-to-asset ratio of a farm. The largest impact on the measure was the value of farm land, but other inputs such as long-term farm liabilities and net farm income also had a significant impact on the debt-to-asset projection for 2018. These findings are shown in Figure 4.5.

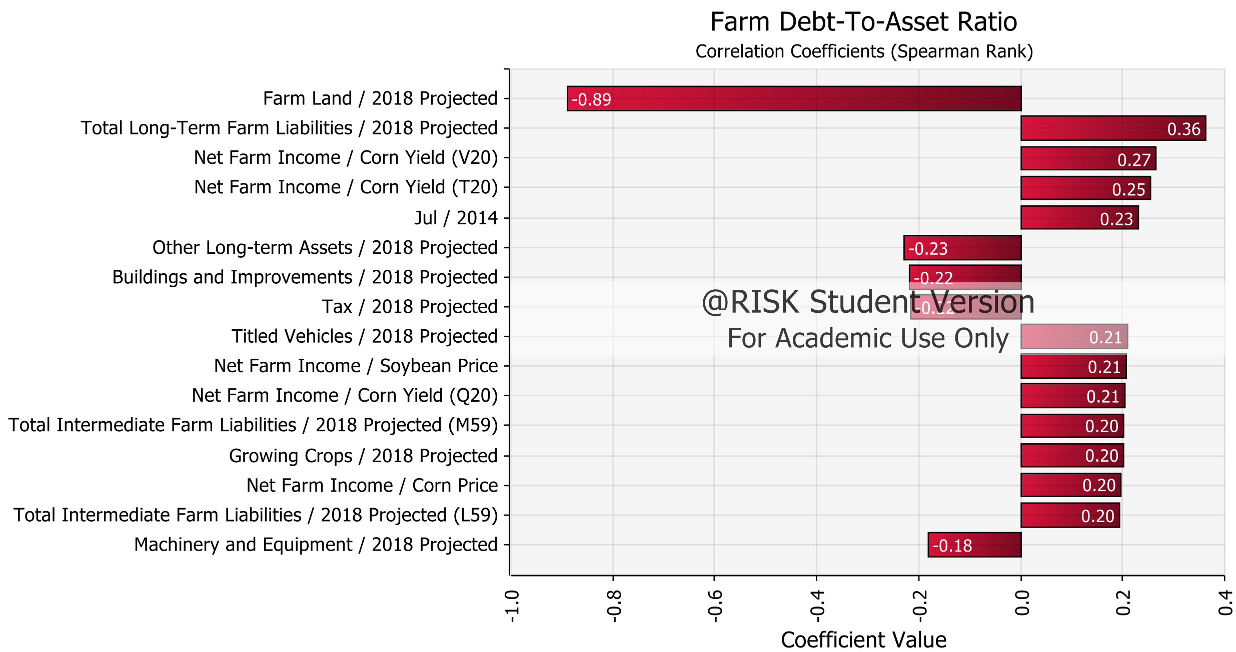

Figure 4.5: Debt-to-Asset Ratio Sensitivity Analysis

Along with exploring the magnitude of key financial measures, considering patterns or interesting results is another area of importance for this section. One significant finding in the base case model is the pattern between prices received for corn and soybeans and the cost of raising these crops. Data show the cost of production has continued to rise over the last few years, and displays a significant upward trend since 2008, the first year of data used for this study. While the cost of production continues to rise, prices have experienced downward trends, especially since the highs of 2012. This finding validates initial assumptions that farmers are paying more to produce corn and soybeans, but receiving lower prices, and therefore generating less farm income as a result.

Another interesting financial value to consider is the family living cost category. While the data and model reflect that farming has seen a decrease in profitability since 2012, family living costs don't seem to be adjusting to the financially tough times. This is interesting, as one would tend to expect the opposite. From the results, it has shown families have not changed their cost of living. This may mean they continue to spend the same amount of money while their farming operations continue to see diminishing profitability.

