MEASURES OF BANK PERFORMANCE, LIQUIDITY RISK AND THEIR RELATIONSHIP WITH FARM INCOME VOLATILITY

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Measures of Bank Performance, Liquidity Risk and Their Relationship with Farm Income Volatility

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ABSTRACT

The objective of this paper is to analyze the impact of farm-level risk on bank performance in the state of North Dakota. Farm-level risk has been quantified into a single measure of the volatility of net farm income. Bank performance was examined through two profitability ratios, ROE and ROA, as well as a measure of liquidity risk, the financing gap ratio. Using random effects regression model, relationships between performance measures and bank-specific, agricultural and macroeconomic variables were examined. Panel data from banks and farms in North Dakota for the years 2005-2014 were included. Each type of variable showed significance to performance ratios indicating meaningful relationships with internal factors and macroeconomic factors alike. Results also showed that variability in business operations of bank financed companies is also relevant to bank performance. Continued risk management within financial institutions is vital to maintaining or increasing performance.

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INTRODUCTION

As the globalization of companies throughout the world continues to increase, the global economy becomes more codependent. Recent world economic conditions have proven to be highly volatile; uncertainty in one country or region of the world has more visible impacts on other countries. This is particularly relevant in the United States; because of this country's economic size and impact, the US has seen itself become more susceptible to fluctuations in other countries. While many aspects of the global and national economy tend to be affected by global volatility, the agriculture industry remains highly sensitive to fluctuations globally and nationally alike.

An overarching factor that has had impacts on the world agricultural industry is technological advancements. Technology is a major part of agriculture just as it is throughout other industries; it factors into all levels of production within the industry. In recent history technological advancements in this industry have improved not only efficiency of production but the effectiveness as well. Advancements in genetics, precision planting, harvesting and tracking, erosion protection techniques and improvements in food safety, are all integral in the current world agricultural industry.

Due to the high levels of technological advancement, the world is currently facing a new problem: abundant supply, low usage, and low prices. Early 2015 saw an encouraging outlook that China would be increasing their imports of US food exports (Radford 2015). However, Chinese imports of the major commodities decreased rapidly in August of 2015. This was a solid indication that low international prices had lost their attractiveness as the seasonal demand decreased and industries downstream in the production system remained weak (Radford 2015).

China chose to devalue their currency on August 11, 2015 (Cendrowski 2015). This not only made US dollar-denominated commodities more expensive for holders of the Chinese currency, but also affected other areas of trade like fossil fuels and manufacturing. As the market fluctuated, China reduced coal, iron ore, and crude oil imports significantly. Their decreased demand for US exports across multiple industries affected prices of those related commodities here in the US (Radford 2105).

In addition, competition exists from South American markets with commodities available at typically lower prices than the US. Major political changes in South American countries, specifically Brazil and Argentina which are integral producers of soybeans, have had an impact on the US economy as well (Brown 2016). With new leaders and upcoming policy changes, investors are optimistic in these emerging markets. These governmental changes are attractive to investors because in the world environment there is potential for growth despite the high potential risk involved and any added investment options are taken advantage of. In addition, the markets are moving in sync with one another; emerging markets in these countries are driven by such factors as commodity prices and US interest rates (Brown 2016). However, the risk lies in the fact that both countries rely on China importing their commodities and the risk that new leaders will fail to make policy changes.

The strength of the United States dollar affects trade with not only South American countries like Brazil and Argentina but also with Russia. The Russian ruble has been weakened in recent years because of fluctuations in the oil industry (Kottasova 2016). It's important to note that Russia and its neighbor Ukraine have become major exporters of grain and thus positioned themselves as important players in the world agriculture industry.

In March of 2014, Crimea, formerly a portion of Ukraine, was annexed into the Russian Federation (BBC News 2016). With the annexation came many adjustments for both Ukraine and Russia. Russia faced sanctions from Western countries that targeted Russia's state finances, energy and arms sectors, as well as placing asset freezes and travel bans on many of senior Russian officials and separatist leaders. In retaliation, Russia has placed an embargo on a wide range of foods, which affects food exporters in the Western world (BBC News 2016).

Many hoped increasing agriculture development of Ukraine would result from the major conflict with Russia. Recent policy changes in the European Union have helped this development become reality. Policy changes now allow genetically modified commodities to be produced in Ukraine where they were banned previously. While agriculture was a major part of plans to revitalize the country it hasn't been impervious to recent economic declines. As of early 2015, agriculture only comprised roughly 10% of the economy in the country despite half of the land being arable (Demirjian 2015).

These world conditions are forcing the US agriculture industry to face many challenges. On a national level, the US agriculture sector is adjusting to the world industry environment. In the US some of the major effects of world events have been decreasing prices, profit margins and loan interest rates. Supply and demand of commodities, both grain and livestock, have become a precarious balancing act. With outside pressures on the industry, adjustments have had to be made at all levels of production.

The US dollar, particularly in its strength compared to foreign currencies, has become something of a setback for commodity prices in the US. With the currency exchange rates with competing nations favoring foreign production, US producers are in a position where their goods are priced so low costs are not being covered while at the same time the price is too high for

importers to purchase. Not only that, but countries with weaker currencies, like Russia, Ukraine, Brazil, Argentina and Canada, are expanding their crop acreage which will add to their competitive advantage in current conditions.

With low prices and average to high input costs facing producers and those along the supply chain in the industry, profit margins are increasingly tight. The bright spot in the situation for the industry is the relatively low interest rates. This has saved many producers from exiting the industry altogether. With the shifts in industry prices, margins and interest rates, many farmers have faced increasing their credit demands with their financers, rebalancing their current debt, selling portions of accumulated assets or ceasing to do business entirely.

Not only are grain exports affected by weak foreign currencies, but the livestock industry has faced issues as well. With grain prices being moderately low, this translates to low feed cost for livestock producers. For some producers that are involved in both crop and livestock production under a single firm, they've used their situation as an advantage to balance their decreased income for one commodity and increased income for the other. This comes with another challenge as the increased animal protein production levels will start to pressure meat prices downward of the year in 2016 (CoBank 2015).

The issue of supply and demand in the commodities market is oftentimes out of the control of the producers. In the livestock sector of the industry, close attention to limiting their supply and avoiding flooding the market to remain in sync with anticipated meat demand will be the challenge faced by producers. As we go into the 2016 production year, there are adequate carry-in stocks that have yet to become burdensome. However, as the crop year progresses, the size of the harvest in the US will do the most in setting price expectations. Unless some natural

event occurs somewhere in the world, over-supply will continue to be a major factor in low US commodity prices as demand remains the same globally.

Related forces outside of the agriculture industry in the US that have a significant impact on production are the monetary policy and the federal funds rate. With producers so heavily relying on credit to maintain operation costs and survive until harvest, it's crucial to examine how the price of credit has remained low. Monetary policy in the US is defined by the Federal Reserve as its actions to influence the availability and cost of both money and credit (Labonte 2016). Their statutory mandate is to work towards "maximum employment, stable prices, and moderate long-term interest rates" based on the Congressional Research Report published in January of 2016. Price stability is addressed through inflation rates. Interest rates are determined by a target federal funds rate. The federal funds rate is the federally mandated rate that banks are allowed to borrow and lend reserves. After the financial crisis set in, the federal funds target decreased from 5.25% to a range from 0% to 0.25% in December of 2008. This rate was not adjusted until December 2015 when the Federal Reserve began rising interest rates slowly, aiming to maintain a stimulating monetary policy (Labonte 2016).

Regulations within the financial industry affect the agricultural industry as well. The blame for the financial crisis of 2008 is largely attributed to banks accumulating significant amounts of sub-prime credit in their portfolios. Since then, one of the biggest changes in regulations that US banks have faced is the increase in the quality and amount of Tier 1 capital (Foster). The Basel Accords, which were in the process of being implemented when the crisis occurred, adjusted; Basel III requires banks with deficient capital to cut dividends substantially, sell assets, and issue new common equity to shareholders. These regulation changes have led to the liquidation of major banks such as Lehman Brothers, Wachovia and Washington Mutual. But

it also allowed the industry to successfully be recapitalized. The crisis taught regulators two main things: more attention needs to be paid to Tier 1 capital that permits financial institutions to survive a crisis and large banks need more capital than their smaller counterparts as they operate with large securities portfolios and have crucial involvement in market making activities (Foster).

With the financial crisis in 2008 came the bursting of the housing market bubble. The results of both the financial crisis and the housing market burst had effects across the country. In North Dakota, however, many aspects of the state's economy seemed immune to these oftentimes global repercussions. North Dakota saw increased home values, the lowest unemployment rate in the US, increased real state GDP, revenue surplus, and most notably, in July of 2011 North Dakota set a record for the most oil ever produced in a single month (Perry 2011).

However, as more time has passed since the crisis, North Dakota has found itself responding to national and global trends alike. Prices for commodities produced have fallen to moderate levels just as they are elsewhere in the country. This has led to decreased net farm income; based on data reported by the USDA Economic Research Service, net farm income dropped from $3,512 million in 2012 to just $295 million in 2014.

In the last five years, North Dakota farms have been affected by global conditions, as represented in Figure 1. The upward trend from 2010 to 2012 covered most levels of production, cash income, intermediate expenses, and labor expenses. When crop cash receipts fell from 2012 to 2013 and from 2013 to 2014, expenses continued to rise causing net farm income to decrease significantly. These economic conditions forced producers in the agriculture industry to rely more heavily on their financers, placing pressure on their local banks to expand credit lines.

