

**Banking Efficiency Analysis for Two Special Years during Recent Financial Crisis**

by

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## Abstract

This paper covered almost thirty thousand groups of commercial banks' quarterly data in 2007 and 2011 to analyze the influence of 2008 financial crisis on banking performance, and investigate if there is any difference of financial crisis effects on banking efficiency between the agricultural banks and non-agricultural banks. This paper focuses on the influence on the early 21<sup>st</sup> century's Great Recession while paying attention to risk factor effect in banking performance analysis. Being cost model the base of the paper, manipulation occurs in both Translog and Cobb-Douglas methods finding banking performance statistics to make a conclusion of the financial crisis influence and risk factor effect on banking operation and development. From the analysis results, banking operation is less efficient in 2007 compared with banking operation in 2011, and banks' risk preference is changed by financial crisis.

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## List of Abbreviations

y	Total Loans
y1	NonAgricultural Loans
y2	Agricultural Loans
wl	Average Cost of Labor
PLabor	Average Cost of Labor
ql	Number of Employees
wfc	Average Cost of Capital
PCapital	Average Cost of Capital
qfc	Total Liabilities
obs.	Observations
Std.Dev.	Standard Deviation
AG	Agricultural Banks
Non	Nonagricultural Banks
FDIC	Federal Deposit Insurance Corporation

## Chapter 1

### Introduction

The first 21st century's financial crisis was the worst event in world-wide economic development since the Great Depression of the 1930s. In history, there are several economic recessions and economists never stop studying their causes; however, it seems no one and no strategy could really stop the negative consequences for the economy. It is not surprising that after the 2008 financial crisis, researchers re-focused on this economic incident again. The effect of financial crisis in the financial market and in the financial organization has become the core topic of many studies. Some research focuses on the causes of these crises while others seek to learn about the economic recovery approach and give advise financial organizations and government decision makers. However, only a limited research thinks about the 2008 financial crisis' influence on agricultural development in the US. In fact, there is significant relationship between banking industry and US agricultural development. In recent study, researchers found that an additional billion in loans could increase about ten percent agricultural GDP growth rate. Additionally, they discovered that loans lending by commercial banks could result in higher agricultural GDP growth rates, and almost forty percent of lending is done by commercial banks for agricultural industry operation. (Hartarska, V.,D. Nadolnyak, and X Shen, 2015). Thus, the financial crisis impacted the



banking industry performance and researchers should not neglect the changes of rural areas.

The earlier financial crisis research focused on learning about banking performance and banking efficiency by using different economics and mathematical methods. At that time, researchers tried to pick up suitable variables about banking management and operation to set a model to study the cost and profit of banks. Within the banking performance field, some of the researchers were not satisfied with only analyzing the cost and profit with input and output factors, and began thinking about the role of risk factors when in banking efficiency analysis, so that they used variables to calculate risk factors and classified different risk categories to discover the effect of risk and risk control approaches.

Based on the previous literature and the recent economic environment, this paper collects data of the years 2007 and 2011 which is pre and post financial crisis, using the quarterly data of almost thirty thousand observations. The influence of 2008 financial crisis on banking efficiency is studied by comparing 2007, which is the time before the financial crisis bursting year, and 2011, which is the time after the financial crisis worst year. In 2007, some market index, trading affair and business behavior in financial market and real estate market has been considered as the economy depression omen for the financial crisis in 2008, when the researchers and economists began to analyze the cause of the great recession. 2007 is an important year for observing the operating condition and the changes of financial organization. In 2008, the economy suffered and the US underwent through the most severe economy recession since 1930s-the Great Recession. After 2008, based on the effort of business organizations and governments,

the economic conditions improved and recovery started. Although it is hard for the economy to grow to the level it was before the financial crisis in a short period of time, the development of economy kept in an increasing trend. Three years later, in 2011, most researchers, economists and governors believed that the worst economy-developing period had ended. In addition, Federal Reserve Bank of St. Louis announces the 2000s Great Recession timeline, the timeline starts from 2007 to 2011, so based on the Federal Reserve Bank reports and analysis, 2007 and 2011 also could be considered as two significant symbolic years among the timeline. If 2007 could be a prediction year of 2008 financial crisis, 2011 could be a prediction year of economy recovery. Therefore, analyzing these two years' banks' data to discuss the effect of 2008 financial crisis should be reasonable and meaningful.

In this paper, we would not only compare the two years of banking data analysis results, but also pay attention to risk factors to test the risk effect on the banking efficiency. Additionally, previous study indicated that agricultural banks' loans could increase employment in the US agricultural industry (Johnson, J, 2009), and that any change of commercial banks' loans to agriculture sector would cause significant change of agricultural industry performance (Mishra, A.K., C.B. Moss, K.W. Erickson, 2008). Then, we would like to see the risk and financial crisis influence on different categories of banks, so we compare the risk and financial crisis effects and bank performance between agricultural banks and non-agricultural banks. Based on the previous literature, most researchers apply two approaches to differentiate agricultural banks and non-agricultural banks. One is the Federal Reserve System definition and the other one is the Federal Deposit Insurance Corporation definition, in this study, we would choose Federal

Deposit Insurance Corporation definition to define agricultural banks, and we would discuss these two definitions and explain the reason of our choice in data section.

## Chapter 2

### Literature review

The banks' performance would be influenced by several elements, such as customers' preference, currency exchange rate, stock market condition, government policy, operation strategies of banks, and other economic environment and internal banks' influential factors. Therefore, banking efficiency becomes an important researching field, and researchers attempt to manipulate different factors and approaches to examine the banking performance, such as Georgios, George and Alexia (2016) combined data envelopment analysis and regression model to analyze cost efficiency in US banking industry, Hussain and Hassan (2012) applied stochastic frontier approach with considering risk-taking behavior to study US commercial banks' efficiency. With so many uncontrollable influential factors, banks have to learn how to reduce the negative influence of risks and how to manage the risks to keep the level of efficiency scale, nonetheless, based on our analysis, banks did not consider risks very serious before 2008. They tried their best to pursue profits no matter how severe the risks were. Furthermore, the great recession in the late 2000s brought the challenge to all the banks and made them become aware of the significance of risk again. Because of these reasons, this study would focus on comparing the bank efficiency of agricultural banks and nonagricultural banks pre and post the economic recession of the 2000s, and it would concern the vital effect of risk during the financial crisis.

The previous literature compares bank performance before and after the 2008 financial crisis and pays special attention to the risk analysis, banks' categories differentiation, and the influential factors of the bank operation. There are several different approaches to classify the categories of banks for research, such as the size of banks, the banks' main business scope, the ownership of banks, etc. In this paper, we focused on the banks' main business scope to differentiate agricultural banks and nonagricultural banks. Agricultural banks are an important and special group of the US banking industry and a crucial component of the US agricultural system. Therefore, their performance and financial conditions are essential to agriculture development. Due to the agricultural banks feature, the operation model and profit structure of agricultural banks are different from nonagricultural banks. (Settlage, D.M., P.V. Preckel, and L.A. Settlage, 2009).

In the early times, David L. Neff, Bruce L. Dixon, and Suzhen Zhu (1994) began to do the research related to agricultural bank efficiency and inefficiency analysis and began to discover the most suitable and appropriate approach to obtaining bank data, categorizing the bank input variables and output variables, and setting up the proper time period to do the research. At that time, they used a translog cost function, which we intend to use to complete the analysis on banking efficiency before and after 2008 financial crisis, to do their research as well. How to differentiate outputs and inputs among all the variables was the first issue they faced, but they were able to eventually solve it. They defined loans and assets as outputs, as well as deposits and other liability funds as inputs, and all operating and interest costs of the bank as total costs. In addition,

they used other substituted solution to discuss the outputs and inputs, especially to discuss the classification of deposits and liabilities.

Onelack Choi, Spiro E. Stefanou, and Jeffrey R. Stokes also showed their interest on doing research about efficiency of U.S. Agricultural Banks in 2007. They attempted to demonstrate the efficiency distinction by comparing the results from different econometric methods, and explored the influence of bank-specific characteristics on efficiency study with different analysis approaches. Some examples include one step and two step of stochastic cost frontier approach and one step and two step of data envelopment analysis. When categorizing input and output, they defined the sum of total loans and total deposits as outputs, as well as labor, expenses for the premises and fixed assets, and the sum of interest and other expenses as inputs. They also considered the total number of employees as labor input, considered all non-interest expenses related to the use of premises, equipment, furniture, and fixtures as expenses for the premises and fixed assets; they considered interest paid on deposits and other non-interest operating expenses as other expenses. According to their views, U.S. agricultural production was not capital intensive and analyzing the efficiency of agricultural banks was an extremely critical research field for agricultural development. They conducted the research by considering time period but without utilizing risk directly into their research model. Although they did not put risk into analyzing process immediately, they thought about risk impact on banking performance and agricultural industry after their research.