While the financial results of this section validate the idea farmers have received less profits for their commodities produced in recent years, it is important to acknowledge that farm equity has increased since 2008. Throughout time, considerable increases in net worth were experienced through 2017, and the model regularly projects, for the 2018 year, that equity will remain steady or result in a small increase. This information is extremely important, as it shows the chief asset of land on farm balance sheets has held its value, even during the trying times agriculture has experienced in the last five years. This is a significant finding because with almost 80% of a farm's worth coming from its land, real estate is an essential portion of the balance sheet.

Along with all of this, something important to note is the corn and soybean prices and yields typically observed for farms in the Red River Valley. Since actual prices for 2018 were available through the USDA, these were used in the model. Stochastic yield factors were generated using the @RiskPert function, as previously mentioned in the model section. While actual price data were available, volatility was still included. Marketing crops through the marketing year can drastically impact the revenue generated from crops being produced. Yield fluctuations can also significantly impact a balance sheet. For example, when simulating the model and changing the volatility from 10 percent to 15 percent for a typical Red River Valley Farm, the revenue generated from the crop production changed by over $25,000 for each crop being produced. This result is extremely significant in supporting the idea that using risk-management programs, such as federal crop insurance, and being proactive with marketing can significantly reduce the chances of catastrophic financial issues for a farm.

Finally, another area of importance for this model is the relationship between corn and soybean prices and yields. As shown in the figure below, the correlation matrix was constructed to display the relationships between these variables. A Spearman Rank correlation was used to determine the strength of the relationships between the variables. Overall, most results were as expected. The relationship between corn and soybean prices was extremely positive at .952, indicating fluctuations in the market tend to follow extremely similar patterns. A strong negative relationship (-.717) between corn prices and yields lead to the conclusion that if yields are lower, corn prices tend to be higher, and vice versa. This followed the typical law of demand. There was also a positive relationship between corn and soybean yields, although it was not as strong as was shown with prices.

Table 4.3: Correlation Matrix

	Corn Price ($)	Soybean Price ($)	Corn Yields (bu/acre)	Soybean Yields (bu/acre)
Corn Price ($)	1			
Soybean Price ($)	0.952	1		
Corn Yields (bu/acre)	-0.717	-0.778	1	
Soybean Yields (bu/acre)	-0.122	-0.188	0.0616	1

The relationship between soybean prices and yields is interesting to consider. The relationship, although negative, was much lower than one would anticipate. The Spearman Rank correlation was run twice to verify findings, and the same results were found. This was interesting and may be explained by the large basis in Western Minnesota, along with a smaller demand for soybeans in the Red River Valley region.

4.2. Base Case Compared to Minnesota Case

Comparing the base case to another situation was an important part of this research. For comparison, data from three counties in south-central Minnesota was collected. These counties included Renville, Redwood, and Yellow Medicine. This area was selected for a few reasons. First, USDA production maps showed that this part of Minnesota produced the same typical corn-soybean rotation as the Red River Valley. To compare results to the base case, an area of typically higher yields and cash prices received was sought out. This, and the fact that farms in the area are typically around 860 acres, made for some interesting comparisons.

Table 4.4: Minnesota Case Counties

Minnesota Counties
Renville
Redwood
Yellow Medicine

The first financial calculation considered was the CDRC. Table 4.5 and Figure 4.6 describe CDRC for the comparison case. The results of this calculation were much different than originally anticipated. The value of this calculation experienced much more volatility than expected, and negative CDRC calculations resulted from 2014 to the projected 2018 value. While this was the case, the projections for 2018 do show a slight improvement, which is explained by the increase in net farm income and add-back of interest expenses.