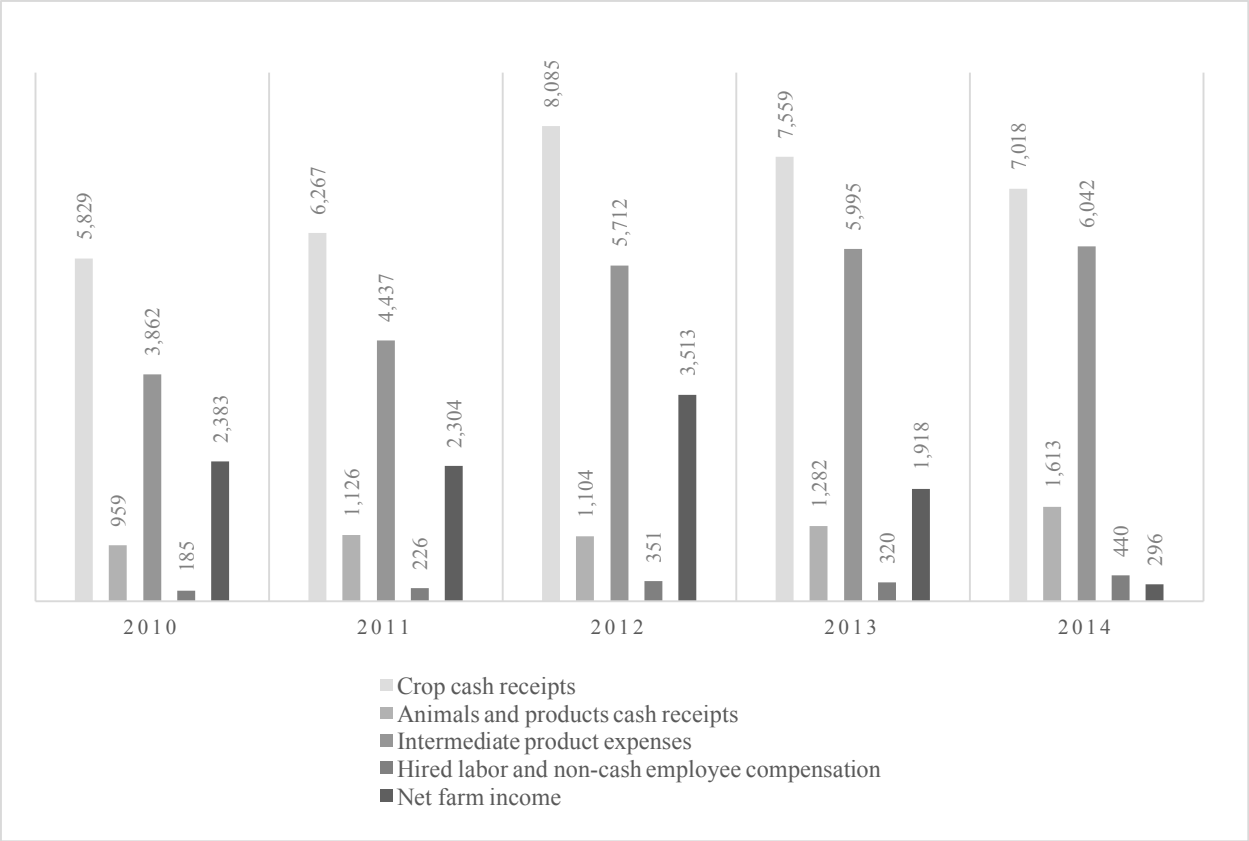

Fig. 1. Value Added to the US Economy by the Agriculture Sector in North Dakota.
Data Source: USDA Economic Research Service

Banks of all sizes are essential for agriculture operations; the banking industry is the nation's most important supplier of credit to agriculture. With increased demands for credit, banks have had constant growth in their loan portfolios. Rural banks allow focus to be placed on nonquantitative, or soft, information about their customers (Greeley 2013). While the main considerations of capital eligibility are accounted for, banks in rural areas, specifically North Dakota, have to extend credit to their customers which are more often farmers or ranchers. This leads to loan portfolios with considerable percentages diversified into the agriculture industry.

The agriculture industry is susceptible to many intrinsic and extrinsic factors. Rural banks that rely on agricultural accounts may be more prone to changes in the agriculture economy. Banks are structurally different than most types of businesses. In general, agricultural companies

use credit and equity to finance operations that produce a product that is sold for profit. A bank's source of income is the returns they make on lending money out to its customers. With these activities comes a certain level of risk. When loaning money to a customer there is the risk that they will pay late, pay less than what they owe, or not pay at all and default on the loan. Credit risk is a major risk banks face in day to day operations. With rural banks extending credit, and thus creating credit risk for themselves, to businesses that are operating in volatile conditions, does this create the potential for more risk to the bank's profit than originally thought?

As the economy in North Dakota shifts to adjust due to current conditions, how will the banks within the state be affected? It's important to understand this portion of our economy as world conditions continue to change as well as circumstances at home. Previous years saw the state of North Dakota in a flurry of activity as the oil boom occurred and brought with it numerous jobs and significant income to the state and its residents. As the oil production wanes and slumps into a bust, North Dakota is facing a shrinking economy, falling employment, and deep spending cuts as the economy shrinks rapidly. By examining data that covers previous shocks in both the agriculture industry and the financial industry, we can use the historical responses and reactions to predict future activity.

The objective of this paper is to analyze the impact of farm-level risk on bank performance in the state of North Dakota. Farm-level risk has been quantified into a single measure of the volatility of net farm income. Bank performance can be examined through several different measures. Given the financial structure of banks, in that high percentage of income is earned off of loans and leases which are categorized as assets, one ratio analyzed is the return on assets. Other variables included in the analysis include size dummies based on the amount of total loans and leases, whether the institution has 12% of their loan portfolio allocated to farm

loans, efficiency ratio, and the net interest margin. This paper will provide significant insights into the relationship between banks and agricultural institutions in the state of North Dakota that can be used to improve performance in the future.

The following chapter of this paper entitled Literature Review will examine research previously conducted on this topic. The Methodology chapter describes the empirical and theoretical aspects of the model used to examine this problem. Details on the data used to quantify this issue are included in the Methodology chapter as well. Finally, the results of the analysis and conclusions to be drawn from the results are included in sections under the same names.

LITERATURE REVIEW

Credit Risk

Credit risk and its associated capital requirements are defined through various models. In their 2005 paper, Ani Katchova and Peter Barry defined credit risk models and developed models specific for agricultural lenders. In the case of agricultural investments, most use the loss-based method to calculate losses due to credit risk because the debt and equity claims of farm businesses are not traded in active secondary markets (Katchova, Barry. 2005). Under their methods, credit risk is defined using the concepts of expected and unexpected loss. Expected loss (EL) is a measure that is found using historical data of past experience and is treated as a cost of lending for the business. Often expected loss is shown on a bank's financial statements as loan loss allowances. Unexpected loss (UL) represent the maximum loss at a desired solvency rate with a probability of occurrence, α (Katchova, Barry. 2005). Credit value at risk or VaR is a measure that has been commonly used in recent years. Barry defines it as the sum of the expected loss, EL, and the unexpected loss, UL:

$$VaR(1-\alpha) = EL + UL(\alpha) \qquad \text{(Eq. 1)}$$

Credit value-at-risk represents the total loss that will be exceeded with the probability α and therefore the needed total capital to backstop credit risk at a desired solvency rate (1-α) (Katchova, Barry. 2005).

Financial institutions and banks in particular are exposed to credit risk. Simply defined in *The Handbook of Credit Risk Management*, credit risk is the possibility of losing money due to the inability, unwillingness or nontimeliness of a counterparty to honor a financial obligation (Bouteille, Coogan-Pushner. 2012). As banks are in business to extend credit, their level of credit risk is highly significant to their business operations. Institutions such as banks and hedge funds

are able to use such activities to create a profit, therefore it can be inferred that not all credit risk is detrimental.

Of those organizations exposed to credit risks, banks have the largest credit portfolios and possess the most sophisticated risk management organizations (Bouteille, Coogan-Pushner. 2012). However, as the financial system has undergone crises in recent years, the environment of lending has changed in response. With higher regulatory capital requirements and low margins, banks have had a decreased desire to take on credit risk. However, most large banks are still exposed to a high level of credit risk which is combatted by distinct risk management divisions whose goal is to analyze and thoroughly examine the riskiness of individual borrowers. In conjunction with those activities, lenders more and more are using asset-backed lending practices.

The asset-backed lending practice is defined as banks lending money or securities against the provision of collateral such as Treasury bonds or equity (Bouteille, Coogan-Pushner. 2012). In this practice, should the borrower fail to repay their obligation the institution can liquidate the asset to pay off part of or the entirety of the obligation. Asset-backed lending isn't without its caveats as it often coincides that a borrower fails to pay because of fluctuations in the market that also devalue the assets being used as collateral on the loan.

A single measure, such as VaR, shouldn't be used to quantify whether a transaction will be good or bad with respect to credit risk. Using four standard parameters to analyze and compare credit risk exposures is a better approach (Bouteille, Coogan-Pushner, 2012). The exposure, default probability, recovery rate and tenor of the transaction should all be considered when deciding its significance. For the purposes of this study default probability will be discussed further in the following section.

Default Probability

The probability of default is the likelihood that a borrower will fail to pay their obligation, or default, at some point in the future. This measure will never be zero. Even the strongest entity that has a very low chance to default can't be written off because one never knows what could happen. As witnessed in the financial crisis of 2007-2008 in the United States, the notion of "too big to fail" no longer holds true.

In 2007 the paper, "A Multi-objective Approach for the Prediction of Loan Defaults," was published as a study that applied a multi-objective evolutionary optimization algorithm in generating decision rules for predicting loan default in a typical credit institution. The issue is presented as credit institutions adapting to growing credit risk scrutiny by performing in house rating and approval procedures on large transactions, typically over $5 million (Odeh, Koduru, Das, Featherstone, Welch 2007). Because of the higher cost of this method, statistical models are often used for scoring smaller volume loans. When managers and credit officials manually evaluate credit applications they do not face a single objective. Assuming bank officials have to attempt to optimize two or more criteria or goals at the same time, conventional optimization problems, which are designed for single objective optimization problems, are incapable of handling these problems (Odeh, Koduru, Das, Featherstone, Welch 2007).

The proposed, multi-objective optimization algorithm approach offers the credit analyst more flexibility in customizing what aspects are included in the estimation process. Understanding that a typical credit institution has the goal to minimize portfolio loss, the paper uses fuzzy inference system for predicting loan default to allow expert knowledge to be incorporated in the credit appraisal process (Odeh, Koduru, Das, Featherstone, Welch 2007). The conclusion of this study presented cooperating results with prior studies using different

methodology. Namely, loan default is inversely related with owners' equity. The study showed clear empirical evidence of strong indicators of default status. They found that if a business maintains low working capital and poor repayment history, then the business has a higher probability of defaulting on the loan (Odeh, Koduru, Das, Featherstone, Welch 2007).

Another fundamental notion of default probability is that it increases with time. As time passes the financial strength of the borrower will tend to deteriorate and companies have a higher chance to default in the long term than the short term (Bouteille, Coogan-Pushner, 2012). Probability of default is not a measure that is readily observable. Therefore, there are different methodologies to quantify the measure. For the sake of this paper the method explained is the most commonly used methodology to assign a default probability to a counter party (Bouteille, Coogan-Pushner, 2012). Typically default probabilities are determined through a two-step process of assigning a rating to the counterparty and then examining the default probability of similarly rated counterparties.

In 2014, a paper with a focus on default risk for agricultural lenders was published to examine two specific risks prevalent in agricultural activities. This paper proposed and estimated a default risk model that accounted for commodity price volatility and climate (Castro, Garcia 2014). Knowing that banks have a standard technique of evaluating risks they're facing by examining their portfolios and the risk associated with them, this paper strove to incorporate a default risk model into it. Through performance of stress tests on the portfolios of rural banks, it resulted in indications that while both climate and commodity price volatility do affect economic capital, climate factors have a larger effect than commodity price volatility (Castro, Garcia 2014).