Several years later, the researchers noticed that risk should be considered and utilized when analyzing the banking performance and computing the profit efficiency score. In 2012, Shen and Hartarska applied default risk, interest risk, liquidity risk, capital

adequacy and diversification risk in their banks' performance analysis and focused on the return on assets (ROA) in the banking industry. Even earlier, Daniel M. Settlage, Paul V. Preckel, and Latisha A. Settlage (2009) used data envelopment analysis to examine the efficiency of agricultural banks in one year to indicate the difference between the standard cost efficiency level and risk-adjusted profit efficiency level. They attempted to use this approach to examine the performance of the agricultural banking industry, and pointed out the advantage of the risk related research technique, which resulted in a higher degree of efficiency in the banking industry compared to the approach without consideration risk influence. With risk calculation and application, they utilized gap risk, interest rate risk and default risk into the model. And like other researchers, they also needed to solve how to differentiate the inputs and outputs. They then list deposits, Fedfunds purchased, subordinated debt, other borrowed funds, premises and fixed assets, and employees as inputs, and loans, leases, investment securities, trading assets, fed funds sold, and other assets as the outputs. In their literature, the grouping of input and output is clearer and more specific compared to the previous literature.

After researchers began to pay attention to risk in evaluating the banking industry performance, how to manipulate risk factors and how to minimize the negative effect from risk became a new consideration for them. In most researchers' minds, the derivatives became one of the practicable and efficient methods to deal with the risk. After inserting different categories of risk factors, such as credit risk, interest rate risk, liquidity risk, capital adequacy and operating risk to study banking industry performance and risk situations Shen (2013) demonstrated the influence of derivative activities on banks' profitability and variability before and after the 2000s great recession. In addition,

Shen and Hartarska (2013) tried to add a vector of endogenous variables and a dummy variable to analyze return on asset to get the derivative's effect on credit risks and interest risks during and after the 2008 financial crisis. Based on Shen's (2013) risk analysis, agricultural banks are less affected by credit risk and interest rate risk compared to their effects on nonagricultural banks. Meanwhile, with return on asset (ROA) analysis, Shen and Hartarska (2013) found that increasing liquid assets could reduce overall risk and increasing capital base could increase overall risk for banks. By comparing the research results of agricultural banks and nonagricultural banks, they explained that the spinoff assets had differing effects on risk level and profitability with different categories of banks. Further study was done on the size of agricultural banks and nonagricultural banks, they believed that agricultural loans had different effects on different size agricultural banks, and that the effective derivatives could be considered as one of the most important elements to make agricultural banks survive in the 2000s recession. However, speculating derivatives may hurt nonagricultural banks, based on risk level and profitability. After all, Shen (2013) concluded and suggested that effective risk management of agricultural banks should be considerable, due to the fact that agricultural banks are essential to agricultural economy development.

Although agricultural banks play a critical role in agricultural economy development and cannot be ignored in developing the country's entire economy, agricultural financial industry is considered unhealthy, risky and one of the main factors causing the 2008 economic crisis before. Based on these kinds of views and the severe influence of financial crisis, some researchers including Li, Escalante, Epperson and Gunter (2013) focused on finding out the real trigger of the 2000s



economic recession and made an assumption that agricultural sector could be affected. However, after analyzing capital adequacy, asset quality, management risk, profitability, liquidity risk, loan portfolio composition and risk, funding arrangement, structural and macroeconomic variables in their early warning model, Li, Escalante, Epperson and Gunter (2013) found that the agricultural sector should not be counted as the cause of bank failure. With a low agricultural loan delinquency rates compared with banks' overall loan delinquency rates, they concluded that agricultural lenders were in a stronger financial-healthy condition compared with other lenders. It should be noted, however, that agricultural lending should not be considered an effective method of avoiding bank failure. Therefore, based on previous study, agricultural financial industry could not be considered as riskier and less healthy compared with other sectors of the financial industry, and should not be considered as the starter or main initiating element of the 2000s financial crisis.

Aside from risk analysis, researchers also use different models to analyze the bank efficiency level to study the 2008 economic recession and to compare the performance of agricultural banks and nonagricultural banks during this particular time period. Instrumental variables probit approach and maximum likelihood estimation technique were used to conduct bank failure analysis and to calculate the efficiency scores by Li, Escalante, Epperson and Gunter (2012). They attempted to compare the effects of efficiency score and macroeconomic factors on the financial health and the operating status of banks during 2008 financial crisis time period. After the analysis, they concluded that both internal and external factors, such as banking business decisions, banking business conditions, and unemployment conditions could influence the banks'

performance during the great recession. Also, when doing analysis on agricultural banks and nonagricultural banks separately, they found that agricultural banks operated more efficiently than did nonagricultural banks. Bank size also becomes an interesting topic when analyzing the banks' efficiency; for example, Hughes and Mester (2013) tried to do research about economic recession by learning about the change of scale economies, thus they pointed out the standard minimum cost function not the most appropriate for analyzing scale economies. In their study, they used both standard model and model accounting for managerial risk preferences and endogenous risk-taking with the data before and after 2000s recession to do the analysis to find the scale economies. For further study, they also included technology factors and systematic risk with risk-return-driven cost function. When comparing the results of different models, they found that the scale economies were not similar when changing the model. Additionally, they related the bank size with scale economies and showed that too-big-to-fail was not the rule for bank bankruptcy. To analyze the efficiency of economies, Song, Li and Escalante (2015) used tranlog stochastic frontier model to find out the allocative efficiencies of commercial banks. Based on the results, they discovered that higher costs loans diminished the level of efficiency and they suggested that the banks should learn how to manipulate financial capital, physical capital and labor input allocation to keep the level of efficiency. Through the analysis, the study tried to clarify the survival strategies of banks in the economic recession and underlined the success of agricultural financial industry sector in the 2000s great recession.

Based on previous literature about studying banking industry in 2008 financial crisis period, especially the discussion about agricultural banking sector's role in this

great recession, we are interested in studying the banks' performance before and after the worst year of 2000s Great Recession. We are interested in seeing the influence of financial crisis and all the essential operating elements' effect on banks' efficiency level, and to learn about if there is any difference between the operating condition of agricultural banks and the operating condition of nonagricultural banks during this particular time period. At the same time, we will compare the analyzing results of risk related model and risk unrelated model to see the effect of the risk factor on banking performance by using default risk.

## Chapter 3

### Model

In previous literature, when analyzing the cost in banking field, the researchers tried to use many different categories of models to learn about the cost of banking industry, such as stochastic cost frontier estimation, data envelop analysis, translog stochastic frontier, early warning model, two production models, endogenous switching model, ordinary least squares model, and propensity score matching model, etc., or analyzing banking performance to pay attention on return on assets. However, this paper will try to consider and analyze the banking field as ordinary production industry analysis and will try to analyze the cost of “producing” loans by using Cobb-Douglas function and Translog regression analysis based on basic cost function model to do the research.

Also, when building up the model, this paper selects several categories of raw data from Federal Reserve Bank of Chicago commercial banks’ data, which are total loans and leases, farmland loans secured by real estate, loans to finance agricultural production and other loans to farmers, salaries and employee benefits, number of full time employees at end of period, total interest expense, total liabilities, expenses of premises and fixed assets, and premises and fixed assets. All the data are commercial banks’ quarterly data and explained by call report.

With the commercial banks’ raw data and call report from Federal Reserve Bank of Chicago, we used the selected raw data to recalculate all the variables which would be

used in setting up the basic cost function model. Firstly, the general translog cost function could be presented as

$$\begin{aligned} \ln TC = & \alpha_0 + \sum_i \alpha_i \ln q_i + \sum_j \beta_j \ln p_j + \frac{1}{2} \sum_i \sum_r \gamma_{ir} \ln q_i \ln q_r \\ & + \frac{1}{2} \sum_j \sum_s \delta_{js} \ln p_j \ln p_s + \sum_i \sum_j \theta_{ij} \ln q_i \ln p_j + \varepsilon \end{aligned}$$

where TC is total cost,  $q_i$  are output(s),  $p_j$  are input prices,  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ , and  $\theta$  are parameters to be estimated, then combined with the variables in this study, as we discussed our definition for outputs and inputs,  $q_i$  (output(s)) include total loans, nonagricultural loans, and agricultural loans;  $p_j$  (input prices) contains price of labor and price of capital. There are two basic cost functions which are

$$tc=f(y, wl, wk, wfc)$$

$$tc=f(y1,y2, wl, wk, wfc)$$

In these two functions of the model, we need five variables in the first function, and six variables in the second function. The difference between these two functions is the output part. In the first function, we only consider the bank's total loans as output, which means we do not distinguish any categories among the bank's loans. In the second function, we differentiate the loans of bank and after calculating, we use nonagricultural loans and agricultural loans separately as the two kinds of outputs of the bank. Therefore, in these two functions,  $y$  is total loans,  $y1$  is nonagricultural loans,  $y2$  is agricultural loans,  $wl$  is average cost of labor,  $ql$  is number of employees,  $wfc$  is average cost of capital,  $qfc$  is total liabilities,  $wk$  is average fixed cost,  $qk$  is premises and fixed assets,  $tc$  is total cost, and all the variables are from recalculating the raw data. Total loans ( $y$ ) is total loans and leases, nonagricultural loans ( $y1$ ) is equal to total loans and leases (total loans ( $y$ )) minus

farmland loans secured by real estate and minus loans to finance agricultural production and other loans to farmers, agricultural loans ( $y_2$ ) is calculating by farmland loans secured by real estate plus loans to finance agricultural production and other loans to farmers. In addition, number of employees could not be ignored in this model, but, we would not use the number of employees as an individual variable, we would manipulate it to calculate other variables. Therefore, number of employees ( $q_l$ ) is number of full time employees at end of period, average cost of labor ( $w_l$ ) is calculating by salaries and employee benefits divided by number of full time employees at end of period (number of employees ( $q_l$ )), average cost of capital ( $w_{fc}$ ) is equal to total interest expense divided by total liabilities ( $q_{fc}$ ), average fixed cost ( $w_k$ ) is expenses of premises and fixed assets divided by premises and fixed assets ( $q_k$ ). When we calculate average cost of capital ( $w_{fc}$ ) and average fixed cost ( $w_k$ ), we include two important variables which are total liabilities ( $q_{fc}$ ) and premises and fixed assets ( $q_k$ ), but these two variables are not used as individual variables in the model. In the end, the dependent variable total cost ( $tc$ ) is equal to salaries and employee benefits plus expenses of premises and fixed assets plus total interest expense. Accordingly, in the model, we include ten different variables; however, three of ten variables are not used here directly.