Table 4.5: Minnesota Case CDRC

	Net Farm Income	Depreciation	Net Non-Farm Income	Family Living	Interest Expense on Term Loans	CDRC
2008	$ 168,004	$ 29,873	$ 33,655	$ 54,753	$ 28,291	$ 205,070
2009	$ 53,256	$ 28,288	$ 35,903	$ 54,652	$ 24,938	$ 87,773
2010	$ 163,560	$ 44,495	$ 29,089	$ 64,097	$ 25,055	$ 198,102
2011	$ 113,322	$ 38,488	$ 32,931	$ 67,360	$ 25,062	$ 142,443
2012	$ 265,427	$ 48,090	$ 27,014	$ 73,032	$ 23,613	$ 291,112
2013	$ (37,311)	$ 59,746	$ 27,151	$ 73,724	$ 23,763	$ 39,595
2014	$ (58,068)	$ 56,746	$ 29,418	$ 95,421	$ 25,779	$ (21,296)
2015	$ (58,868)	$ 54,236	$ 30,290	$ 66,179	$ 24,999	$ (14,722)
2016	$ (47,260)	$ 56,299	$ 35,017	$ 76,769	$ 31,694	$ (12,627)
2017	$ 13,605	$ 47,463	$ 41,628	$ 87,360	$ 36,934	$ (8,595)
2018	$ 13,605	$ 45,553	$ 32,913	$ 72,569	$ 28,100	$ (3,676)

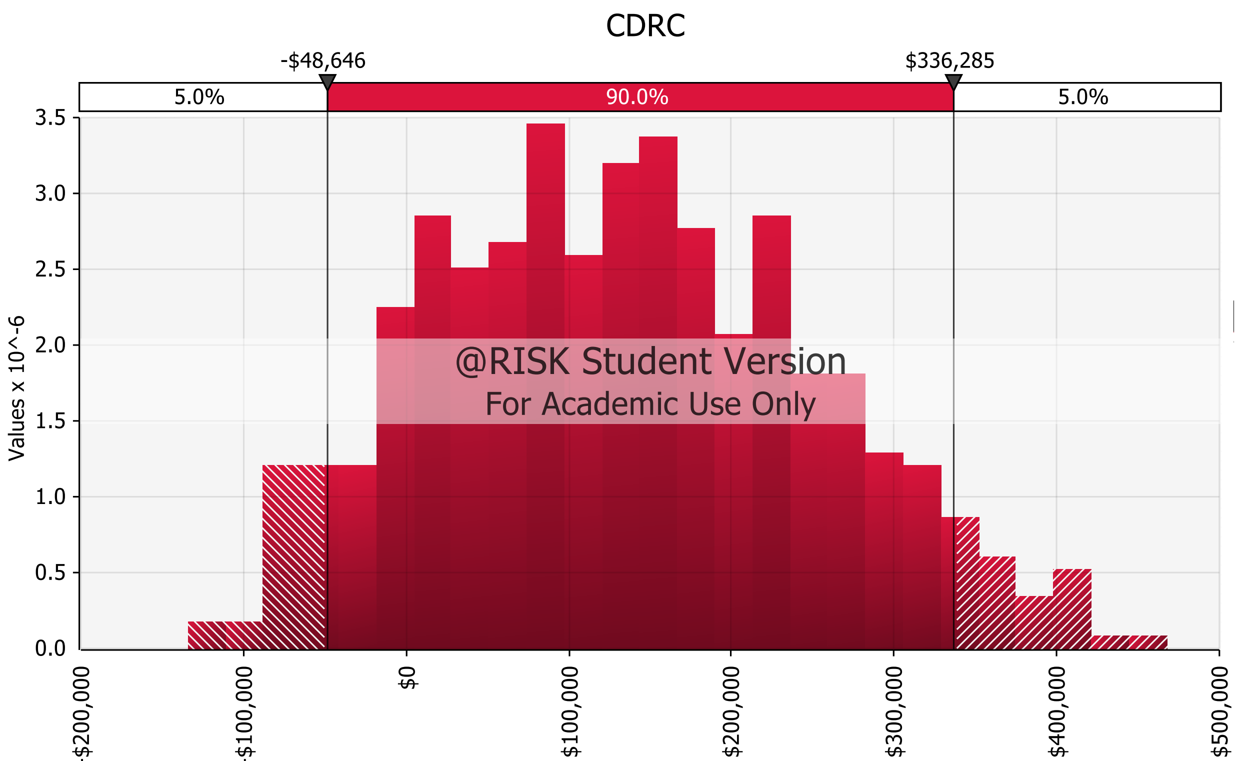

Figure 4.6: CDRC

When comparing these results to the base case, there are some interesting similarities between the two farm types. Both the base case and Minnesota model project increases in CDRC. More interestingly, the CDRC projection from the base case is significantly higher than the Minnesota projections. Explanations for this significant difference include a variety of factors. To begin, the price and yield differences farmers receive for their corn and soybeans play a significant role in determining net farm income. Along with this, the Minnesota case region experienced poor weather and a financially tough year in 2013, resulting in a significant drop in the overall CDRC value. The significant drop has had lasting impacts on the farm financials since. While the CDRC is expected to increase, the farm financials will take some time to come back from the tough financial history of the industry. Also, important to note is the Minnesota case continues to project a negative CDRC for the 2018 year. This is interesting, as it may suggest farmers in this region of Minnesota may be more impacted by lower prices moving forward.