Credit Scoring

"The State of the Art in Credit Evaluation" by Raj Chhikara was published in the *American Journal of Agricultural Economics* in 1989. Given the volatility of the agriculture environment and the economy in the US during the 1980s, this study sought to examine past credit-scoring models, recent developments and possible future research trends on this topic. "Most of the credit-scoring models…seek to provide predictions of default probabilities based on customer attributes" (Chhikara 1989). Various credit scoring models and approaches were examined in the paper. Many of the models examined had limitations; at the time the paper was written the focus of future research included possible advances in technology. It was stated in the conclusions of the paper that despite the "increasingly sophisticated techniques have been used to develop these models, their usefulness in dealing with the general credit-granting decision problem has been limited by their almost exclusive focus on assessing default risks" (Chhikara 1989).

By 2000, large financial institutions, specifically banks, had come to rely heavily on internal credit risk rating systems (Treacy, Carey 2000). They were viewed as integral methods to measure and manage their exposure to credit risk from both individuals and portfolios. The paper by Treacy and Carey described those internal rating systems that were at use in the 50 largest US banking systems (Treacy, Carey 2000). They sought to illuminate the relationships between the forms and functions of the internal rating systems. Through the course of the research they found that there are a minimum of 11 specific characteristics of the internal rating systems that should be promoted more than they already are (Treacy, Carey 2000). They also found that over time, internal ratings have grown both in practice and importance. They determined that no one internal rating system will always be right in every circumstance.

However, not having some system to evaluate and manage risk within an institution that lends credit would be detrimental to the businesses' success.

As already discussed, a singular measure won't give a clear picture of the state of an individual whether it be an institution or an individual borrower. Similarly, a credit rating is a relative measure of a firm's financial strength. It simply implies that higher grades have less chance of default than a lower grade. But to come up with the credit rating a company's operating environment, strength of management and other drivers of financial strength are analyzed and then assigned a grade. Ratings can come from internal measures or rating agencies. Once ratings are assigned, the historical data for similarly rated institutions is examined for the historical default frequency based on that rating.

An important aspect of credit ratings is the idea of credit score migration. In 2002, Peter Barry, Cesar Escalante and Paul Ellinger published a paper in the *Agricultural Finance Review* on "Credit Risk Migration Analysis of Farm Businesses." At the time migration analysis was deemed a relatively recent method behind analyzing credit risk. "The migration approach to credit risk measurement is based on historic rates of movements of individual loans among the classes of a lender's risk rating or credit-scoring system" (Barry, Escalante, Ellinger 2002). Migration rates are routinely utilized by major rating companies for bonds and other publically traded securities. Applying this concept to agricultural businesses only furthers credit providers' insight into the risk in lending to them. The benefit of using this method is that it provides a "richer, more comprehensive perspective on credit risk and loan losses than relying solely on the measurement of historic default rates" (Barry, Escalante, Ellinger 2002).

The analysis performed in the paper focused on farm data from Illinois farms; they used three financial indicators from annual farm-level data from 1985-1998. They had three

classification criteria: a credit-scoring model for term loans, a profitability variable, and a repayment capacity variable. The main results followed results from similar studies of credit risk migration. "Migration rates and related measures for the three classification criteria and the time sequences…results are consistent in that the frequencies are highest for remaining in the same class, the rates decline for movements to more distant classes and the incidence of downgrading tends to exceed the occurrence of upgrading" (Barry, Escalante, Ellinger 2002). With limitations on data, improved analysis relies on consistent data gathering from agricultural businesses. However, the analysis was able to "demonstrate the applicability of credit migration concepts to the evaluation of farmers' credit risks" (Barry, Escalante, Ellinger 2002).

Continued study of credit score migration was published in 2004 focusing on business cycles and migration trends. Phillips and Katchova tested whether migration probabilities differ across business cycles as well as whether they depend on previous period migration trends (2004). Using similar data that previous studies did, their paper built on the previous agricultural finance studies by applying additional migration analysis to the farm level data (Phillips, Katchova 2004).

Their results of migration analysis were similar to the previous agricultural finance studies, such as the paper by Barry, Escalante and Ellinger. In examining the business cycles, results indicated that "farm businesses exhibit a greater tendency to upgrade when the national economy is in expansion and to downgrade when the economy is in recession" (Phillips, Katchova 2004). Statistical significance of the results suggest that such macroeconomic conditions do affect the financial performance of farm businesses, indicating the importance for agricultural lenders to include such factors in their migration analysis to minimize their credit

risk (Phillips, Katchova 2004). Including credit risk migration analysis is a significant way for lenders to examine the credit risk faced by lending to agricultural businesses.

By 2005, further literature was published in the *Agricultural Finance Review* in an article titled "Credit Risk Migration and Downgrades Experienced by Agricultural Lenders." In contrast to Barry's paper in 2002, they used data from the side of the lender. Their study showed that "lender risk ratings are much more stable than ratings based on credit scores estimated from financial statements," as well as specific borrower characteristics playing a more influential role than the type of agricultural enterprise (Gloy, Ladue, Gunderson 2005).

In their study they acknowledged that "lenders consider both financial and non-financial factors" (Gloy, Ladue, Gunderson 2005). Because of this, it implies that there will be a difference in results when using lender credit risk ratings instead of ratings based on estimated credit scores (Gloy, Ladue, Gunderson 2005). Compared to results from the paper by Barry, Escalante and Ellinger, which utilized farm record data, this analysis had results showing substantially greater tendencies for borrowers to remain in their current credit risk class (Gloy, Ladue, Gunderson 2005). The general results indicate that lender risk ratings are more stable than ratings based on credit scores estimated from financial statements and highlight the importance of the role that non-financial factors play in assessing credit risk (Gloy, Ladue, Gunderson 2005).

This paper will also utilize the analysis performed that determined the probability of default and the risk-rating class for loans in an agricultural setting (Featherstone, Roessler, Barry 2006). Probability of default is an element in the equation that defines expected loss. The conceptual framework breaks the expected loss down into probability of default, loss given default and exposure at default. In this way the equation includes the aspects necessary to

examine credit risk and the capital adequacy of the institution: how much risk is present, the institution's risk tolerance level, and the amount of capital that should be retained to offset the risk (Featherstone, Roessler, Barry, 2006). In examining the individual loans, Barry used recommended criteria from the Basel Accord as well as adding other performance measures to accommodate the agricultural nature of the analysis. Their recommendations include measures of a firm's repayment capacity, solvency, earnings, operating leverage, financial efficiency, liquidity, management, industry standing and collateral positions.

After the financial crisis of 2008, banks began closer examination of the risk they exposed themselves to. A paper published in the *Canadian Journal of Agricultural Economics* in 2009, "Assessing Credit Risk in an Agricultural Loan Portfolio," focused on the importance of credit risk models to banks in both Canada and the United States. In order to appeal to rural agricultural lenders, they created a study that "focuses on agriculture and identifies the key features of such a model" (Pederson, Zech 2009).

The main objective for the study was to find a suitable credit risk model to use in agricultural situations. Examining models that include agricultural aspects require including certain characteristics of the data such as cyclical performance, significant degrees of inter-correlation among default rates, historical default correlations, and economic cycle adjustments (Pederson, Zech 2009). They found that the direct approach, developed in their paper, to the lender's credit risk modeling problem provided the flexibility needed to address those characteristics. The study showed that "agricultural lenders…can usefully employ their loan portfolio data to fulfill the regulatory requirements of internal capital assessment and test the Basel capital model assumptions of a single asymptotic risk factor and infinite portfolio diversification" (Pederson, Zech 2009). The implications of this study extend to not only internal

credit management for banks but also presented a strategy for credit lenders that, in the future, could "result in lower interest rates and increased safety and soundness of agricultural financial institutions in the United States and Canada" (Pederson, Zech 2009).

Performance

Profitability is similar to credit risk in that it's more than a single measure to be analyzed. Rather, profitability is another measure of the strength of a company that requires examining more than one indicator or ratio. Some of the most common measures of profitability include the firm's return on equity, return on assets and examining the profit margin ratio.

In 2012, the *Agricultural Finance Review* published a paper titled "Drivers of agricultural profitability in the USA: An application of the DuPont expansion method," which addresses all of these ratios. By using the DuPont expansion method, they examined the three ratios that make up return on equity: net profit margins, asset turnover, and assets to equity (Mishra, Harris, Erickson, Hallahan, Detre 2012). The goal of their study was to utilize the DuPont expansion method to "investigate the impact of demographics, specialization, tenure, vertical integration, farm type, and regional location on the three levers of performance" within the return on equity ratio (Mishra, Harris, Erickson, Hallahan, Detre 2012).

Using farm-level data they used a "system of equations…to analyze the various factors that drive the components of ROE" (Mishra, Harris, Erickson, Hallahan, Detre 2012). This study went further than previous literature by using factors such as farm type, region and size. Their results showed that the main drivers of profit margins, asset-turnover, and asset-to-equity had some similar results, and are shown in Table 1.

Table 1

Key Drivers of ROE Components

	Profit Margins	Asset-Turnover Ratio	Asset-to-Equity Ratio
Contracting			X
Farm Size			X
Farm Typology	X		
Government Payments received	X	X	
Off Farm Income		X	
Operator Age		X	
Operator Education	X		
Specialization	X	X	X
Vertical Coordination		X	

Source: Mishra, Harris, Erickson, Hallahan, Detre 2012.

The *Academy of Banking Studies Journal* published a paper, "The Determinates of a Community Bank's Profitability," in 2013. Their purpose was to offer a possible methodology that could be repeated by commercial banks to find which of their products offered affected their net profit the most. The authors had results "to inform bank management of internal relationships between products, as well as to help explain which products most heavily contribute to bank profitability (Lamb, Harper, Minnis, Chuo 2013). The paper examined data from 2000 to 2012 which includes the financial crisis and is reflected in data presented on bank failures during this time. They drew from the "disturbing trend regarding commercial bank failures" the importance of banks understanding their profitability and how it can be managed (Lamb, Harper, Minnis, Chuo 2013).

The study "presents a process for identifying the determinants of profitability of a specific community bank using sound statistical procedures" (Lamb, Harper, Minnis, Chuo 2013). They created a sound model that is repeatable by any commercial bank wishing to identify the products offered that will affect profitability. They found both the independent variables that are most significant to net income as well as the limitations of their examination of the "information contained within the matrix and the interaction of each of the variables with the others" (Lamb, Harper, Minnis, Chuo 2013). "The explanatory power exhibited by the models indicates the value of the information resulting from the regressions" (Lamb, Harper, Minnis, Chuo 2013).