After building up the basic cost function model, the research does transformation based on the basic model and uses other methods, such as meanscaling, normalizing, analyzing with and without restrict, creating quartile to drop the outliers, and doing the interaction, to deal with the raw data. Then, we could use the modified basic cost function model to do next step research and to figure out if there is any different analysis result due to different conditions, such as the analysis result of considering different types of

loans-----agricultural loans and nonagricultural loans and the analysis result of considering different types of banks-----agricultural banks and nonagricultural banks. Then, the modified model could be estimated with general translog cost function.

With the econometrics analysis results from transformation, the research would try to explain the econometrics statistics results. Through the results, we would try to find out the economy scale and the performance difference between agricultural banks and non-agricultural banks. We would also attempt to figure out the influence of 2000s Great Recession on banks' performance pre and post 2008 crisis by comparing the statistics results between 2007 and 2011. All the analysis would be based on general translog cost function by comparing results from Cobb-Douglas and Translog Specifications.

At the same time, the paper also tries to analyze and demonstrate the difference between the results from specifications accounting for risk and specifications not accounting for risk. When reviewing previous literature, there are several different categories of risk when analyzing banking industry. In this paper, we select and insert default risk factor, which is non-performing loans divided by the total loans as an independent variable, in the cost functions model.

$$\text{Default Risk} = \text{non-performing loans} / \text{total loans}$$

Because Federal Reserve Bank of Chicago changes the rule and dataset after 2010, the raw data and call report which are used to calculate non-performing loans are different, but all of the raw data are categorized as past due 90 days and nonaccrual loans (Appendix Equation 1 and Equation 2). This study uses these two specifications in the analysis one with loan default risk and one without default risk for each of the two years. In addition, these specifications are used in a sample of agricultural banks and

nonagricultural banks independently. Results permit comparison of the two different approaches (Translog regression and Cobb-Douglas Analysis), and two different years (2007 and 2011), as well as specification with risk factor and without risk factor. The impact of all the independent variables in the model are also evaluated, for the different categories of loans-----agricultural loans and nonagricultural loans, so we then could try to understand the influence of different factors on banks' performance before and after 2008 financial crisis based on different research conditions.



## Chapter 4

### Data

This study uses the banks' data for all banks regulated by the Federal Reserve System, Federal Deposit Insurance Corporation, and the Comptroller of the Currency; we collected all the data from Federal Reserve Bank-Chicago with individual bank basis (Federal Reserve Bank of Chicago). In addition, Federal Reserve Bank of St. Louis reports the number of commercial banks in the U.S. based on time series, and demonstrates the different measurements of the changing number of commercial banks with chart (Figure 1). From the chart, we could see that a substantial change of the number of commercial banks from 2007 to 2011; this period of time (2007-2011) is also the full timeline reported by Federal Reserve Bank of St. Louis.

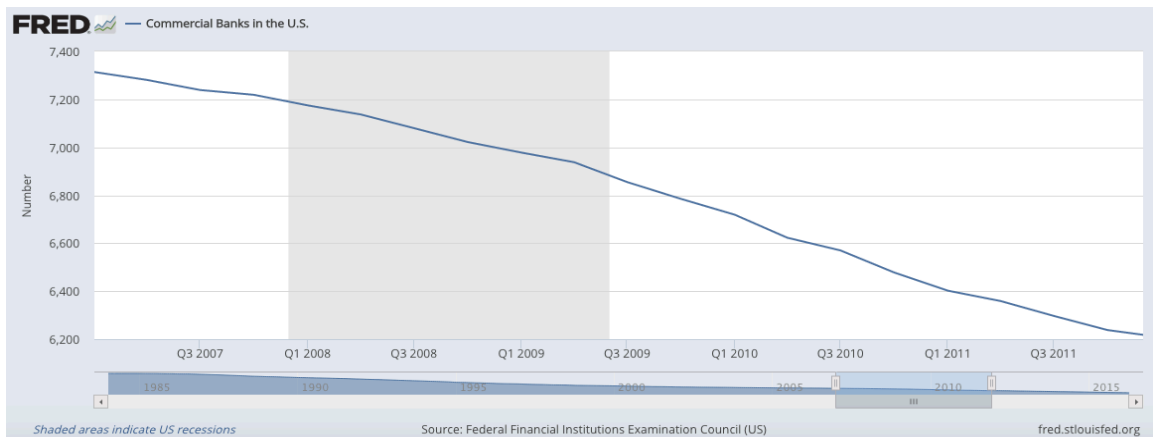


Figure 1 Commercial Banks Number Changes

Due to the financial crisis time line, 2008 could be considered as the lowest level of economic activity. The paper then chooses analyze two significant years, 2007 and

2011, that is, the years before and after the 2008 financial crisis years. In 2008, the banking industry endured a severe “earthquake”; compared with 2007 loans lending level, new loans to large borrowers fell by 79% in 2008 (Victoria Ivashina, David Scharfstein, 2009). The earthquake wave shocked the whole world’s economies and the famous 2008 financial crisis came out. 2011 is considered as the first year that the financial crisis period was over and when economic recovery began. Although the economy environment was not as good as before (2011), all the economy’s freezing conditions began to recover and became better than 2008 (Raskin, S.B. ,2011). In this study, almost thirty thousand groups of commercial banks' quarterly raw data from the Federal Reserve Bank-Chicago are used and the raw data is explained by Federal Reserve Bank’s Call Reports. In addition, all the raw data have been merged as yearly data before being used for this study. All the categories of banks’ data are included in this study for analyzing and comparing the banking efficiency before and after 2008. We then focus on comparing efficiency of agricultural banks and nonagricultural banks in different years. Therefore, determining the appropriate way of distinguishing agricultural banks from nonagricultural banks is an essential step for doing the research.

Based on the previous literature, there are two mainstream approaches to differentiate agricultural banks and non-agricultural banks. One is the Federal Reserve System definition, which states that if the rate of bank’s agricultural loan to total loan is greater than the mean rate of agricultural loan to total loan for all banks, then the bank is an agricultural bank. The other one is the Federal Deposit Insurance Corporation definition which is if the rate of bank’ loans to agricultural field is 25 percent or more out of the total amount of bank’ loans, then we could define the bank as the agricultural

bank. Following Federal Reserve System definition, based on 2007 commercial banks data, mean rate of agricultural loans to total loans for all banks is 0.1253, there are almost nine hundred commercial banks (around thirty-five hundred groups of commercial banks' raw data) more than the number of agricultural banks defined by Federal Deposit Insurance Corporation definition. Based on 2011 commercial banks data, mean rate of agricultural loans to total loans for all banks is 0.1382, following Federal Reserve System definition, there are almost seven hundred commercial banks (around three thousand groups of commercial banks' raw data) more than the number of agricultural banks defined by Federal Deposit Insurance Corporation definition. Since the mean rate of agricultural loan to total loan for all banks of each year would be different, and the ratio comparison result would be different and imprecise, this paper chooses Federal Deposit Insurance Corporation (FDIC) agricultural banks definition instead of Federal Reserve System definition to differentiate agricultural banks and non-agricultural banks. Because of 2008 financial crisis, there are about one thousand commercial banks bankruptcy and shut down in the US, but the number of agricultural banks does not change significantly. Based on FDIC definition, there are 2,024 agricultural banks in 2007 and there are 1,927 agricultural banks in 2011. Based on the number of agricultural banks in 2007, there are 315 agricultural banks shut down due to 2008 financial crisis, but the actual number of agricultural banks does not decrease as much as the number of bankruptcy agricultural banks based on the number of agricultural banks in 2007, which means, there some commercial banks become "new" agricultural banks after 2008 financial crisis.

By analyzing the bank performance, after discovering the raw data and deciding the method to define the agricultural banks and the banks' inputs and outputs is the next

significant step to start research. After understanding the inputs and outputs, we can then figure out the expense and cost of banking operation, and to build up the model to study the cost of banking outputs.