The current ratio of the comparison farm was also analyzed. As one would expect in the current environment, this calculation reveals some stress in the operation since the record-high year in 2012. Although this is the case, the trend does not currently indicate severe financial action. Projections for 2018 in both the base and Minnesota cases indicate the ratio will be slightly higher than they were in 2017 but remain an important variable for economists and lending institutions to track, especially if market prices remain as low as they have in the past five years. Current ratio projections for the comparison case are available in Figure 4.7.

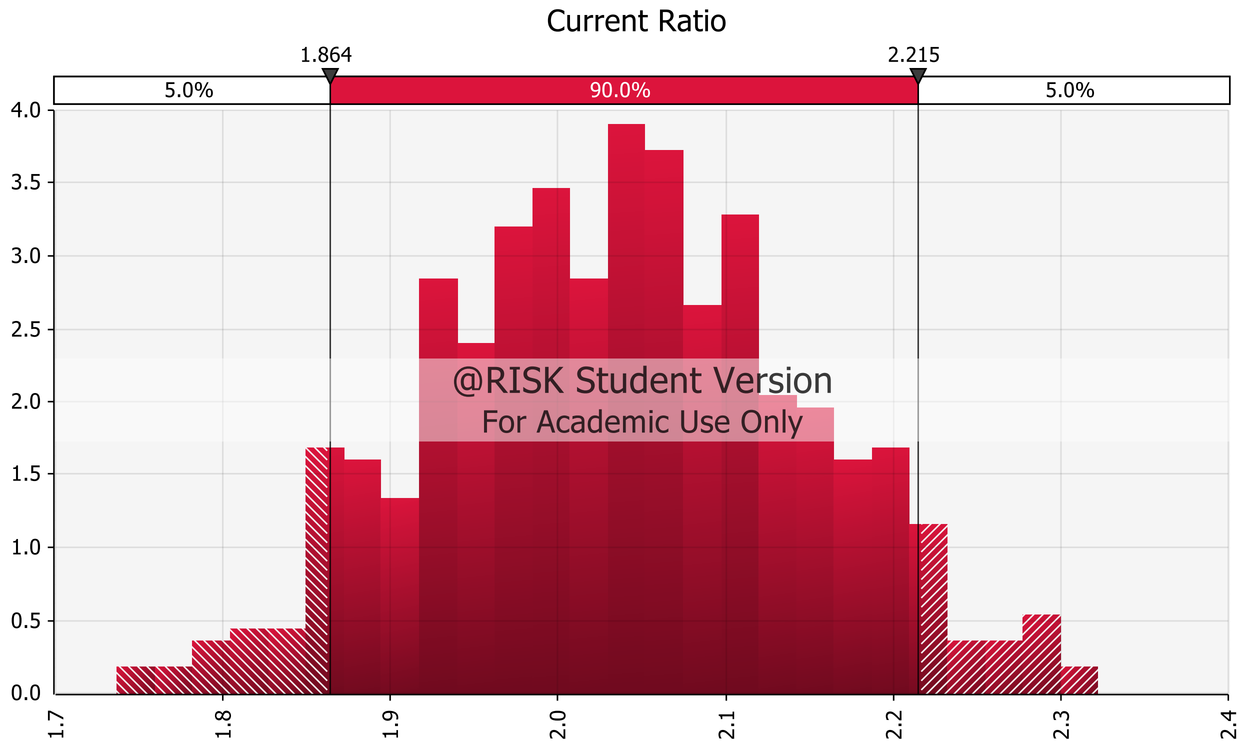

Figure 4.7: Current Ratio

The final @Risk output function considered for evaluation is the debt-to-asset ratio of the Minnesota farm. This ratio, as previously mentioned, indicates how many assets are financed through debt, and if the farm were to be sold tomorrow, how much equity the owners would receive for their assets. This calculation yielded different results for the base case and Minnesota case. Data shows this financial ratio has been better than expected for farms in the Red River Valley, even with low rates of return in corn and soybean production. This conclusion indicates farmers in the Red River Valley and have made financially smart decisions for their operations, despite the tough financial times. The Minnesota case