Farm Economy in North Dakota

The paper published by North Dakota State University in 2002, "The Role of Agriculture in the North Dakota Economy," illustrates the importance of agriculture in the state of North Dakota and thus this analysis. Using both statewide and regional data, the report assessed the "role of agriculture in the North Dakota economy" (Leistritz, Coon, Lambert 2002). Their analysis revealed that over time, agriculture's role in North Dakota's economy has decreased in a relative sense. However, they show that it is still the "cornerstone of the state economy and remains the largest goods and services exporting sector" (Leistritz, Coon, Lambert 2002). They highlighted three main points of the importance of agriculture: it accounts for 25% of the basic economic activity and 36% of all exported goods and services, it directly employs almost 11% of the state's workers, and the state "ranks second in the nation in the percentage of gross state product derived from agriculture" (Leistritz, Coon, Lambert 2002).

METHODOLOGY

Data

Data for this analysis was gathered for the eighty banks that are based in North Dakota and from the North Dakota Farm Business Management Association for North Dakota farm financial information. The data spans 15 years, from 2000-2014 which covers a span of time both before and after the financial crisis. Table 2 details summary statistics of data utilized in the regression. Table A1 describes sources and calculations, when appropriate, of individual variables.

Table 2

Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
B_ID	39	22.24056	1	77
Year	2009.5	2.874148	2005	2014
LquidityRisk	-0.0563056	0.1515915	-0.5047092	0.7207313
ROE	0.1039379	0.0617888	-0.22182	0.26416
ROA	0.010239	0.005828	-0.01998	0.02474
Size	11.51822	1.084987	9.498672	15.00062
AgBank	0.5909091	0.4919857	0.000000	1.00000
F_VOL	5.351105	1.460725	3.185315	7.45471
F_VOL_1	5.591749	1.338361	3.769768	7.45471
GDP	0.0346	0.02128	-0.0092	0.0652
Crisis	0.10000	0.300195	0.00000	1.00000
EFF	0.6627404	0.1314025	0.258	1.2405
NIM	0.040089	0.0062161	0.0017	0.061
EC_A	0.0964688	0.0201039	0.0559	0.1928
NCO_LL	0.0030614	0.006808	-0.0247	0.0746
F_LN	0.2973247	0.1673655	0.00000	0.6806467
C_LN	0.1581629	0.0892062	0.0022848	0.6500131
I_LN	0.0775707	0.0627622	0.0067817	0.4573408
O_LN	0.0363074	0.0567153	0.00000	0.340554
F_LN_G	0.1265661	0.9743558	-1.00000	18.2069
T_LN_G	0.1403802	1.476387	-1.00000	33.14991

The reports of financial data from the Federal Deposit Insurance Corporation's website are all standardized and organized in the same manner, reports were therefore compiled for each of the banks based in North Dakota for the years 2000-2014. The financial statements that are provided by the FDIC contain useful information about both performance, financial structure, and demographics for each institution. This data was narrowed to the period of 2005-2014 to utilize five year moving averages for the performance variables, Return on Assets and Return on Equity.

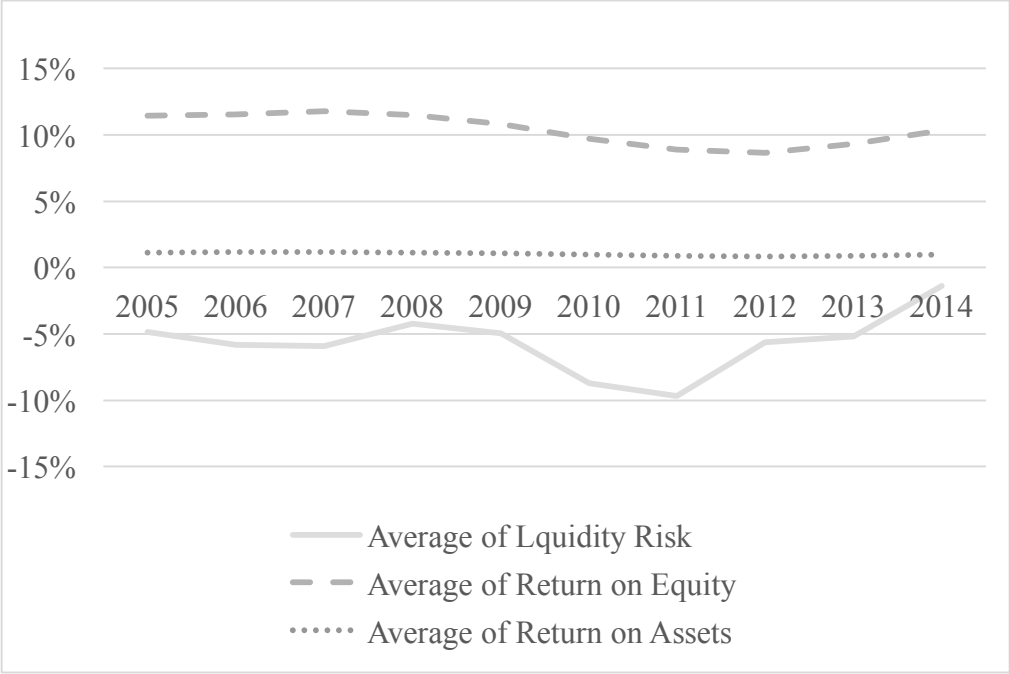

Fig. 2. Bank Performance Trends. Data Source Table A3.

Figure 2 above shows the trends of annual averages across the state of North Dakota. Return on Assets remained stable across the span of ten years observed. Return on Equity in contrast fell after the financial crisis of 2008 and continued to fall until 2011 where it started to increase again. Liquidity risk was even more volatile in the years following the crisis. It fell to -9.67% on average for 2011 before increasing to -5.64% the following year. By 2014 the average liquidity risk ratio increased to -1.39%.

In addition to data regarding performance, data on the financial structure of the banks was also included and analyzed. Two of these measures, Net Interest Margin and Equity Capital to Assets ratio, remained overall fairly stable, with slight decreases over time.

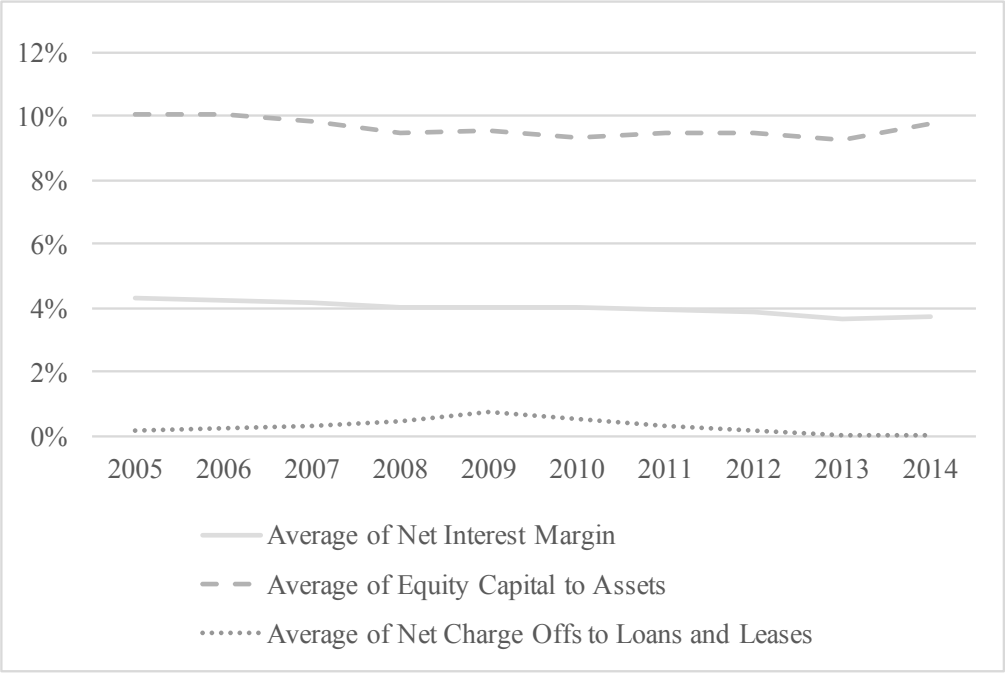

Fig. 3. Bank Financial Structure. Data Source Table A3.

As seen in Figure 3, in 2009, one reporting year after the financial crisis of 2008, saw a slight peak in the ratio of Net Charge Offs to Loans and Leases. From 2007 to 2008, average net charge offs nearly doubled. When the average net charge offs doubled again from 2008 to 2009 it increased that ratio given loans and leases increased at a much lower rate. This created the slight peak in the ratio's trend line in Figure 3.

Figure 4 illustrates trends in the annual average configuration of North Dakota banks' loan portfolios. The main types of loans offered by banks and included here are separated into Farm, Commercial, Individual and Other loans.

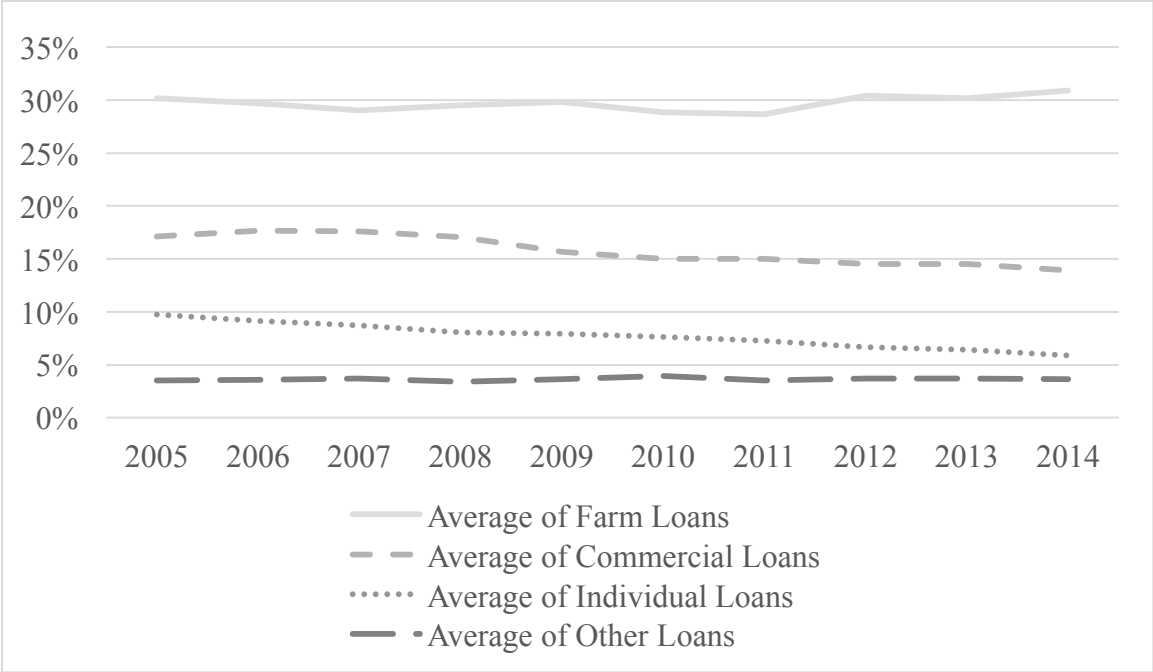

Fig. 4. Bank Loan Portfolio Trends. Data Source Table A3.