Unlike other industries that could produce concrete and counted products with directly and easily defined inputs, the banking industry is more difficult to distinguish between outputs and inputs. In previous literature, different researchers demonstrated different ways of understanding and categorizing about inputs and outputs in banking industry. For example, David L. Neff, Bruce L. Dixon, and Suzhen Zhu (1994) categorized loans and assets as outputs, deposits and other liability funds as inputs, and all operating and interest costs of the bank as total costs; Onelack Choi, Spiro E. Stefanou, and Jeffrey R. Stokes (2007) used the sum of total loans and total deposits as outputs, and labor, expenses for the premises and fixed assets, and the sum of interest and other expenses as inputs. Daniel M. Settlage, Paul V. Preckel, and Latisha A. Settlage (2009) explained their understanding about input and output to sort deposits, Fed funds purchased, subordinated debt, other borrowed funds, premises and fixed assets, and employees are input, and loans, leases, investment securities, trading assets, fed funds sold, and other assets are the output. Based on previous literature and the data from Federal Reserve Bank of Chicago we try to define output and input directly and clearly in this study, so we define the loans as outputs and deposits, fixed asset, premises, and salaries and employees benefits as inputs. Additionally, we define salaries and employee benefits, expenses of premises and fixed assets, and total interest expense as total cost. Then, after classification the outputs and inputs, we begin to build up the cost function

model to do the research on cost of bank making loans and to analyze the banking efficiency.

When the researchers began to be interested in banking performance research, they began to use the cost related models with differentiating outputs and inputs carefully. For instance, David L. Neff, Bruce L. Dixon, and Suzhen Zhu (1994) used a translog cost function, Onelack Choi, and Spiro E. Stefanou, and Jeffrey R. Stokes (2007) used one step and two step of stochastic cost frontier approach, but very few of them attempted to insert risk as one of the independent variables in the cost function model. Although some of the researchers began to think about risk effect, risk aversion or risk control when analyzing the banking condition, such as Onelack Choi, Spiro E. Stefanou, and Jeffrey R. Stokes (2007), but they only discussed the possible influence from risk on banking efficiency and agricultural industry, they did not manipulate risk as a variable in their model. Other researchers, such as, David Bernstein (1996), Laurent Weill (2003) and Aaron Steelman and John A. Weinberg (2015), tried to use nonparametric model or other theoretical descriptive and inferential model to discuss the risk. In this paper, after reviewing previous literature in which researchers inserting risk as a factor into their model and conducting analysis with risk straightforwardly, such as Daniel M. Settlage, Paul V. Preckel, and Latisha A. Settlage (2009), they demonstrated the difference between the standard cost efficiency level and risk-adjusted profit efficiency level. Shen and Hartarska (2012) utilized default risk, interest risk, liquidity risk, capital adequacy and diversification risk in their banks' performance analysis, therefore we would try to use risk factor as the independent variable in the model, not only describing the importance of risk in banking efficiency, but doing analysis relating with risk directly.

Based on the basic cost function model, this paper would put risk factor into the analysis model. After reviewing the previous literature, there are several different ways to define and calculate risk, such as liquidity risk, default risk, interest risk and operating risk, due to the fact that this paper would pay much more attention to cost of outputs, in other words, the cost of loans. We would then use default risk to calculate the risk factor, which is to calculate the ratio of nonperforming loans to the total loans. This paper considers past due 90 days and nonaccrual loans as the non-performing loans and selects 80 categories of raw data to calculate non-performing loans based on the Call Report (FFIEC041 and FFIEC002) and commercial banks' data of Federal Reserve Bank of Chicago.

After manipulating raw data to calculate the variables used in the analysis, there are two tables present the summary statistics for 2007 and 2011 commercial banks for all variables used in this study, for example, total cost, total loans, agricultural loans, nonagricultural loans, input factor variables and risk factor. The first column of each table list the variables included in the model, from second column to sixth column, the columns list all the statistics of variables, such as observations, mean, standard deviation, minimum, and maximum. Furthermore, each column displays statistics for agricultural banks and nonagricultural banks separately, risk factors' summary statistics also contained in the two tables. From the summary statistics, we notice that the amount of agricultural banks is less than the amount of nonagricultural banks, and we need to do transformation on all variables for analysis and measured in thousands.

Variable	2007 Obs		Mean		Std. Dev.		Min		Max	
	Ag Banks	Nonag Banks	Ag Banks	Nonag Banks	Ag Banks	Nonag Banks	Ag Banks	Nonag Banks	Ag Banks	Nonag Banks
tc(Total Cost)	7214	24368	18455.36	50432.2	403828.2	934507.1	-4	0	21700000	57800000
y(Total Loans)	7989	24368	292905.3	963672.8	1974477	1.27E+07	0	2	46800000	629000000
y1(NonAgricultural Loans)	6989	24368	35140.95	952515.1	110138.5	1.26E+07	0	2	4417883	626000000
y2(Agricultural Loans)	6989	24368	24341.47	11157.69	53359.87	102439.4	0	0	1733422	6697000
wl(PLabor)	6921	24349	36.03411	37.57051	32.88902	33.64736	0	0	969.4589	3031.5
wfc(PCapital)	6978	24368	0.0201203	0.0193252	0.1553408	0.0112685	0	0	12.76283	0.6970708
wk(Average Fixed Cost)	6778	23843	0.6097384	0.2488072	5.365208	0.8565517	-0.002924	-0.2564548	233.4	57
risk(Risk)	7300	24368	0.0119267	0.0148466	0.023563	0.214547	0	0	0.5368313	33.05013

Table 1 2007 Commercial Banks Summary Statistics

Variable	2011 Obs		Mean		Std. Dev.		Min		Max	
	Ag Banks	Nonag Banks	Ag Banks	Nonag Banks	Ag Banks	Nonag Banks	Ag Banks	Nonag Banks	Ag Banks	Nonag Banks
tc(Total Cost)	6703	20843	11228.59	33846.62	237589.1	616191.7	-720	0	12500000	37400000
y(Total Loans)	7496	20843	319881.8	1189780	1981334	1.69E+07	0	2	42700000	719000000
y1(NonAgricultural Loans)	6565	20843	44543.2	1175905	144347.2	1.68E+07	0	2	5094000	710000000
y2(Agricultural Loans)	6565	20843	32397.97	13874.49	81305.92	138030.5	0	0	2953000	9364000
wl(PLabor)	6504	20819	40.11429	41.42559	35.42773	25.17702	-254.75	0	1806	559.322
wfc(PCapital)	6561	20843	0.0063079	0.0064087	0.0239962	0.0103701	0	0	1.498314	1.123965
wk(Average Fixed Cost)	6390	20358	0.5082226	0.3285151	2.67957	1.907309	0	-0.2592593	98.65517	115.2143
risk(Risk)	6964	20843	0.017745	0.0407557	0.0820262	0.1752538	0	0	5.186244	24.33404

Table 2 2011 Commercial Banks Summary Statistics

## Chapter 5

### Analysis and Result

Based on the call report and almost thirty thousand groups of commercial banks' quarterly data (nearly nine thousand commercial banks included in this research) from Federal Reserve Bank of Chicago, we analyze two years, 2007 and 2011, separately. Following Federal Reserve System definition, based on 2007 commercial banks data, there are almost nine hundred commercial banks (around thirty-five hundred groups of commercial banks' raw data) more than the number of agricultural banks defined by Federal Deposit Insurance Corporation definition. Following Federal Deposit Insurance Corporation definition, 2,024 commercial banks (more than seven thousand groups of banks' raw data) could be categorized as the agricultural banks. Based on 2011 commercial banks data, following Federal Reserve System definition, there are almost seven hundred commercial banks (around three thousand groups of commercial banks' raw data) more than the number of agricultural banks defined by Federal Deposit Insurance Corporation definition. Following Federal Deposit Insurance Corporation definition, 1,927 commercial banks (less than seven thousand groups of banks' raw quarterly data) could be defined as agricultural banks. As the discussion in Data section, this paper would apply FDIC (Federal Deposit Insurance Corporation) definition to differentiate agricultural banks from nonagricultural banks. At the same time, we use the basic cost functions with Cobb-Douglas and Translog regression Analysis approaches to



study these two years' commercial banks' data with different conditions, such as doing the research about agricultural banks and nonagricultural banks independently, as well as with risk factor and without risk factor.

## **5.1 Analyzing 2007 Commercial Banks**

After analyzing 2007 commercial banks' data from Federal Reserve Bank of Chicago, it shows that the number of banks which could be defined as agricultural banks is less than the number of the nonagricultural banks (the amount of nonagricultural banks is around four times as many as the amount of agricultural banks). Due to the agricultural definition (Federal Deposit Insurance Corporation definition), 2,024 commercial banks (more than seven thousand groups of banks' raw data) could be categorized as the agricultural banks, and the other almost (more than) six thousand commercial banks (more than twenty-four thousand groups of banks' raw data) could be defined as nonagricultural banks. After manipulating the raw data (for example, merge, meanscale and normalize, etc.) and sorting the groups of commercial banks' raw data based on the agricultural definition to prepare studying the data about agricultural banks and nonagricultural banks individually. Table 1 summarizes all the variables used in the model, such as the total cost (tc), total loans (y), non-agricultural loans (y1), agricultural loans (y2), average cost of labor (wl), average cost of capital (wfc), and average fixed cost (wk). Total costs, cost of labor, cost of capital and outputs---total loans as well as agricultural loans and nonagricultural loans are measured in thousands of dollars. In the

research we use transformed variables by first normalizing and then meanscaling each of the variables for ease of interpretation.