farms are expected to experience a significant decrease in the debt-to-asset ratio calculation. This may be an indication that farms have taken on more risk and debt than their financial means, which may indicate farm management practices need to change. Debt-to-asset projections for the comparative case are available in Figure 4.8.

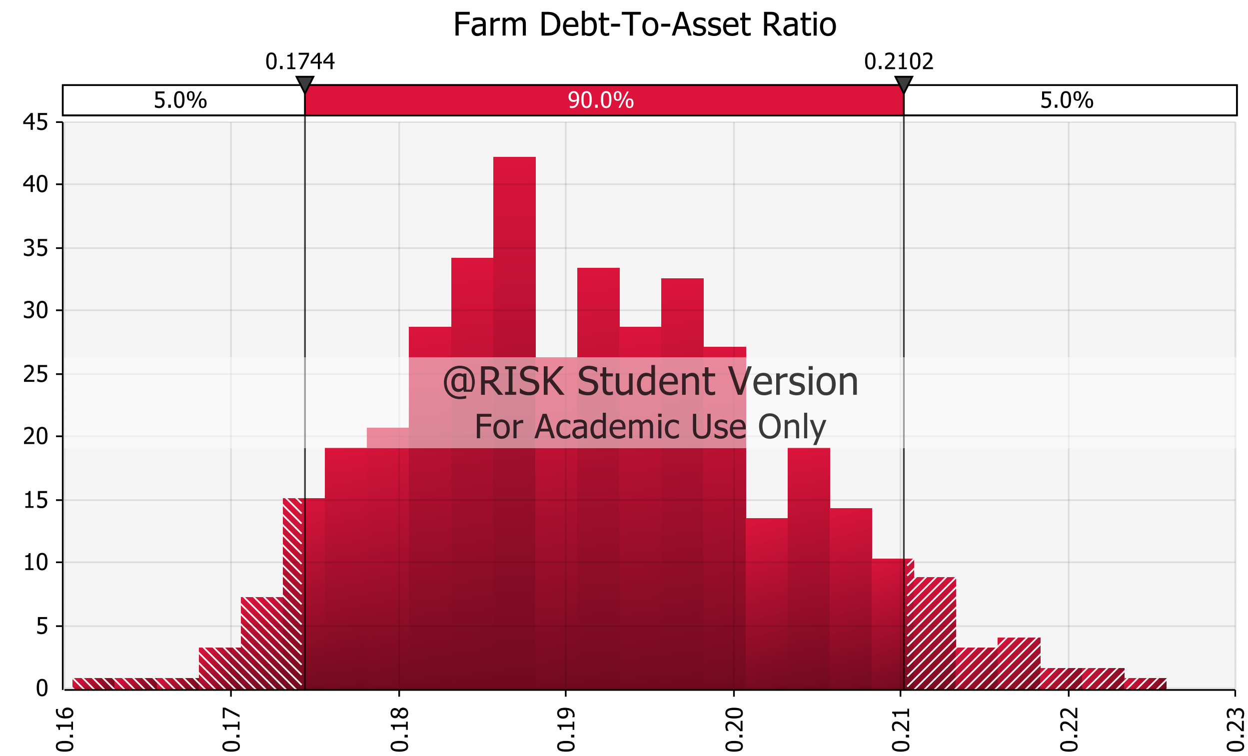

Figure 4.8: Debt-to-Asset Ratio

Aside from these findings, it is important to discuss a few differences between the base case and Minnesota farms. Farms in south-western Minnesota tend to be smaller than that of the Red River Region, leading to lower gross crop sales. However, the price received for corn and soybeans tended to be higher in the Minnesota counties. This is due to the difference in the location of each case. However, input costs and the overall cost of producing a crop are slightly higher in Minnesota than in the base case, probably due to economies of scope and scale. With more acres, average costs are distributed over more land, making the costs of inputs and production slightly lower. Also interesting to note is the significant difference in equipment values found when comparing the two areas. Farms in Minnesota tended to have less value in machinery and equipment, and therefore a lower intermediate asset value in the balance sheet. This is probably explained by the fact that smaller operations require fewer pieces of equipment.