Over the time period examined there was relative stability in the portfolio weights. Farm loans stayed, on average, around 30% of the bank's portfolio, decreasing slightly from 2009 to 2011. Commercial loans decreased after the 2008 financial crisis. Individual loans overall had a downward trend, flattening slightly from 2008 to 2009. Other loans increased minimally from 2008 to 2009 before continuing along a constant trend.

We used data from the North Dakota Farm Business Management Association spanning this period of ten years from 2005-2014. The North Dakota Farm Business Management Association is an education program that has gathered actual farm records from over 500 farms enrolled in the program across the state. The information we utilized were the farms that had data observations at least 17 different times. The data set includes aspects from farm financial statements, primarily the balance sheet and the income statement. It also includes demographic information about the farms such as the farmers' ages and years operating the farm. The variable created and used from the farm-level data set was our measure of farm income volatility.

Data gathered from the North Dakota Farm Business Management Association, specifically, net farm income from operations, was used to calculate an annual percent change for each reporting farm. This annual percent change was calculated using the following:

$$\%NFI = (NFI_t - NFI_{t-1})/NFI_{t-1} \quad \text{(Eq. 2)}$$

where %NFI is the percent change in net farm income from operations, NFI_t is net farm income from operations in time *t*, and NFI_{t-1} is net farm income from operations in time *t-1*. This percent change was then used to find 5-year rolling averages for each farm. Using the 5-year average of annual percent change in net farm income for each farm, a yearly average for the state was calculated to represent annual farm income volatility.

To include macroeconomic variables in the analysis, data on both Gross Domestic Product (GDP) and a dummy variable representing the financial crisis were run in the regression. GDP was found on the website run by the United States Bureau of Economic Analysis, which is a part of the United States Department of Commerce. Using the data provided of US GDP in current dollars, an annual percentage change was calculated.

$$\%GDP = (\$GDP_t - \$GDP_{t-1})/\$GDP_{t-1} \quad \text{(Eq. 3)}$$

where %GDP is the percent annual change in US GDP, $\$GDP_t$ is the real current dollar level of US GDP in time *t*, and $\$GDP_{t-1}$ is the real current dollar level of US GDP in time *t-1*.

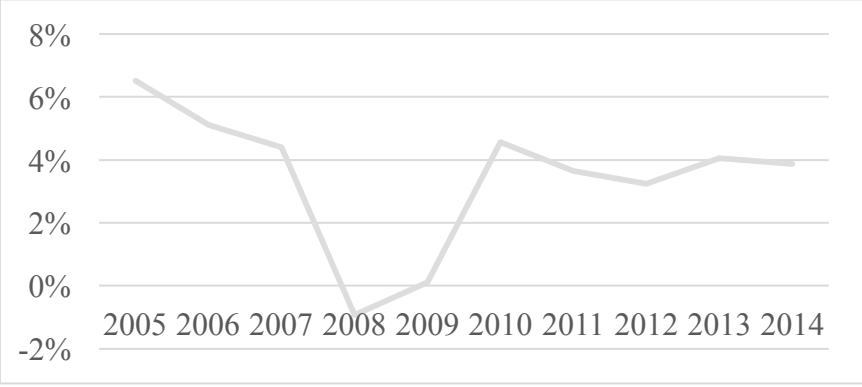

Fig. 5. Trend of Percent Change in US GDP. Data Source Table A3.

This representation of the United States' economic activity on a national level was included in the regression as an independent variable. The trend in US GDP is illustrated in Figure 5. Given the time period examined, it's understandable that there would be volatility in this measure of economic activity. The drop in the trend line coincides with the financial crisis and it's lasting effects on the United States' economy.

Because of its potential effects on the variables examined in the regression, a dummy variable was added with a value of "1" for the year 2008 and a value of "0" for all other years.

Empirical Model

Return on Equity

Return on Equity is a common measure used to examine a business' performance. The ratio in its simplest form is:

$$ROE = \frac{NI}{E} \quad \text{(Eq. 4)}$$

where ROE is the Return on Equity, NI is Net Income and E is the Stockholder's Equity. The ratio shows how much the company was able to profit in relation to how much of the company is owned by the company or its stockholders. ROE is considered a profitability ratio given it examines how the company is able to profit from the investment made by the company into itself and made by the stockholders.

In addition to its simplest form, ROE has an expanded form, most often called the DuPont Model. This expansion allows for further examination of the possible factors of ROE. The DuPont Expansion Model is

$$ROE = \frac{Net\ Income}{Sales} \times \frac{Sales}{Total\ Assets} \times \frac{Total\ Assets}{Equity} \quad \text{(Eq. 5)}$$

Each portion of the expansion model is a different type of examination of a company's performance. The first portion of the expansion, Net Income/Sales, is the equation for profit

margin and examines the company's profitability. The second portion, Sales/Total Assets, is the equation for asset turnover and is a measure of a company's asset management. Finally, Total Assets/Equity is known as the equity multiplier and is a measure of how a company utilizes their liabilities to finance their assets. The higher the ratio, the more a company is earning on their equity, proving to be efficient managers of the equity in the company. This ratio is comparable across companies within the same industries and overall market comparisons, and thus is widely used to analyze profitability. Some of the variables included in the regression relate back to this expansion method. Measures of size, returns and financial leverage are included as *Size, NIM*, and *EC_A*.

Return on Assets

Similar to Return on Equity, Return on Assets is a measure of profitability. The ratio is more simple, however, defined as

$$ROA = \frac{Net\ Income}{Total\ Assets} \quad \text{(Eq. 6)}$$

This ratio shows how a company profits from managing their assets to generate earnings. The higher the ratio percentage is, the more a company is earning on less investment. Where ROE is comparable between different companies across different markets at times, ROA is more limited in how it should be used for comparison. ROA is a ratio accepted to be suitable for comparison between previous ROA measures recorded within the same company and ROA measures of a similar company.

Liquidity Risk

While ROE and ROA both measure a company's performance, measuring liquidity is a way to evaluate a company's financial health. Liquidity ratios show a company's capacity to pay off short term debts. "Liquidity is generally defined as the ability of a financial firm to meet its

debt obligations without incurring unacceptably large losses" (Lopez 2008). Liquidity risk for a deposit institution, such as a bank, occurs when there is an inability to pay those debt obligations. Specifically, deposit institutions face liquidity risk from "ongoing conduct of business…and the subsequent need to meet those demands through liquidating assets or borrowing funds" (Saunders, Cornett 2011). "Financial firms are especially sensitive to funding liquidity risk since debt maturity transformation…is one of their key business areas" (Lopez 2008). For financial firms, it is important to manage and examine this risk, at times on a daily basis.

There are different ways to measure a deposit institution's liquidity exposure; for this paper the method used is analyzing the financing gap. As defined by Saunders and Cornett, a financing gap is the difference between the average loans and average deposits of the institution (2011). By managing this risk, institutions are able to "identify potential future funding problems" (Lopez 2008). Especially after the financial crisis of 2008, managing liquidity risk is important for all types of financial institutions; thus its inclusion in this analysis. For the sake of this paper, liquidity risk is defined as the financing gap ratio:

$$Liquity\ Risk = \frac{NLL - IB\_D}{NLL} \quad \text{(Eq. 7)}$$

with NLL representing net loans and leases and IB_D representing interest-bearing Deposits.

Panel Data Analysis

Panel data is appropriate for this analysis because it allows inclusion of data that represents the "behavior of entities observed across time" (Torres-Reyna 2007). Thus, it allows for data across multiple years and multiple entities in a single dataset that can be analyzed. Panel data also allows for data outside the entities being analyzed, even to the point that the analysis can "control variables you cannot observe or measure like cultural factors or difference in

business practices across companies; or variables that change over time but not across entities" (Torres-Reyna 2007).

The data set is first declared to be panel data so STATA recognizes it when running regressions. "Bank_ID" represents the entities and "Year" represents the annual time variable (*t*). As not all banks had data for all years, the dataset was declared unbalanced.

Torres-Reyna explains when Random effects is an appropriate method to apply to panel data:

> The rationale behind random effects model is that, unlike the fixed effects model, the variation across entities is assumed to be random and uncorrelated with the predictor or independent variables included in the model...If you have reason to believe that differences across entities have some influence on your dependent variable then you should use random effects. An advantage of random effects is that you can include time invariant variables. In the fixed effects model these variables are absorbed by the intercept.

The standard random effects model is:

$$Y_{it} = \beta X_{it} + \alpha + u_i + v_t + w_{it} \qquad \text{(Eq. 8)}$$

where Y_{it} is the dependent variable where *i* = entity and *t* = time. X_{it} represents independent variables with β as the coefficient for the independent variables. The intercept is represented by α, u_i is the entity error term and v_t is the time error term and w_{it} is the remaining random error term. Using this regression model, the assumption is made "that the bank's error term is not correlated with the predictors, allowing for time-invariant variables to play a role as explanatory variables" (Torres-Reyna 2007).

Return on Equity Model

This model provides an economic analysis of the factors on return on equity of North Dakota banks. Within the analysis, factors that are both internal and external to bank operations are included. In order to examine the relationships between return on equity and the bank-specific, agricultural and macroeconomic variables, the panel fixed effect regression model was developed to be defined as:

$$ROE_{it} = c_i + \sum_{b=1}^{B} \lambda_b \Pi_{it}^{b} + \sum_{s=1}^{S} \delta_s \Pi_t^{s} + \sum_{m=1}^{M} \gamma_m \Pi_t^{m} + \varepsilon_{it} \quad \text{(Eq. 9)}$$

where ROE_{it} is return on equity of *i*th bank at time *t*, with *i*=1,…,N, *t*=1,…,T. $\Pi_{it}^{b}, \Pi_{jt}^{s}, \Pi_{jt}^{m}$ are bank-specific, agricultural and macroeconomic variables *b*=1,…,B, *s*=1,…,S, *m*=1,…,M, respectively. *c* is a constant term; ε_{it} is the error term.