After doing transformation on all the variables (normalizing, meanscaling and taking logarithm), with considering one output condition (total loans ( $y$ )), we estimate Cobb-Douglas specification and analyze agricultural banks and nonagricultural banks independently. We also specify Translog model and analyze the data. Since the Cobb-Douglas functional form is a subset of the Translog, we can test to see which one is more appropriate. Ramsey RESET test and F test with a null hypothesis of the additional Translog terms are jointly equal to zero is appropriate. The results from the test of the joint significance of the model's first equation additional variables with F-statistics reject the null hypothesis.

With comparing these two different approaches' statistics test result P-value, all the P-value is very small, which means the additional independent variables have big influence in the dependent variable and belong in the model. By comparing all the other statistics from the analysis, we can conclude that Translog regression approach is better than Cobb-Douglas approach for analyzing agricultural banks with one output condition. In other word, when analyzing the banks' total cost with considering single output, total loans ( $y$ ), we prefer Translog regression approach rather than Cobb-Douglas approach based on the researching results.

We consider two specifications. For the first specification, we only consider one output-----total loans ( $y$ ), and, in the second specification, we differentiate the output with two categories----- nonagricultural loans ( $y_1$ ) and agricultural loans ( $y_2$ ) instead of total loans ( $y$ ) and use again the Cobb-Douglas approach and Translog regression

approach to analyze the banking performance, same as one output specification, Translog regression approach is preferred for two outputs specification analysis.

The main focus of this analysis is to determine if the agricultural banks are as efficient as nonagricultural banks and to establish if there is a change in efficiency from 2007 to 2011. Since the data are normalized and meanscaled, the coefficient on the  $y$  variable---output and the sum of  $y_1$  and  $y_2$  in the specification of nonagricultural loans and agricultural loans are compared to 1 to establish scale efficiency---increasing, decreasing or constant returns to scale. We test if the estimated coefficient on  $y$  is equal to one and if so we say that the banks are experiencing constant returns to scale. If that coefficient is less than 1 we say that the banks have increasing returns to scale and if they are more than 1 we say that they have decreasing returns to scale.

Table 3 shows that in specifications with one output---total loans---with and without risk both agricultural banks and nonagricultural banks seem to be exhibiting constant return to scale because the coefficient is equal to one. For 2007 banking performance analysis, we could conclude that there are constant returns to scale.

Table 3 also permits to see the differences in scale economies with and without controls for risk with output measured as the total value of loans. The results for both agricultural banks and nonagricultural banks are somewhat puzzling because the higher level of risk is associated with lower costs, while in fact a typical result is the higher levels of risk (measured by higher value of the portfolio at risk variable) is associated with higher total costs. However, the magnitude of the coefficients is very small and one percent increase in the loans overdue more than 90 days (risk) is associated with -0.00684 decrease in costs in agricultural banks and a decrease of -0.00909 in nonagricultural

banks. These are very small effects. Table 4 which presents results from specification where output is split in agricultural loans and nonagricultural loans shows that the same small statistically significant negative relation but of tiny magnitude and thus not economically significant.

The estimated coefficients of the rest of the variables in Table 3 are also consistent with the expectations. Increase in capital costs is associated with much higher increase in cost relative to increase in the cost of labor for agricultural banks (0.676 and 0.354 respectively), while this impact is 0.890 and 0.136 in nonagricultural banks for specifications without risk (first columns for agricultural banks and nonagricultural banks in Table 3).

Table 4 show the models where the output of the banks is not only total loans ( $y$ ), but the output is divided into two categories---nonagricultural loans ( $y_1$ ) and agricultural loans ( $y_2$ ). The estimated results show that agricultural banks are further away from constant returns to scale than are nonagricultural banks. The summation of the coefficients of  $y_1$  and  $y_2$  of 0.843 suggest increasing returns to scale while that in nonagricultural banks are very close to constant returns to scale. The same direction relation holds in a specification that accounts for the risk level of the banks. The summation of the coefficients of  $y_1$  and  $y_2$  is 0.854 which means that agricultural banks do not have constant returns to scale. When there is no risk factor in the model, for agricultural banks in 2007, the total cost could increase by 0.843 for a unit increasing in agricultural loans and nonagricultural loans. When there is risk considered in the model, for agricultural banks in 2007, the total cost could increase by 0.854 due to increasing

agricultural loans and nonagricultural loans. Then, for 2007 agricultural banks analysis, we underestimate the impact of costs of agricultural banks' outputs.

Based on all the results of 2007 banking efficiency analysis with risk factor, we could conclude that our specifications are adequate and agricultural banks are too small relative to nonagricultural banks. The result on risk suggest that the banks could reduce cost by taking higher risk level is counterintuitive but the magnitude is very small. We could speculate that banks took too much risks and used non-balance sheet risk mitigating strategies to decrease costs and which allows the default rate to have a negative association with costs. It is also possible that the results are due to the fact that banks have misreported some of the elements that enter into the variables loans overdue 90 days or more.

Variable	Agricultural Banks		NonAgricultural Banks	
	Translog without Risk	Translog with Risk	Translog without Risk	Translog with Risk
ln(Total Loans)	1.005*** (0.0135)	0.993*** (0.0138)	1.018*** (0.00308)	0.974*** (0.0033)
ln(PLabor)	0.354*** (0.0398)	0.353*** (0.0436)	0.136*** (0.0110)	0.193*** (0.0123)
ln(PCapital)	0.676*** (0.0400)	0.669*** (0.0434)	0.890*** (0.00937)	0.842*** (0.0109)
ln(Risk)		-0.00684*** (0.00208)		-0.00909*** (0.00135)
ln(PLabor) <sup>2</sup>	0.378*** (0.0350)	0.338*** (0.0484)	0.0799*** (0.0117)	0.0705*** (0.0170)
ln(PLabor)*ln(PCapital)	-0.397*** (0.0331)	-0.350*** (0.0453)	-0.163*** (0.00856)	-0.157*** (0.0118)
ln(PCapital) <sup>2</sup>	0.377*** (0.0370)	0.323*** (0.0474)	0.163*** (0.00805)	0.152*** (0.00965)
ln(Total Loans) <sup>2</sup>	0.0945*** (0.00473)	0.0820*** (0.00505)	0.0930*** (0.00128)	0.0702*** (0.00155)
ln(PLabor)*ln(Total Loans)	-0.0200 (0.0132)	-0.0260* (0.0148)	-0.122*** (0.00330)	-0.111*** (0.00430)
ln(PCapital)*ln(Total Loans)	0.0323** (0.0132)	0.0315** (0.0145)	0.140*** (0.00276)	0.139*** (0.00375)
Constant	9.398*** (0.0217)	9.401*** (0.0218)	10.52*** (0.00481)	10.52*** (0.00471)
Observations	6,460	5,715	23,791	20,512
R-squared	0.965	0.967	0.955	0.96
F	19928	16789	56235	48787

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 3 2007 Commercial Banks Analysis OneOutput Condition

Variable	Agricultural Banks		NonAgricultural Banks	
	Translog without Risk	Translog with Risk	Translog without Risk	Translog with Risk
ln(NonAgricultural Loans)	0.589*** (0.0110)	0.596*** (0.0112)	0.929*** (0.00367)	0.919*** (0.00361)
ln(Agricultural Loans)	0.254*** (0.0117)	0.258*** (0.0120)	0.0614*** (0.00253)	0.0598*** (0.00248)
ln(PLabor)	0.401*** (0.0228)	0.410*** (0.0246)	0.257*** (0.0139)	0.302*** (0.0143)
ln(PCapital)	0.597*** (0.0229)	0.588*** (0.0247)	0.713*** (0.0124)	0.670*** (0.0128)
ln(Risk)		-0.00646*** (0.00202)		-0.0129*** (0.00135)
ln(PLabor) <sup>2</sup>	0.384*** (0.0338)	0.344*** (0.0471)	0.162*** (0.0181)	0.153*** (0.0257)
ln(PLabor)*ln(PCapital)	-0.398*** (0.0321)	-0.356*** (0.0442)	-0.205*** (0.0159)	-0.216*** (0.0211)
ln(PCapital) <sup>2</sup>	0.382*** (0.0360)	0.336*** (0.0466)	0.169*** (0.0160)	0.197*** (0.0191)
ln(NonAgricultural Loans) <sup>2</sup>	0.174*** (0.0113)	0.182*** (0.0118)	0.0618*** (0.00180)	0.0548*** (0.00184)
ln(NonAgricultural Loans)*ln(Agricultural Loans)	-0.123*** (0.0115)	-0.125*** (0.0121)	-0.00739*** (0.00100)	-0.00604*** (0.00101)
ln(Agricultural Loans) <sup>2</sup>	0.163*** (0.0145)	0.145*** (0.0152)	0.0190*** (0.000926)	0.0173*** (0.000913)
ln(PLabor)*ln(NonAgricultural Loans)	0.0173 (0.0160)	0.0134 (0.0180)	-0.0891*** (0.00478)	-0.0779*** (0.00526)
ln(PCapital)*ln(NonAgricultural Loans)	-0.0228 (0.0160)	-0.0230 (0.0178)	0.0896*** (0.00433)	0.0821*** (0.0047)
ln(PLabor)*ln(Agricultural Loans)	-0.0369** (0.0179)	-0.0371* (0.0200)	0.0219*** (0.00381)	0.0246*** (0.00399)
ln(PCapital)*ln(Agricultural Loans)	0.0566*** (0.0180)	0.0527*** (0.0199)	-0.0209*** (0.00357)	-0.0233*** (0.00374)
Constant	7.947*** (0.00839)	7.953*** (0.00867)	10.57*** (0.00551)	10.57*** (0.00545)
Observations	6,460	5,715	17,832	16,296
R-squared	0.968	0.969	0.968	0.970
F	13706	11905	38230	34877