A few off-farm findings that derived from this case are also important. First, the average family living cost for the Minnesota family was less than that of the Red River Valley. Along with this, the average off-farm income was higher. This finding revealed the concept that Minnesota families tend to have more off-farm income, probably explained by the smaller farm size and a smaller demand for labor. Along with this, Minnesota families tended to have a lower cost of living, and therefore more cash available to be used to support a family during tough times in agriculture.

4.3. Projections vs. Actual results

Throughout the duration of this project, new farm financial data became available for 2018. With the addition of this data, the projected values were compared to the actual results of farms in the Red River Valley by taking the absolute value of the difference between calculations. Overall, some of the projections for the 2018 crop year were nearly identical to 2018 actual results. For example, the machinery and equipment category yielded a 0.72 percent difference. Other areas, such as tax expenses, resulted in slightly-higher variations due to the complexity of determining the amount of tax a farm will pay in a given year. However, overall the model yielded results that indicate the model was efficient in projecting farm financials.

5. CONCLUSION

This chapter revisits the purpose of this study and the research objectives. Next, a review of the methodology and model developed are discussed. Along with this, important conclusions are explored. Finally, limitations of this paper and opportunities for further research are discussed.

5.1. Summary of Project

5.1.1. Purpose of the Project

This paper set out to analyze farm financial statements in order to better understand the effects of changes in interest rates, prices, and yields. Farmers could gain perspective on their current financial situations from the paper's analysis. That is, an accurate model that brought an operation's balance sheet and income statement together can help to develop an effective plan for upcoming expenses and allow farmers to be more prepared for cash flow issues into the future. Increased awareness of their situations should also result in better management strategies in which farmers can work to mitigate their risk, market their crops to lock in prices, and cut down on income unknowns.

5.1.2. Objectives of the Project

As stated previously, the three main objectives are to:

1. Develop a model that represents an average Red River Valley corn and soybean farm's balance sheet and income statement.
2. Determine how repayment capacities of farms have recently been impacted.
3. Examine how price and yield fluctuations influence net income and farm cash flows.

These objectives provide perspective on the current financial situation of farms in the Red River Valley and Minnesota cases. Uncertainty in interest rates and commodity prices moving forward into the future was modeled to gain insight on the best financial plan for individual farm operations in the future. The developed model brought the balance sheet and income statement of an operation together and used @Risk simulation to estimate projections for 2018 farm financials. This model was designed with intentions of helping farmers make smart management decisions and to mitigate their risk and cash flow concerns.

5.1.3. Methodology of the Project

The model for this project was constructed by using average farm financial variables from 2008 to 2017. Prices and yields for corn and soybeans were collected and average interest rates charged by lending institutions were incorporated. Using this data, a stochastic simulation model was used to produce projections for farms in the 2018 crop year. For the model, @Risk add-in for excel was utilized. This program provided simulated results and an accurate representation of farm financials for the base case. In addition, another set of farm financials for a different area was developed to determine any similarities or differences in financial ratios. Three counties in south-western Minnesota were selected for this comparison. Again, financial information, corn and soybean prices and yields, and interest rate data were collected. The model was simulated using @Risk and projections for 2018 were generated. Correlation matrices for both cases were incorporated to account for the relationships between corn and soybean prices and yields. Sensitivity analyses were also included to determine how financial calculations were impacted by input variables.