Extending Equation 9 to reflect the variables, as summarized in Table 2, the model is formulated as follows:

$$\begin{aligned} ROE_{it} = {} & c_i + \lambda_1 Size_{it} + \lambda_2 AgBank_{it} + \lambda_3 EFF_{it} + \lambda_4 NIM_{it} \\ & + \lambda_5 EC\_A_{it} + \lambda_6 NCO\_LL_{it} + \lambda_7 F\_LN_{it} + \lambda_8 C\_LN_{it} \\ & + \lambda_9 I\_LN_{it} + \lambda_{10} O\_LN_{it} + \lambda_{11} F\_LN\_G_{it} + \lambda_{12} T\_LN\_G_{it} \\ & + \delta_1 F\_VOL_t + \delta_2 F\_VOL\_1_t \\ & + \gamma_1 GDP_t + \gamma_2 Crisis_t \end{aligned} \quad \text{(Eq. 10)}$$

Bank-specific variables include natural log of total assets (Size), farm loan portfolio greater than or equal to 25% indicator variable (AgBank), efficiency ratio (EFF), net interest margin (NIM), equity capital to assets ratio (EC_A), net charge offs to loans and leases ratio (NCO_LL), farm loan portfolio percentage (F_LN), commercial loan portfolio percentage (C_LN), individual loan portfolio percentage (I_LN), other loans portfolio percentage (O_LN), annual farm loan growth (F_LN_G), and annual total loan growth (T_LN_G).

The agricultural variables included were farm income volatility (F_VOL), and a one year lagged version of farm income volatility (F_VOL_1). These variables captured information regarding fluctuations in the agricultural economy.

Macroeconomic variables include annual change in gross domestic product (GDP) and an indicator variable for the year 2008 representing the financial crisis of 2008 (Crisis).

Equation 10 is first estimated through fixed effects regression taking each bank's return on equity ratio as the dependent variable. It was tested with the Breusch-Pagan Lagrange multiplier for random effects and the null hypothesis that variances across entities is zero was rejected, indicating random effects is a suitable model. Thus, we used random effects rather than fixed effects model.

Return on Assets Model

This model provides an economic analysis of the factors on return on assets of North Dakota banks. Within the analysis, factors that are both internal and external to bank operations are included. In order to examine the relationships between return on assets and the bank-specific, agricultural and macroeconomic variables, the panel fixed effect regression model was developed to be defined as:

$$ROA_{it} = c_i + \sum_{b=1}^{B} \lambda_b \Pi_{it}^{b} + \sum_{s=1}^{S} \delta_s \Pi_{t}^{s} + \sum_{m=1}^{M} \gamma_m \Pi_{t}^{m} + \varepsilon_{it} \qquad \text{(Eq. 11)}$$

where ROA_{it} is return on assets of *i*th bank at time *t*, with *i*=1,…,N, *t*=1,…,T. $\Pi_{it}^{b}, \Pi_{jt}^{s}, \Pi_{jt}^{m}$ are bank-specific, agricultural and macroeconomic variables *b*=1,…,B, *s*=1,…,S, *m*=1,…,M, respectively. c is a constant term; ε_{it} is the error term.

Extending Equation 11 to reflect the variables, as summarized in Table 2, the model is formulated as follows:

$$\begin{aligned} ROA_{it} = {} & c_i + \lambda_1 Size_{it} + \lambda_2 AgBank_{it} + \lambda_3 EFF_{it} + \lambda_4 NIM_{it} \\ & + \lambda_5 EC\_A_{it} + \lambda_6 NCO\_LL_{it} + \lambda_7 F\_LN_{it} + \lambda_8 C\_LN_{it} \\ & + \lambda_9 I\_LN_{it} + \lambda_{10} O\_LN_{it} + \lambda_{11} F\_LN\_G_{it} + \lambda_{12} T\_LN\_G_{it} \\ & + \delta_1 F\_VOL_t + \delta_2 F\_VOL\_1_t \\ & + \gamma_1 GDP_t + \gamma_2 Crisis_t \end{aligned} \qquad \text{(Eq. 12)}$$

Bank-specific variables include natural log of total assets (Size), farm loan portfolio greater than or equal to 25% indicator variable (AgBank), efficiency ratio (EFF), net interest margin (NIM), equity capital to assets ratio (EC_A), net charge offs to loans and leases ratio (NCO_LL), farm loan portfolio percentage (F_LN), commercial loan portfolio percentage (C_LN), individual loan portfolio percentage (I_LN), other loans portfolio percentage (O_LN), annual farm loan growth (F_LN_G), and annual total loan growth (T_LN_G).

The agricultural variables included were farm income volatility (F_VOL), and a one year lagged version of farm income volatility (F_VOL_1). These variables captured information regarding fluctuations in the agricultural economy.

Macroeconomic variables include annual change in gross domestic product (GDP) and an indicator variable for the year 2008 representing the financial crisis of 2008 (Crisis).

Equation 12 is estimated first through fixed effects regression taking each bank's Return on Assets ratio as the dependent variable. It was tested with the Breusch-Pagan Lagrange multiplier for random effects and the null hypothesis that variances across entities is zero was

rejected, indicating random effects is a suitable model. Thus, we used random effects rather than fixed effects model.

Liquidity Risk Model

This model provides an economic analysis of the factors on liquidity risk of North Dakota banks. Within the analysis, factors that are both internal and external to bank operations are included. In order to examine the relationships between liquidity risk and the bank-specific, agricultural and macroeconomic variables, the panel fixed effect regression model was developed to be defined as:

$$L_{it} = c_i + \sum_{b=1}^{B} \lambda_b \Pi_{it}^{b} + \sum_{s=1}^{S} \delta_s \Pi_t^{s} + \sum_{m=1}^{M} \gamma_m \Pi_t^{m} + \varepsilon_{it} \quad \text{(Eq. 13)}$$

where L_{it} is liquidity risk of *i*th bank at time *t*, with *i*=1,…,N, *t*=1,…,T. In this study, it is the financing gap ratio. $\Pi_{it}^{b}, \Pi_{jt}^{s}, \Pi_{jt}^{m}$ are bank-specific, agricultural and macroeconomic variables *b*=1,…,B, *s*=1,…,S, *m*=1,…,M, respectively. *c* is a constant term; ε_{it} is the error term.

Extending Equation 13 to reflect the variables, as summarized in Table 2, the model is formulated as follows:

$$\begin{aligned} L_{it} = {} & c_i + \lambda_1 ROE_{it} + \lambda_2 ROA_{it} + \lambda_3 Size_{it} + \lambda_4 AgBank_{it} + \lambda_5 EFF_{it} \\ & + \lambda_6 NIM_{it} + \lambda_7 EC\_A_{it} + \lambda_8 NCO\_LL_{it} + \lambda_9 F\_LN_{it} + \lambda_{10} C\_LN_{it} \\ & + \lambda_{11} I\_LN_{it} + \lambda_{12} O\_LN_{it} + \lambda_{13} F\_LN\_G_{it} + \lambda_{14} T\_LN\_G_{it} \\ & + \delta_1 F\_VOL_t + \delta_2 F\_VOL\_1_t \\ & + \gamma_1 GDP_t + \gamma_2 Crisis_t \end{aligned} \quad \text{(Eq. 14)}$$

Bank-specific variables include return on equity (ROE), return on assets (ROA), natural log of total assets (Size), farm loan portfolio greater than or equal to 25% indicator variable (AgBank), efficiency ratio (EFF), net interest margin (NIM), equity capital to assets ratio (EC_A), net charge offs to loans and leases ratio (NCO_LL), farm loan portfolio percentage

(F_LN), commercial loan portfolio percentage (C_LN), individual loan portfolio percentage (I_LN), other loans portfolio percentage (O_LN), annual farm loan growth (F_LN_G), and annual total loan growth (T_LN_G).

The agricultural variables included were farm income volatility (F_VOL), and a one year lagged version of farm income volatility (F_VOL_1). These variables captured information regarding fluctuations in the agricultural economy.

Macroeconomic variables include annual change in gross domestic product (GDP) and an indicator variable for the year 2008 representing the financial crisis of 2008 (Crisis).

Equation 14 is first estimated through fixed effects regression taking each bank's liquidity risk ratio as the dependent variable. It was tested with the Breusch-Pagan Lagrange multiplier for random effects and the null hypothesis that variances across entities is zero was rejected, indicating random effects is a suitable model. Thus, we used random effects rather than fixed effects model.

RESULTS

Analyzing panel data can take many forms. For this study, the data is analyzed through the random effects model to allow for individual effects. Because we have "reason to believe that differences across entities have some influence on [the] dependent variable" it is acceptable to apply random effects regression to this panel data set (Torres-Reyna 2007). Using the program STATA, the data was analyzed to see if random effects was the proper method before taking the results as appropriate and sound.

Table 3

Levin-Lin-Chu Unit-Root Test Results

Variable	Adjusted t* Statistic	p-value	Stationarity
Liquidity Risk	-5.6783	0.0000	*
ROE	-8.2622	0.0000	*
ROA	-11.5184	0.0000	*
Size	-3.6157	0.0001	*
F_VOL	-3.8681	0.0001	*
F_VOL_1	-1.9813	0.0238	*
GDP	-17.7242	0.0000	*
EFF	-10.3304	0.0000	*
NIM	-10.8252	0.0000	*
EC_A	-7.4889	0.0000	*
NCO_LL	-35.5801	0.0000	*
F_LN	-5.5984	0.0000	*
C_LN	-9.4348	0.0000	*
I_LN	-10.0936	0.0000	*
O_LN	-17.8517	0.0000	
F_LN_G	8.0742	1.0000	
D.F_LN_G	-0.5783	0.2815	*
D2.F_LN_G	-5.6502	0.0000	
T_LN_G	12.1934	1.0000	
D.T_LN_G	10.8707	1.0000	
D2.T_LN_G	1.8881	0.9705	
D3.T_LN_G	-17.2905	0.0000	*

The process began with declaring the data as panel data and then testing individual variables for the presence of unit roots. The Levin-Lin-Chu test has a null hypothesis that the series contains a unit root and an alternative hypothesis of the series being stationary. Results from these tests can be found in Table 3 with * denoting stationarity. The variables that required being differenced to achieve stationarity were omitted from the regression due to differing levels of stationarity from the bulk of the data.

With stationarity established, the fixed effects version of the regression was tested for homoskedasticity and autocorrelation. The Modified Wald test has a null hypothesis of homoskedasticity, or constant variance. Results shown in Table 4 show that for all three models the null hypothesis was rejected and thus the data is heteroskedastic.

Table 4

Modified Wald Test Results for Heteroskedasticity

	ROE	ROA	Liquidity Risk
chi2 (77)	3976.6	4496.41	8527.86
Prob>chi2	0.0000	0.0000	0.0000

To test for autocorrelation in the panel data the Wooldridge test was utilized. The Wooldridge test for autocorrelation in panel data has a null hypothesis that there is no first order autocorrelation. Table 5 shows the results of this test on the three models which indicate the presence of first-order autocorrelation.

Table 5

Wooldridge Test Results for Autocorrelation

	ROE	ROA	Liquidity Risk
F(1, 76)	1462.102	1429.865	0.924
Prob > F	0.0000	0.0000	0.3395

To correct for the heteroskedasticity and autocorrelation found in the data, the random effects regression was adjusted to cluster the panel data on the Bank ID variable to produce heteroskedasticity-robust standard error. After this random effects regression was produced with robust standard errors, the Bruesch-Pagan Lagrange multiplier (LM) was utilized to determine whether fixed or random effects regression is appropriate to use. Results from the tests on the three models are shown in Table 6. The null hypothesis in the Bruesch-Pagan LM test is that variances across entities in the panel data is zero. In these models, the null hypothesis is rejected and thus we conclude that random effects is appropriate.