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 4 2007 Commercial Banks Analysis TwoOutputs Condition

## 5.2 Analyzing 2011 Commercial Banks

Upon completion of the research in 2007, we switch our view to 2011, by analyzing 2011 commercial banks data from Federal Reserve Bank. In our analysis, we notice that the number of banks which could be defined as agricultural banks is less than the amount of banks which could be defined as the nonagricultural banks, which is similar as in 2007. For the differentiation of 2011 commercial banks' categories, the amount of nonagricultural banks is about three times as many as the amount of agricultural banks. When we compared the commercial banks' data collected from the Federal Reserve Banks for 2007 and 2011, we could infer that the 2011 data is substantially less than 2007 data. Based on the definition of agricultural banks (Federal Deposit Insurance Corporation definition), 1,927 commercial banks (less than seven thousand groups of banks' raw quarterly data) could be defined as agricultural banks, and more than five thousand and two hundred banks (more than twenty thousand groups of banks' raw data) could be defined as nonagricultural banks. Table 2 summarizes the total cost (tc), total loans (y), non-agricultural loans (y1), agricultural loans (y2), average cost of labor (wl), average cost of capital (wfc), and average fixed cost (wk). Total costs, cost of labor, cost of capital and outputs---total loans as well as agricultural loans and nonagricultural loans are measured in thousands of dollars. In this research, we use transformed variables by first normalizing and then meanscaling each of the variables for ease of interpretation.

After finishing all these steps for transformation, like the analyzing steps for 2007 commercial banks' performance, I start the 2011 analysis based on the model with the



one output condition (total loans ( $y$ )). I estimate Cobb-Douglas specification for agricultural banks and nonagricultural banks separately. In addition, I specify Translog model and analyze the data. Since the Cobb-Douglas functional form is a subset of the Translog, I test to see which is more appropriate. Ramsey RESET test and F test with a null hypothesis of the additional Translog terms are jointly equal to zero is appropriate. The results from the test of the joint significance of the model's first equation additional variables with F-statistics reject the null hypothesis. We know that all the P-values of our predictors are very small (0.000), so predictors are significant and thus associated with total cost's ( $tc$ ). Based on this conclusion, we could consider the Translog regression approach as suitable approach for the second equation analysis.

For the data from 2011, we also consider two specifications in 2011. In the first specification, we only consider total loans ( $y$ ), in the second specification, we do the estimation with considering nonagricultural loans ( $y_1$ ) and agricultural loans ( $y_2$ ) separately, and apply Translog regression approach to analyze the banking performance.

The main purpose of this study is to learn if the agricultural banks are as efficient as nonagricultural banks and to discover any changes in efficiency from 2007 to 2011. Since the data are normalized and meanscaled, the coefficient on the  $y$  variable---output, and the sum of  $y_1$  and  $y_2$  in the specification of nonagricultural loans and agricultural loans are compared to one to describe scale efficiency---increasing, decreasing or constant returns to scale. We test if the estimated coefficient on outputs is equal to one, if it is equal to one, the banks have constant returns to scale. If the coefficient is less than one, the banks have increasing returns to scale, and if coefficient is more than one, they have decreasing returns to scale.

Table 5 shows that in specifications with one output---total loans--- with and without risk both agricultural banks and nonagricultural banks seem to have constant return to scale because the coefficient of total loans is equal to one. For 2011 banking performance analysis, we could conclude that there are constant returns to scale.

Table 5 also indicate the differences in the scale economies with and without risk factor with output measure as the total value of loans. The results for both agricultural banks and nonagricultural banks indicate that higher level of risk is associated with higher costs. The magnitude of the coefficients is small and one percent increase in the loans overdue more than 90 days (risk) is associated with 0.0179 increase in total costs in agricultural banks and an increase of 0.00254 in nonagricultural banks. Table 6 which presents results from specification where output is split in agricultural loans and nonagricultural loans indicates that the statistically significant positive relation but magnitude is small. Compared with 2007 risk coefficient for agricultural banks, the magnitude of 2011 agricultural banks is bigger than 2007 agricultural banks', risk is economically significant for 2011 agricultural banks.

The estimated coefficients of the rest of the variables in Table 5 are also consistent with the expectations. Increase in labor costs is associated with much higher increase in cost relative to increase in the cost of capital for agricultural banks (0.718 and 0.364 respectively), while this impact is 0.566 and 0.541 in nonagricultural banks for specifications without risk (first columns for agricultural banks and nonagricultural banks in Table 5).

Table 6 show the models where we use nonagricultural loans (y1) and agricultural loans (y2) instead of total loans (y) to discover 2011 banking industry with default risk

involved. The estimated results show that agricultural banks are further away from constant returns to scale than are nonagricultural banks. The summation of the coefficients of  $y_1$  and  $y_2$  of 0.805 suggest increasing returns to scale while that in nonagricultural banks are very close to constant returns to scale. The same direction relation holds in a specification that accounts for the risk level of the banks. The summation of the coefficients of  $y_1$  and  $y_2$  is 0.812 which means that agricultural banks do not have constant returns to scale. For 2011 agricultural banks analysis, when there is no risk factor in the model, agricultural banks' total cost could increase by 0.805 due to increasing agricultural loans and nonagricultural loans, but when there is risk in the model, the result shows that agricultural banks' total cost increase by 0.812 due to increasing agricultural loans and nonagricultural loans. So for 2011 agricultural banks analysis, we underestimate when there is no risk in the model.

Based on all the results of 2011 banking efficiency analysis with risk factor, we could conclude that our specifications are adequate and agricultural banks are too small relative to nonagricultural banks. The result on risk suggest that the banks could decrease total cost by taking less risk which is different compared with 2007 where the sign was negative but its magnitude economically small.

Variable	Agricultural Banks		NonAgricultural Banks	
	Translog without Risk	Translog with Risk	Translog without Risk	Translog with Risk
ln(Total Loans)	0.950*** (0.0140)	0.936*** (0.0149)	1.007*** (0.00434)	0.962*** (0.00474)
ln(PLabor)	0.718*** (0.0285)	0.730*** (0.0305)	0.566*** (0.0107)	0.602*** (0.0113)
ln(PCapital)	0.364*** (0.0255)	0.339*** (0.0269)	0.541*** (0.00862)	0.475*** (0.00941)
ln(Risk)		0.0179*** (0.00262)		0.00254 (0.00195)
ln(PLabor) <sup>2</sup>	0.126*** (0.0323)	0.130*** (0.0351)	0.120*** (0.0102)	0.0959*** (0.0111)
ln(PLabor)*ln(PCapital)	-0.127*** (0.0243)	-0.120*** (0.0257)	-0.188*** (0.00702)	-0.161*** (0.00783)
ln(PCapital) <sup>2</sup>	0.0768*** (0.0199)	0.0689*** (0.0202)	0.156*** (0.00579)	0.119*** (0.00656)
ln(Total Loans) <sup>2</sup>	0.0861*** (0.00542)	0.0765*** (0.00598)	0.0900*** (0.00164)	0.0638*** (0.00208)
ln(PLabor)*ln(Total Loans)	-0.00754 (0.0103)	-0.00209 (0.0113)	-0.0547*** (0.00328)	-0.0399*** (0.00406)
ln(PCapital)*ln(Total Loans)	0.0394*** (0.00922)	0.0299*** (0.00996)	0.0943*** (0.00257)	0.0682*** (0.00337)
Constant	8.952*** (0.0212)	8.963*** (0.0217)	10.28*** (0.00717)	10.28*** (0.00715)
Observations	6,152	5,541	20,325	19,434
R-squared	0.958	0.958	0.940	0.942
F	15378	12523	35425	31736

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5 2011 Commercial Banks Analysis OneOutput Condition