5.2. Conclusions

Specific financial calculations, including the CDRC, current ratio, and debt-to-asset ratio were simulated for the base case and comparison case. While some of the results were as expected, others were different than some in the industry would expect given current commodity market prices. One of the most interesting results from the model involved CDRC. While the base case resulted in a projected increase in CDRC, the Minnesota model projected the opposite results. There are numerous explanations for this difference, including price and yield differences. Along with this, the Red River Valley base case data has presented steady growth in CDRC since 2016. A contribution of this project is recognizing this and acknowledging it may take many years to come back from the tough financial years the industry has experienced. Also, important to note is the Minnesota case projected an increase in CDRC for the 2018 year, indicating the farm may begin to follow a similar trend to that of the base case.

Following CDRC evaluations, trends of the current ratio of the farm were analyzed. As one would expect with the times of agriculture, this calculation has indicated some stress in the operation since the record-high year in 2012. However, importantly and surprisingly, projections for 2018 in both the base and comparison cases indicated improvements in the current ratio.

The debt-to-asset ratio showed different outlooks for the base case and Minnesota case. Projections indicated the financial ratio has been better than expected for farms in the Red River Valley, even with low rates of return in corn and soybean production. This factor leads to the conclusion that farmers in the Red River Valley have made financially smart decisions for their operations, despite the tough financial times.

Aside from these findings, differences between the base case and Minnesota farms were discussed. Farms in south-western Minnesota tended to be smaller than that of the Red River Region, so naturally farms showed a lower gross crop sales. The cost of producing a crop was found to be slightly higher in Minnesota than in the base case, probably due to economies of scope and scale. Also interesting to note is farms in Minnesota tended to have less value in machinery and equipment, and therefore a lower intermediate asset value in the balance sheet.

As was explained in Chapter 4, the financial ratios simulated from the model were important in assessing farm financials for the base and Minnesota cases. The CDRC, current ratio, and debt-to-asset ratio are all significant indicators used by industry and academia which were discussed in detail in this paper.

5.3. Suggestions for Further Research

Further research on topic could begin with 2019 farm financial projections. This information would be valuable as commodity markets continue to be unpredictable and prices remain unstable. In doing this, the project could be used beyond the academic world and in the lending industry. Farmers could also use the model to input their own numbers and get personalized records, as each producer has slightly different break evens, costs of production, and overall expenses.

Other areas that could build on this research include studies on farm land values. Tracking trends and projecting values of farmland in the future would be interesting and could alter the model balance sheet drastically. Along with this, the family living variable would be interesting to research. Although net farm income has been and is projected to be down for the 2018 year, it seems as though families have not adjusted their spending to accommodate for these losses. Conducting further research to indicate if families are living beyond their means would be interesting, and if so, how long the family-farm can sustain that way of life. Finally, considering other farm types would be extremely interesting. Looking at different types of livestock-producing operations or dairy farms could yield different results than crop farms.

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APPENDIX. DETERMINATION OF AGRICULTURAL INTEREST RATES

Several variables may determine how banks decide the rates they charge their customers. Regression analysis was used to examine these variables. Regressions were performed to provide greater insight on a theoretical model of interest rates that is based on risk-bearing costs and funding costs.

The data for these regressions was found from two different sources. All of the financial ratios, including the average debt-to-asset ratio, average current ratio, and average operating profit margin ratio were extracted from the University of Minnesota's FINBIN website. For the sake of simplicity and data availability, only information collected from Minnesota farms was included. While there were several thousand farms included in the initial survey, FINBIN averages the data. The average debt-to-asset ratio and average operating profit margin were divided by 100 in the excel data set. The average current ratio was kept in its original form from the FINBIN site ("Whole Farm Summary Report").

The other data for this paper, including the average effective federal funds interest rate and the average rate banks charged, was derived from the Kansas City Federal Reserve website (Anon Nov. 2018). Yearly averages were taken to match the form of FINBIN data. The tables below show the variable abbreviations and their corresponding descriptions, along with the summary statistics.