Table 6

Bruesch-Pagan Lagrange Multiplier Test Results

	ROE	ROA	Liquidity Risk
chibar2(01)	576.72	418.14	862.63
Prob > chibar2	0	0	0

The next step is evaluating the regression results directly, identifying statistically significant variables, and interpreting their coefficients. Variable statistical significance, at the 95% confidence level, is based on the p-value statistic returned in the regression. P-values less than 0.10 indicate significance at the 10% level, values less than 0.05 indicates significance at the 5% level and values less than 0.01 indicates significance at the 1% level. This significance is denoted in Table 7 by *, **, and ***, respectively. Size, farm income volatility, and individual loan portfolio percentage were significant across all three models with varying significance. Similarities were seen in the variables significant to return on equity and return on assets with size, farm income volatility, lagged farm income volatility, crisis indicator, efficiency ratio, net charge offs to loans and leases ratio and farm, commercial and individual loan portfolio percentages significant to both regressions.

Table 7

Regression Results

	ROE		ROA		Liquidity Risk	
ROE	-		-		0.2863026	
ROA	-		-		-2.523282	
Size	0.0209906	***	0.0014934	***	0.0378994	***
AgBank	-0.0098073		-0.0009849		0.0361181	**
F_VOL	0.0122225	***	0.0012556	***	-0.00916	*
F_VOL_1	-0.0148013	***	-0.0014186	***	-0.0074832	
GDP	0.0322406		0.0054607		-0.9285094	*
Crisis	-0.0092417	***	-0.0007288	***	-0.0182534	
EFF	-0.204724	***	-0.0199922	***	0.0154417	
NIM	-0.4936163		-0.0651498		5.332871	***
EC_A	-0.3647406	***	0.0095821		0.5358623	
NCO_LL	1.203912	***	0.1134388	***	-0.3443637	
F_LN	0.1664664	***	0.0168103	***	-0.0467685	
C_LN	0.1613894	***	0.0157175	***	0.1554601	
I_LN	0.1700399	***	0.0149854	**	-0.3206503	*
O_LN	0.057013		0.0051927		0.0738626	
_cons	-0.0212642		0.0001753		-0.6584419	

In the model with return on equity as the dependent variable ten of the fourteen variables included were found to be significant at the 1% level. The size variable returned a positive coefficient which confirms the idea that bigger banks have an advantage of economies of scale in that the more assets a bank has the higher the returns they have the potential to earn. As farm income volatility increases so does return on equity as shown by the positive coefficient. This follows the idea that when farms have higher profits, they're able to pay off their debt owed to the bank. Farm income volatility lagged one period was significant with a negative coefficient. If F_VOL in time *t-1* was positive, it implies that farm income increased, thus it could be inferred that the operators used the income to pay off their debts with the bank. If they pay off their debts in time *t-1* it would decrease the bank's assets going in to time *t* and thus decrease returns slightly as the assets are lower than the year before. The crisis indicator variable returned a

negative coefficient indicating the negative market fluctuation that occurred in 2008 because of the financial crisis decreasing returns overall. Efficiency also had a negative coefficient which could indicate that the higher the efficiency ratio, the more money is going to operating expenses instead of staying income for the bank. A lower efficiency ratio is desired, however, only when it indicate a lower percentage of net income going towards operating expenses. Equity capital to assets returned a negative coefficient which indicates an inverse relationship between this ratio and return on equity. For the equity capital to assets ratio to increase either equity capital has to increase or assets has to decrease, or both. If this increase in equity capital to assets ratio stems from an increase in equity capital while income remains the same, it logically follows that the ratio of return on equity would decrease. The positive coefficient for the net charge offs to loans and leases ratio indicates the effect of writing loans off of the balance sheet. Artificially reducing assets on the balance sheet in this way tends to boost return on equity measures because of the elimination of unproductive assets. Farm, commercial and individual loan portfolio percentages were all found to be statistically significant and returned positive coefficients. This is a logical conclusion that with more loans offered, it indicates an increase in earning assets, net income and interest income while equity remains the same which in turn increases the ratio of return to equity.

Given the similar statistical significance among the variables for the return on equity regression, examining the magnitude of the coefficients continues to explain the results. Net charge offs to loans and leases returned the highest coefficient, with a 1.00% change in the ratio there is a corresponding 1.204% change in return on equity. The crisis indicator variable returned the second highest coefficient indicating that in 2008 return on equity decreased by 0.92%. Efficiency and equity capital to assets returned similar coefficients of -0.205% and -0.365%

respectively. Farm, commercial and individual loan portfolio percentages returned similar coefficients as well, 0.166%, 0.161%, 0.170% respectively. Farm volatility returned a coefficient of 0.012% while the lagged farm volatility returned a coefficient of similar magnitude but the opposite sign of -0.015%. The size variable returned a positive coefficient of 0.021%.

In the model with return on assets as the dependent variable nine of the fourteen variables included were found to be significant at the 1% level. The size variable returned a positive coefficient which confirms the idea that bigger banks have an advantage of economies of scale in that the more assets a bank has the higher the returns they have the potential to earn. As farm income volatility increases so does return on assets as shown by the positive coefficient. This follows the idea that when farms have higher profits, they're able to pay off their debt owed to the bank, increasing interest income from current assets. Farm income volatility lagged one period was significant with a negative coefficient. If F_VOL in time *t-1* was positive, it implies that farm income increased, thus it could be inferred that the operators used the income to pay off their debts with the bank. If they pay off their debts in time *t-1* it would decrease the bank's assets going in to time *t* and thus decrease returns slightly as the assets are lower than the year before. The crisis indicator variable returned a negative coefficient indicating the negative market fluctuation that occurred in 2008 because of the financial crisis decreased returns overall. Efficiency also had a negative coefficient which could indicate that the higher the efficiency ratio, the more money is going to operating expenses instead of staying income for the bank. A lower efficiency ratio is desired, however, only when it indicate a lower percentage of net income going towards operating expenses. The positive coefficient for the net charge offs to loans and leases ratio indicates the effect of writing loans off of the balance sheet. Artificially reducing assets on the balance sheet in this way tends to boost return on equity measures because

of the elimination of unproductive assets. Farm, commercial and individual loan portfolio percentages were all found to be statistically significant and returned positive coefficients. This is a logical conclusion that with more loans offered, it indicates an increase in earning assets, net income and interest income while equity remains the same which in turn increases the ratio of return to equity.

Given the similar statistical significance among the variables for the return on assets regression, examining the magnitude of the coefficients continues to explain the results. Net charge offs to loans and leases returned the highest coefficient, with a 1.00% change in the ratio there is a corresponding 0.113% change in return on assets. The crisis indicator variable returned the second highest coefficient indicating that in 2008 return on equity decreased by 0.070%. Efficiency returned a coefficients of -0.020%. Farm, commercial and individual loan portfolio percentages returned similar coefficients as well, 0.016%, 0.015%, 0.015% respectively. Farm volatility returned a coefficient of 0.0013% while the lagged farm volatility returned a coefficient of similar magnitude but the opposite sign of -0.0014%. The size variable returned a positive coefficient of 0.0015%.

In the model with liquidity risk as the dependent variable six of the sixteen variables included were found to be significant. Size and net interest margin were statistically significant at the 1% level. The AgBank indicator variable was statistically significant at the 5% level and the remaining three significant variables, farm income volatility, GDP and individual loans, were significant at the 10% level.

A reminder that liquidity risk is defined as the financing gap in this analysis which was calculated as:

$$Liquity\ Risk = \frac{NLL - IB\_D}{NLL} \quad \text{(Eq. 7)}$$

with NLL representing net loans and leases and IB_D representing interest-bearing deposits. The positive coefficient of 0.038% that was returned on the size variable can be explained through the logic that when assets increase (loans and leases) it will increase the liquidity ratio. The same holds true for the AgBank variable returning a positive coefficient of 3.60%. As an indicator variable of the bank maintaining 25% or more in their loan portfolio as farm loans, it follows that as this increases so will liquidity risk ratio. The negative coefficient returned for farm income volatility, -0.0092%, shows the inverse relationship between farm income percent change and the financing gap. When farm income volatility decreases, liquidity risk increases because as farms incur less income, they rely on their existing cash balances. This would indicate their debt remains the same while their interest bearing deposit balance decreases which in turn decreases the liquidity risk ratio. The variable representing percent change in US GDP returned a coefficient of -0.9285. This is interpreted that as GDP percent change falls it increases liquidity risk because the change will be negative and combined with a negative coefficient value logically this will return a positive value. Net interest margin is the difference between interest income and interest expense. In the business of a bank this is translated to income from interest on loans minus expense from interest on deposit accounts. The regression returned a positive 5.333% coefficient for net interest margin. This is logically validated by the concept of a high net interest margin indicating that more income is being generated from loans than expense being generated on deposit accounts. A high net interest margin indicates more loans and returns on loans which increases the liquidity risk ratio. At first glance, correlation between net interest

margin and liquidity risk was expected to be high but as shown in Table A2 they are not excessively correlated. Finally, the variable representing individual loan portfolio percentage returned a negative coefficient of -0.3207. As individuals tend to be predictable in their repayment capacity and credit history as well as borrowing smaller amounts, it follows, that more individual loans would decrease liquidity risk for a financial institution.

CONCLUSIONS

Economic conditions are growing more codependent between nations across the globe. With each industry becoming more dependent on one another, seeing change in one industry is starting to show effects in other industries. In rural areas, agriculture and finance industries are exhibiting such behaviors. Agriculture businesses require financing to operate and financial institutions require a demand for credit.

Both agriculture and financial businesses operate with inherent risk. The financial crisis of 2008 reminded financial institutions the importance of managing their risk. The recent downturn in commodity prices reiterated the same to agricultural businesses. With increased restrictions on and examinations of credit requests, financial institutions have an impact on agriculture financing opportunities. With world commodity competition and price behavior, US farmers have sought to lean more heavily on financing opportunities to remain in business. This vital relationship between agricultural businesses and financial institutions required further evaluation.

Financial institutions, at their core, are an intermediary. They take in deposits and then lend those funds out to earn profits on interest income. Their assets are their loans which are the main source of income for the institution. Understanding the business being financed with bank credit is important for the bank to evaluate the risk associated with that particular loan.

To measure the health of any business implies examining different aspects of performance. Profitability is a highly utilized measure of performance; knowing how much a company is able to profit from their operations.