Variable	Agricultural Banks		NonAgricultural Banks	
	Translog without Risk	Translog with Risk	Translog without Risk	Translog with Risk
ln(NonAgricultural Loans)	0.615*** (0.0108)	0.617*** (0.0115)	0.926*** (0.00567)	0.921*** (0.00568)
ln(Agricultural Loans)	0.190*** (0.0118)	0.195*** (0.0125)	0.0803*** (0.00363)	0.0795*** (0.00362)
ln(PLabor)	0.744*** (0.0162)	0.744*** (0.0171)	0.613*** (0.0138)	0.615*** (0.0138)
ln(PCapital)	0.292*** (0.0148)	0.284*** (0.0155)	0.426*** (0.0109)	0.417*** (0.0108)
ln(Risk)		0.00577** (0.00250)		0.00240 (0.00203)
ln(PLabor) <sup>2</sup>	0.123*** (0.0303)	0.123*** (0.0330)	0.111*** (0.0124)	0.119*** (0.0125)
ln(PLabor)*ln(PCapital)	-0.111*** (0.0228)	-0.106*** (0.0242)	-0.175*** (0.00865)	-0.181*** (0.00869)
ln(PCapital) <sup>2</sup>	0.0511*** (0.0187)	0.0471** (0.0191)	0.108*** (0.00705)	0.108*** (0.00701)
ln(NonAgricultural Loans) <sup>2</sup>	0.175*** (0.0121)	0.179*** (0.0143)	0.0591*** (0.00248)	0.0547*** (0.00252)
ln(NonAgricultural Loans)*ln(Agricultural Loans)	-0.130*** (0.0124)	-0.130*** (0.0144)	-0.00175 (0.00140)	-0.000417 (0.00141)
ln(Agricultural Loans) <sup>2</sup>	0.162*** (0.0155)	0.149*** (0.0174)	0.0190*** (0.00125)	0.0182*** (0.00126)
ln(PLabor)*ln(NonAgricultural Loans)	0.00474 (0.0134)	0.0248 (0.0152)	-0.0547*** (0.00476)	-0.0543*** (0.00484)
ln(PCapital)*ln(NonAgricultural Loans)	0.0104 (0.0123)	-0.00739 (0.0139)	0.0683*** (0.00384)	0.0632*** (0.00389)
ln(PLabor)*ln(Agricultural Loans)	-0.0106 (0.0155)	-0.0256 (0.0168)	0.0330*** (0.00355)	0.0304*** (0.00359)
ln(PCapital)*ln(Agricultural Loans)	0.0335** (0.0144)	0.0398*** (0.0154)	-0.0317*** (0.00296)	-0.0281*** (0.00299)
Constant	7.713*** (0.00907)	7.728*** (0.00938)	10.38*** (0.00906)	10.39*** (0.00902)
Observations	6,152	5,541	16,046	15,463
R-squared	0.963	0.963	0.951	0.951
F	11357	9515	22054	19809

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 6 2011 Commercial Banks Analysis TwoOutputs Condition

### **5.3 Changes Among Commercial Banks From 2007 to 2011**

Because 2007 and 2011 are two important years in the recent financial crisis period, comparing these two years' analyzing results could help to gain some insights about the change of banking industry performance before and after the worst economic environment year: 2008. When there is risk in the model, for 2007 agricultural banks, the coefficient of nonagricultural loans is 0.596, and the coefficient of agricultural loans is 0.258. For 2011 agricultural banks' analysis with risk, the coefficient of nonagricultural loans is 0.617, and the coefficient of agricultural loans is 0.195. For these two years' agricultural banks, agricultural loans' magnitude is smaller than nonagricultural loans, so the increasing of agricultural loans could increase less in total cost compared with the increasing unit by nonagricultural loans, and the agricultural loans could increase agricultural banks' total cost less in 2011. In addition, for nonagricultural banks' analysis, when there is risk in the model, the coefficient of nonagricultural loans is 0.919 and the coefficient of agricultural loans is 0.0598 in 2007. Based on 2011 nonagricultural banks' analysis with risk, the coefficient of nonagricultural loans is 0.921 and the coefficient of agricultural loans is 0.0795. Then for nonagricultural banks, the magnitudes of agricultural loans are smaller than nonagricultural loans' for both of the years, and the agricultural loans could increase total cost of nonagricultural loans more units in 2011 compared its impact in 2007. When there is risk considered in the model, for agricultural banks in 2007, the total cost could increase by 0.854 due to increasing agricultural loans and nonagricultural loans. For 2011 agricultural banks analysis, when there is risk in the model, the result shows that agricultural banks' total cost increase by 0.812 due to

increasing agricultural loans and nonagricultural loans. Based on the risk related analysis for 2007 and 2011, agricultural banks were going through consolidation and agricultural loans and nonagricultural loans returns to scale is higher in 2007. For nonagricultural banks' risk related analysis, nonagricultural banks' total cost increases by 0.9788 around 1 due to increasing agricultural loans and nonagricultural loans in 2007, and total cost increases by 1.0005 around 1 due to increasing agricultural loans and nonagricultural loans in 2011. Then, nonagricultural banks' agricultural loans and nonagricultural loans return to scale becomes slightly higher in 2011.

In conclusion, based on agricultural loans and nonagricultural loans' coefficients in these two years, nonagricultural banks (0.979-2007, 1.001-2011) are more efficient than agricultural banks (0.854-2007, 0.812-2011), because nonagricultural banks' loans' coefficients are almost always equal to one, which means nonagricultural banks have achieved constant returns to scale. For agricultural banks, agricultural banks have increasing returns to scale, and these increase in 2011 relative to 2007. These results suggest that the agricultural banks that failed were not necessarily the least efficient and that there may be other reasons for their failure.

When comparing the influence of default risk on banking performance, the default risk has negative effect on the total cost in 2007, yet has positive effect on the total cost in 2011. Based on our analyzing results, when considering risk's effect in banking performance, banks' operation is more efficient in 2011. In 2007, all the banks could make decision to decrease their total cost by increasing risk level, which is counterintuitive. Therefore, if costs fall when banks take more risk, the all banks would take unnecessary risks and jeopardize depositors savings bringing hidden danger to the

banks. Such wrong strategies and the short term interest preference could be part of the reason for financial crisis and thus we see economically insignificant but statistically significant relationship which likely suggest bank took more risk than they should have. After 2008, in 2011, based on our analyzing results, bank's cost increase with risk as it should be expected. That coefficient of risk is larger for agricultural banks, suggesting that agricultural banks have economically significant relationship with risk, and take more risk would increase their cost and decrease their profit. It seems that financial crisis makes decision makers of banking industry calm down to more risk averse.



## Chapter 6

### Conclusion

In this research, we compared two significant years in this detrimental financial crisis timeline, 2007 and 2011. We considered these two years extraordinary, because 2007 is the last year before the great recession. In 2007, banking industry, real estate industry and any other financial industries and markets were unprecedented prosperous; 2007 seemed to be a booming economic year. Under the unique circumstance, there has been some phenomenon indicating the coming economics disaster. While some people in these industries recognized the emerging problems they were not able to prevent the risk taking and the negative consequences that followed.

This paper uses Translog cost function specification and incorporates default risk to analyze coefficient of agricultural and nonagricultural banks for 2007 and 2011. We find that the risk factor is negative and statistically significant but of a very small magnitude in 2007 commercial banks. However, it is positive and economically significant in 2011 agricultural banks' analysis. In addition, for agricultural banks, which have gone through consolidation and with specification separating agricultural loans from nonagricultural loans, we find that returns to scale is higher in 2007 that it was in 2011. Due to 2008 financial crisis, there were about thousand bankruptcy commercial banks from 2007 to 2011 in the United States, with the number of bankruptcy agricultural banks of only 315. Consequently, agricultural banks' performance is better than nonagricultural

banks prior to the financial crisis period. However, nonagricultural banks' loans' coefficients (0.979-2007, 1.001-2011) are almost always equal to one, which means nonagricultural banks have achieved constant returns to scale and agricultural banks' loans' coefficients (0.854-2007, 0.812-2011) were less than one, which means agricultural banks have increasing returns to scale.

Additionally, agricultural loans having increasing returns to scale are more than nonagricultural loans returns to scale, and agricultural banks increasing returns to scale is more in 2011 after financial crisis. The results also show that banks could reduce their total cost by extending riskier loans when doing business in 2007, meaning that when banks take more risk, they would earn more profit. But in 2011, after the 2008 severe financial crisis year, more risk meant higher cost and thus was less desirable. 2011 is considered as the end of the severe financial crisis, people began to rethink the financial crisis and the causes of it, so when facing with risk, banks could become more careful and calm, and they would make some decisions not only aiming to the profit or revenue, but also taking care of the risk's influence on long-term banking performance more than before.

All of these indicators from the results could offer a clue about what happened before 2008 financial crisis and the changes on banking operation strategy after banks surviving from the great economics recession. This paper focuses on the banking industry, especially agricultural banks and nonagricultural banks. No matter which categories of banks, the 2008 financial crisis' influence is similar. There were many factors that contributed to the financial crisis, and for different industries, these elements' influences would be at different levels. With some influential factors in banking industry, such as

prices of labor and capital which we integral part of the research, when the banks' decision makers face with the adverse economic environment, it is not easy for them to deal with these costs of the operation. In the future research, there should be more years including in the research, such as considering three to five years or more years prior and after financial crisis, to discover if the forecast of financial crisis could be caught earlier. In addition, the future research could observe the economic recovery and learn the recovery strategies with studying more years after financial crisis. In the same time, the future research should also consider regulations, government assistance and other macroeconomic factors in the analysis.

## Bibliography

Steelman, A., & Weinberg, J. A. (2015). The Financial Crisis: Toward an Explanation and Policy Response. *Federal Reserve Bank of Richmond 2008 Annual Report*, 5-17.