Table A1: Variable Descriptions

Variable	Description
aprcb	Average interest rate (= #/100) charged by banks
affer	Average effective federal funds interest rate (= #/100)
dtar	Average debt-to-asset ratio (= #/100)
acr	Average current ratio
aopmr	Average operating profit margin (= #/100)

Table A2: Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
aprcb	5.678	2.219	3.250	9.233
affer	2.633	2.270	.089	6.236
dtar	.491	.0501	.400	.580
acr	1.750	.317	1.330	2.590
aopmr	.195	.066	.081	.346

Number of observations = 25

The summary statistics were derived from the raw data, prior to any logging or first-differencing. This provided a 25-year look-back of the agricultural lending industry. The mean, standard deviation, minimum, and maximum were found for all the variables. The mean interest rate banks charged during this time span was 5.68%, while the standard deviation was 2.22%. Some of this variation could be explained by the change in the federal funds rate and the use of the risk-rating system, where customers are given rates based on the riskiness of lending money to them. The average federal funds rate, or price banks must pay to receive funding, was 2.63%, with a variation (standard deviation) of 2.22%.

Moving into the financial calculations, the debt-to-asset ratio exhibited a mean of .4912, while the standard deviation was .0501. The average current ratio and average operating profit margin both exhibited positive means of 1.75 and .195, with standard deviations of .317 and .066. From this information, it can be concluded the debt-to-asset ratio saw the least amount of variation from the mean, while the average operating profit margin experienced the largest variation.

The first regression was a simple regression that looked at the influence of the effective federal interest rate on the rate that banks were charging. This was done to give a baseline idea of how the main dependent variable effects the independent variable and provides a comparison to see how much the other variables played a role determining the overall rate banks charge. The model estimate was:

$$log(average\ interest\ rate\ charged\ by\ banks) \\ = B_0 + B_1\ log(average\ effective\ federal\ funds\ rate) + error$$

Where the logged average interest rate charged by Midwestern banks for agricultural loans and the logged average effective federal funds rate were used.

The results from running this regression were as expected. There was a direct correlation between the two variables. The R-squared value was .6947, which means 69.47 percent of the model is explained by the federal interest rate variable. This relationship is significant at the one percent level.

The next regression ran included a whole-model regression. In this model, some of the variables were logged and lag variables were created and used in the following equation:

$$log(aprcb\_d) = B_0 + B_1\ log(average\ effective\ federal\ funds\ rate) + B_2\ log(average\ debt - to - \\ asset\ ratio)\ B_3\ log(average\ current\ ratio)\ B_4\ log(average\ operating\ profit\ margin) + error$$

Where the logged average interest rate charged by Midwestern banks for agricultural loans, the logged average effective federal funds rate, the logged average debt-to-asset ratio, the logged average current ratio, and the logged average operating profit margin were used.

The results from this regression were slightly different than originally anticipated. While the R-squared value maintained its value at .6951, all the variables aside from the effective federal interest rate were found to be insignificant, and therefore contributed very little to the overall model.

The table as shown below represents the results of the regressions run for this paper. While the R-squared variables were previously discussed, it is important to consider the coefficients of the significant variables. The only significant variable was the effective federal interest rate, probably due to the size of the data sample available. For regression model four, if the federal interest rate increased by one percent, the average rate charged by banks would increase by .237 percent. For model five, a one percent increase in the effective federal rate would result in a .242 percent increase in the rate banks would charge.

Overall, based on these results, a few conclusions can be drawn. The findings in this analysis support the idea that bank interest rates are correlated at the 1 percent level. However, finding the other variables are an insignificant leaves several questions unanswered. With more data, it may be possible to further explore if a relationship between these insignificant variables and agricultural interest rates exist.

Table A3: OLS Results

Independent Variable	(4)	(5)	(6)
affer_d	.237***	.242***	
	(-.033)	(.036)	
dtar_d		-2.862	-2.547
		(1.673)	(2.980)
acr_d		-1.149	-1.140
		(.745)	(1.329)
aopmr_d		.160	.635
		(.254)	(.435)
Observations	24	24	24
R-squared	0.6947	0.7361	0.118

***, **, * = 1, 5, 10% significance; observations are yearly

In all, the information presented in this paper was interesting and verified banks do indeed follow effective federal interest rates when determining the rates they charge customers. While the effective federal funds interest rate was extremely significant, the true limitation of this study was the sample size of the data, with having only 24 observations after incorporating first-differencing. In the future, a larger data and even more independent variables could be incorporated to build upon the model.