Risk faced by operations is also vital to understanding how a business is operating. In the case of financial institutions, liquidity risk and credit risk are two of the main ten risks faced by

their operations. Credit risk is a measure of the risk exposure due to lending credit. Knowing information on the individual or business the credit is being extended to gives information on the level of risk associated with that particular asset. Liquidity risk is a measure of risk exposure more related to the financial structure of the institution. Having liquidity is to have available funds to pay off debt obligations without a huge loss of income. Having a gap between average loans and average deposits is known as the financing gap and is a common measure of liquidity risk.

We examined bank performance in North Dakota through three performance measures: return on equity, return on assets, liquidity risk. For each measure a model was created to examine the relationship between performance with bank structure, agricultural and macroeconomic factors.

Bank structure variables included size in assets, indicator of farm loans greater than or equal to 25% of the total loan portfolio, efficiency, net interest margin, equity capital to assets ratio, net charge offs to loans and leases ratio, and loan portfolio percentages for farm, commercial, individual and other loans. Measure of farm loan and total loan growth were included in the initial model but omitted after found to be nonstationary variables.

Agricultural factors were represented by farm income volatility and a lagged farm income volatility variable.

Macroeconomic factors were represented by annual percentage growth in US gross domestic product. An indicator variable for the year 2008 was also included to represent the financial crisis of that year.

In order to understand the relationships in the model, across both time and bank entity, a random effects regression model was used to examine the panel data. As random effects

regression model has the fundamental rationale that "variation across entities is assumed to be random and uncorrelated with the predictor or independent variables included in the model" it was deemed appropriate to use (Torres-Reyna 2007). Once the model was built, heteroskedasticity and autocorrelation was accounted for through clustered data and heteroskedastic robust standard errors, the Breusch-Pagan Lagrange multiplier test was used to confirm the appropriateness of using a random effects regression model.

The results for each model were evaluated separately as different measures of performance. Return on equity and return on assets, however, showed similarities in significant variables. The return on equity model alone presented a significant relationship between the equity capital to assets ratio. Size, farm volatility, lagged farm volatility, crisis indicator, efficiency ratio, net charge offs to loans and leases, farm loans, commercial loans, and individual loans were all significant to both the return on equity and return on assets models.

The liquidity risk model presented different significant relationships than the profitability models. The variables with highest significance in affecting the financing gap of a bank were the size of the bank and the net interest margin. The total assets measure is important to evaluate because as assets increase, liabilities need to increase as well lest the financing gap grow too large and increase their risk exposure. Similarly, the net interest margin is important because of the indication of where income is being generated. As assets increase, so does interest income and thus the liquidity risk increases as well. Other significant variables to the liquidity risk model included the AgBank indicator variable, farm volatility, percent change in gross domestic product and individual loans.

The balance of significant relationships between internal factors, macroeconomic factors and agricultural factors shows that banks have multiple areas of operation that require

monitoring. Management of internal financial structuring as well as examining, not only the credit risk associated with financing businesses, farms and individuals, but also current economic conditions to get an accurate picture of their risk exposure, is essential to understanding potential fluctuations in profitability.

To continue this research many avenues could be taken. More focus could be put on internal structure as well as other inherent risks faced by financial institutions. Additional agricultural variables could be included such as commodity price volatility and more measures of farm performance beyond net income volatility. Increasing the area examined from a single state to a region or a national study would increase the usefulness of results, while decreasing likelihood of available data to evaluate. Further models of performance could also be built to include solvency and efficiency ratios which would cover the four main types of business performance.

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APPENDIX

Table A1

Variable Descriptions

Category	Variable	Description
Panel Identifiers	B_ID	Each of the 77 banks in the data set were assigned an ID number (1-77)
	Year	The data utilized was the reported figure for December 31st of the shown year
Performance Measures	LquidityRisk	Liquidity risk was calculated using (Net Loans and Leases - Interest Bearing Deposits)/Total Assets)
	ROE	ROE was taken directly from bank financial statements representing the company's Return on Equity
	ROA	ROA was taken directly from bank financial statements representing the company's Return on Assets
Bank-Specific	Size	Size of the bank is represented as the natural log of Total Assets
	AgBank	A dummy variable indicating a "1" if the bank has more than 25% of its loan portfolio devoted to farm loans
	EFF	Efficiency ratio was taken directly from bank financial statements
	NIM	Net Interest margin was taken directly from bank financial statements
	EC_A	Equity Capital to Assets ratio
	NCO_LL	Net Charge offs to Loans and Leases ratio
	F_LN	Farm Loan percentage of total loans
	C_LN	Commercial Loan percentage of Total Loans
	I_LN	Individual Loan percentage of Total Loans
	O_LN	Other Loan percentage of Total Loans
	F_LN_G	Farm Loan growth on an annual basis
	T_LN_G	Total Loan growth on an annual basis
Macroeconomic	GDP	Annual GDP percentage growth
	Crisis	A dummy variable indicating a "1" if the year recorded is 2008
Farm Economy	F_VOL	Farm Volatility is a measure of changes in farm income across the state of North Dakota

Table A2

Correlation Matrix

	Liquidity Risk	ROE	ROA	Size	AgBank	F_VOL	F_VOL_1	GDP	Crisis	EFF	NIM	EC_A	NCO_LL	F_LN	C_LN	I_LN	O_LN
Liquidity Risk	1																
ROE	0.040	1															
ROA	-0.022	0.928	1														
Size	0.366	0.257	0.151	1													
AgBank	-0.078	0.079	0.125	-0.423	1												
F_VOL	-0.094	-0.002	0.012	-0.067	0.021	1											
F_VOL_1	-0.114	-0.114	-0.119	0.033	0.003	0.736	1										
GDP	-0.043	-0.041	-0.045	0.017	-0.026	-0.449	-0.106	1									
Crisis	0.035	0.066	0.075	-0.045	0.016	0.231	-0.186	-0.726	1								
EFF	-0.019	-0.663	-0.694	-0.257	-0.121	0.120	0.071	-0.078	0.029	1							
NIM	0.393	0.147	0.127	0.014	0.043	0.114	-0.011	-0.003	0.021	-0.133	1						
EC_A	-0.125	-0.079	0.192	-0.161	0.016	-0.041	-0.079	0.034	-0.018	-0.150	0.013	1					
NCO_LL	-0.002	-0.060	-0.067	0.027	-0.078	0.275	0.142	-0.177	0.077	0.203	0.044	-0.116	1				
F_LN	-0.085	0.146	0.208	-0.472	0.829	-0.029	-0.021	-0.003	-0.003	-0.182	0.051	0.095	-0.132	1			
C_LN	0.054	0.091	0.045	0.254	-0.482	0.029	-0.053	-0.020	0.056	-0.011	0.041	-0.116	0.100	-0.588	1		
I_LN	-0.285	-0.092	-0.075	-0.136	-0.140	0.069	-0.018	-0.010	0.031	0.172	-0.057	0.140	0.068	-0.223	-0.075	1	
O_LN	-0.057	-0.156	-0.177	-0.086	-0.122	0.000	0.009	0.013	-0.017	0.212	-0.029	-0.097	0.024	-0.136	-0.041	-0.057	1

Table A3

Annual Trend Data

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Average of Lquidity Risk	-4.84%	-5.81%	-5.91%	-4.23%	-4.94%	-8.69%	-9.67%	-5.64%	-5.19%	-1.39%
Average of ROE	11.43%	11.56%	11.75%	11.47%	10.82%	9.71%	8.88%	8.66%	9.31%	10.35%
Average of ROA	1.15%	1.16%	1.17%	1.14%	1.07%	0.96%	0.87%	0.84%	0.90%	0.98%
Average of F_VOL	3.8806	4.8138	4.8872	6.4620	7.3202	7.4547	6.6992	5.0382	3.7698	3.1853
Average of GDP	0.0652	0.0512	0.0440	-0.0092	0.0011	0.0456	0.0364	0.0324	0.0405	0.0388
Average of AgBank	0.6104	0.5974	0.5584	0.6104	0.6234	0.5974	0.5714	0.5844	0.5714	0.5844
Average of EFF	0.6398	0.6519	0.6637	0.6762	0.7011	0.6804	0.6748	0.6429	0.6542	0.6424
Average of Size	11.1639	11.2447	11.3298	11.4184	11.4866	11.5460	11.6434	11.7295	11.7761	11.8438
Average of NIM	0.0435	0.0424	0.0415	0.0401	0.0405	0.0401	0.0393	0.0391	0.0370	0.0375
Average of EC_A	0.1005	0.1006	0.0987	0.0950	0.0957	0.0935	0.0952	0.0950	0.0925	0.0980
Average of NCO_LL	0.0019	0.0025	0.0035	0.0047	0.0073	0.0051	0.0031	0.0020	0.0001	0.0003
Average of F_LN	0.3018	0.2968	0.2906	0.2953	0.2982	0.2886	0.2867	0.3042	0.3019	0.3092
Average of C_LN	0.1713	0.1765	0.1760	0.1705	0.1570	0.1503	0.1500	0.1455	0.1455	0.1391
Average of I_LN	0.0973	0.0916	0.0874	0.0808	0.0796	0.0766	0.0728	0.0667	0.0641	0.0588
Average of O_LN	0.0351	0.0356	0.0368	0.0338	0.0367	0.0392	0.0352	0.0371	0.0373	0.0365
Average of F_LN_G	0.0899	0.0579	0.1285	0.2391	-0.0088	0.0551	0.1911	0.2985	0.1647	0.1050
Average of T_LN_G	0.1116	0.0713	0.1019	0.0766	0.0235	0.0500	0.1267	0.0580	0.1287	0.6555
Average of C_CoV	0.0494	0.1500	0.2086	0.1608	0.0469	0.1826	0.0970	0.0324	0.1353	0.0495
Average of S_CoV	0.0334	0.1097	0.1764	0.0792	0.0167	0.1075	0.1161	0.0255	0.0535	0.0504
Average of W_CoV	0.0755	0.1020	0.2152	0.1121	0.0528	0.1917	0.0396	0.0522	0.0363	0.0747
Average of NET_CO	96.5385	219.6667	376.3375	611.7000	1215.8250	965.0750	521.6875	308.1875	11.6375	71.0750
Average of TOTAL_LL	97828.55	109567.29	116854.45	129923.94	138010.84	141011.46	153228.45	174779.30	190892.51	216247.78
% change Net_CO	8.58%	127.54%	71.32%	62.54%	98.76%	-20.62%	-45.94%	-40.92%	-96.22%	510.74%
% change TOTAL_LL	12.53%	12.00%	6.65%	11.18%	6.22%	2.17%	8.66%	14.06%	9.22%	13.28%
Average of NET_CO	96.5385	219.6667	376.3375	611.7000	1215.8250	965.0750	521.6875	308.1875	11.6375	71.0750
Average of TOTAL_LL	97828.55	109567.29	116854.45	129923.94	138010.84	141011.46	153228.45	174779.30	190892.51	216247.78