Hartarska, V., Nadolnyak, D., & Shen, X. (2015). Agricultural credit and economic growth in rural areas. *Agricultural Finance Review*, 75(3), 302-312.

Hartarska, V., Shen, X., & Mersland, R. (2013). Scale economies and input price elasticities in microfinance institutions. *Journal of Banking & Finance*, 37(1), 118-131.

Bernstein, D. (1996). Asset quality and scale economies in banking. *Journal of Economics and Business*, 48(2), 157-166.

Weill, L. (2003). Banking efficiency in transition economies. *Economics of transition*, 11(3), 569-592.

Raskin, S. B. (2011). *Putting the low road behind us: a speech at the 2011 Midwinter Housing Finance Conference, Park City, Utah, February 11, 2011*(No. 562).

Ivashina, V., & Scharfstein, D. (2010). Bank lending during the financial crisis of 2008. *Journal of Financial Economics*, 97(3), 319-338.

Neff, D. L., Dixon, B. L., & Zhu, S. (1994). Measuring the efficiency of agricultural banks. *American Journal of Agricultural Economics*, 76(3), 662-668.

Clark, J. A. (1996). Economic cost, scale efficiency, and competitive viability in banking. *Journal of Money, Credit and Banking*, 28(3), 342-364.

Koutsomanoli-Filippaki, A., Mamatzakis, E., & Staikouras, C. (2009). Structural reforms and banking efficiency in the new EU States. *Journal of policy Modeling*, 31(1), 17-21.

Settlage, D. M., Preckel, P. V., & Settlage, L. A. (2009). Risk-adjusted efficiency and risk aversion in the agricultural banking industry. *Agricultural Finance Review*, 69(3), 314-329.

Choi, O., Stefanou, S. E., & Stokes, J. R. (2007). Efficiency differences of US agricultural banks. *Agricultural Finance Review*, 67(1), 55-73.

Li, X., Escalante, C. L., Epperson, J. E., & Gunter, L. F. (2013). Agricultural lending and early warning models of bank failures for the late 2000s Great Recession. *Agricultural Finance Review*, 73(1), 119-135.

Hughes, J. P., & Mester, L. J. (2013). Who said large banks don't experience scale economies? Evidence from a risk-return-driven cost function. *Journal of Financial Intermediation*, 22(4), 559-585.

Shen, X., & Hartarska, V. (2012). Derivatives at agricultural banks. In *SAEA Annual Meeting, Birmingham, AL*.

Song, M., Li, X., & Escalante, C. (2015). A Comparative Analysis of Technical Efficiency and Input Allocation Decisions of Farm Lenders in the Commercial Banking Industry and the Farm Credit System during the Late 2000s Recession. In *2015 Annual Meeting, January 31-February 3, 2015, Atlanta, Georgia* (No. 196696). Southern Agricultural Economics Association.

Shen, X., & Hartarska, V. M. (2013). Risk Management in Agricultural Banks: An Application of Endogenous Switching Model. In *2013 Annual Meeting, February 2-5, 2013, Orlando, Florida* (No. 143092). Southern Agricultural Economics Association.

Aliaga-Díaz, R., & Olivero, M. P. (2010). Is there a financial accelerator in US banking?: Evidence from the cyclicity of banks' price–cost margins. *Economics Letters*, *108*(2), 167-171.

Li, X., Escalante, C. L., Epperson, J. E., & Gunter, L. F. (2012). Technical efficiency and the probability of bank failure among agricultural and non-agricultural banks. In *Agricultural and Applied Economics Association 2012 Annual Meeting, Seattle, August* (pp. 12-14).

Shen, X. (2013). *Financial Derivatives and Bank Performance* (Doctoral dissertation, Auburn University).

Kondeas, A. G. (1998). *Banking efficiency in the European Union: 1989-1995*. (Doctoral dissertation, Auburn University).

Michaelides, P. G., Tsionas, E. G., Vouldis, A. T., & Konstantakis, K. N. (2015). Global approximation to arbitrary cost functions: A Bayesian approach with application to US banking. *European Journal of Operational Research*, *241*(1), 148-160.

Greenbaum, S. I. (1965). Banking Structure And Costs: A Statistical Study Of The Cost-Output Relationship In Commercial Banking. *The Journal of Finance*, *20*(1), 103-104.

Lawrence, C. (1989). Banking costs, generalized functional forms, and estimation of economies of scale and scope. *Journal of money, credit and banking*, *21*(3), 368-379.

Honohan, P., & Klingebiel, D. (2003). The fiscal cost implications of an accommodating approach to banking crises. *Journal of Banking & Finance*, *27*(8), 1539-1560.

Berger, A. N., & Humphrey, D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European journal of operational research*, *98*(2), 175-212.

Berger, A. N., & DeYoung, R. (1997). Problem loans and cost efficiency in commercial banks. *Journal of Banking & Finance*, *21*(6), 849-870.

Pulley, L. B., & Braunstein, Y. M. (1992). A composite cost function for multiproduct firms with an application to economies of scope in banking. *The Review of Economics and Statistics*, 221-230.

Wu, T., Caudill, S. B., Gropper, D. M., Hartarska, V., & Mixon Jr, F. G. (2012). Does Input Substitutability in Banking Differ across Accession and Non-Accession Countries in Central and Eastern Europe?. *Journal of Economic Integration*, 195-205.

Caudill, S. B., Gropper, D. M., & Hartarska, V. (2012). Microfinance institution costs: effects of gender, subsidies and technology. *Journal of Financial Economic Policy*, *4*(4), 292-304.

Belkhir, M. (2009). Board structure, ownership structure and firm performance: evidence from banking. *Applied financial economics*, *19*(19), 1581-1593.

Johnson, J. (2009). Rural Economic Development in the United States An Evaluation of the US Department of Agriculture's Business and Industry Guaranteed Loan Program. *Economic Development Quarterly*, 23(3), 229-241.

Mishra, A. K., Moss, C. B., & Erickson, K. W. (2008). The role of credit constraints and government subsidies in farmland valuations in the US: an options pricing model approach. *Empirical Economics*, 34(2), 285-297.

Chortareas, G., Kapetanios, G., & Ventouri, A. (2016). Credit market freedom and cost efficiency in US state banking. *Journal of Empirical Finance*, 37, 173-185.

Hussain, M. E., & Hassan, M. K. (2012). Competition, Risk Taking and Efficiency in the US Commercial Banks Prior to 2008 Financial Crisis. *Available at SSRN 2003066*.

Greene, W. H. (2000). *Econometric analysis*.

Federal Reserve Bank of Chicago - Federal Reserve Bank of Chicago. (n.d.). Retrieved September 23, 2016, from <https://www.chicagofed.org/>

Federal Reserve Economic Data - FRED - St. Louis Fed. (n.d.). Retrieved September 23, 2016, from <https://fred.stlouisfed.org/>

## Appendix

Table 1 Variables' Definition and Calculation

Variable	Definition and Calculation
y	Total Loans=Total Loans and Leases
y1	Nonagricultural Loans=Total Loans and Leases-Farmland Loans Secured by Real Estate-Loans to Finance Agricultural Production and Other Loans to Farmers
y2	Agricultural Loans=Farmland Loans Secured by Real Estate+Loans to Finance Agricultural Production and Other Loans to Farmers
ql	Number of Full Time Employees at End of Period
wl	Average Cost of Labor=Salaries and Employee Benefits/Number of Full Time Employees at End of Period
qfc	Total Liabilities
wfc	Average Cost of Capital=Total Interest Expense/Total Liabilities
qk	Premises and Fixed Assets
wk	Average Fixed Cost=Expenses of Premises and Fixed Assets/Premises and Fixed Assets
tc	Total Cost=Salaries and Employee Benefits+Expenses of Premises and Fixed Assets+Total Interest Expense
risk	Default Risk=Non-performing Loans/Total Loans

Equation 1

Based on call report FFIEC 041,

Non-performing loans = rconf174+rconf176+rconf175+rconf177+rcon3494  
+rcon3495+rcon5399+rcon5400+rconc237+rconc229+rconc239+rconc230+rcon3500+rc  
on3501+rconf180+rconf182+rconf181+rconf183+rconb835+rconb836+rcon1607+rcon1  
608+rconb576+rconb577+rconb579+rconb580+rcon5390+rcon5391+rcon5460+rcon546  
1+rcon1227+rcon1228+rcon3506+rcon3507+rcon5613+rcon5614+rcon5616+rcon5617+  
rconc867+rconc868+rcon1659+rcon1661+rcon6559  
+rcon6560+rcon1249+rcon1250+rcon5381+rcon5382+rcon1255+rcon1256  
+rconf167+rconf168+rcon1597+rcon1583+rconc241+rconc226+rcon3530+rconc410+  
rconc411

Equation 2

Based on call report FFIEC 002,

Non-performing loans= rcd1607+ rcd1608+ rcd1422+ rcd1423+ rcd3184+  
rcd3185+ rcd1624+ rcd1625+ rcd1629+ rcd1582+ rcd3530+ rcd740+ rcd741+  
rcd742+ rcd743+ rcd744+ rcd745+ rcd746+ rcd767+ rcd768+ rcd769