DETERMINING THE IMPACT OF A NEW FARM CREDIT

BRANCH IN EAST CENTRAL OKLAHOMA

By

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Abstract: As a major provider of credit to agricultural producers, continuity of business is an important concern for Farm Credit. This study seeks to estimate the change in annual new loan volume that a new Farm Credit branch would generate using county market and spatial characteristics. Annual new loan volume data from Farm Credit of East Central Oklahoma for each of the 51 counties in the region from 1993 to 2012 are regressed against each county's proximity to an office, total cash receipts for crops and livestock, acres rented, and value of agricultural real estate. Results confirm that annual new loan volume is significantly impacted by distance from potential borrowers in the county to the nearest lending office, acres of agricultural land rented, and value of agricultural real estate. Loan volume predictions are used to simulate the impact of additional Farm Credit offices, including offices recently opened. The methodology utilized here allows Farm Credit to predict the financial consequences of opening a new branch, allowing for more profitable branch placement decisions. The existing literature focuses on the effect of credit availability on agricultural production and lacks specificity and a managerial perspective of the effect of producers' characteristics on the success of the Farm Credit System. In contrast, this research offers detailed insight into the profitability of additional offices in East Central Oklahoma.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The Farm Credit System is a vital source of credit for farmers and producers in America. Since

its formation in 1916 as a network of a dozen federal Land Banks, Farm Credit has evolved from

a much-needed solution to an industry threatening credit shortage to rapidly growing cooperative

of 78 local associations and four Farm Credit banks (Farm Credit Network, 2014). Today, nearly

one third of rural American's financing needs are met by the Farm Credit System (Farm Credit of

East Central Oklahoma, 2014). Providing reliable credit at competitive rates is part of Farm

Credit's mission of serving American agriculture and the foundation of this research. The

availability of capital is a substantial concern for farm operators of all corporate structures but for

small family farms, the issue is paramount. In 2007, 84.7% of farms in Oklahoma were family-

owned and operated sole proprietorships (USDA NASS, 2014). Family farms are typically

financed through owner equity as opposed to corporate shareholders or stock investors. To

supplement owner equity, producers may also hold debt to finance operating costs and equipment

purchases. Often, the debt of a family farm is secured by real estate that also includes the family's

home. The foreclosure of this real estate would mean much more than simply the loss of business

assets. Thus, it is important for these types of borrowers to have access to affordable, reliable

credit to finance their operations. There are several options for financing farms including

commercial banks, credit unions, and personal lending. However, not all l lending institutions

offer products that are specifically designed for a seasonal payoff structure. Additionally, many

retail lending institutions perceive some aspects of agricultural production as higher in risk than other small businesses. Operational lines of credit for a farm can be secured by the actual livestock or crops during the production process. The idea of loans secured by living collateral may be perceived as more risky to a lending institution that does not typically lend for agricultural purposes. With small farms especially, credit may be offered but at a higher rate than would be offered to a non-farm business (Bard et al., 2000). The Farm Credit System provides an agriculturally specialized, nationally covered, borrower-owned financial solution specifically tailored to farmers' needs.

Problem Statement

The location and availability of credit suppliers are important to the profitability of agricultural producers in the surrounding areas (Ciaian and Falkowski, 2012). In fact, according to Briggeman et al. (2009), an increase in capital availability could increase agricultural production and profit. Conversely, market demographics in an area are important to the profitability and success of the Farm Credit System. Operation characteristics may indicate the credit needs of a particular region. In addition, the relative location of Farm Credit branches to a specific location can be indicative of the credit availability to the region. How do agricultural market dynamics and proximity to a Farm Credit lender affect new loan volume of Farm Credit? Further, as a major provider of credit to farmers and operators, continuity of business is an extremely important concern for Farm Credit. Farm Credit of East Central Oklahoma has added two branches in the last 20 years. The decision of new branch location was based on the success of field offices currently in those locations and gaps in market coverage (Sutterfield and Burk, 2014). There is no procedure in place to determine the optimal location of a new branch in a new location. The addition of a new branch could potentially benefit producers in the area by decreasing transportation cost and making Farm Credit a more convenient source of credit. However, if the additional loan volume the branch would generate does not exceed the cost of building the branch, it is economically inefficient and will result in profit loss.

Objectives

The subject of this research is Farm Credit of East Central Oklahoma (FCECO). The objective of this study is to estimate the change in annual new loan volume that a new lending office (branch or field office) would generate. Specifically, this study models long-term annual new loan volume of the area affected by the new office and determines the impact on the entire East Central Farm Credit region. Results are used to simulate the impact of adding additional Farm Credit offices, including offices recently opened. The methodology utilized here allows Farm Credit to predict the financial consequences of opening a new office, allowing for more profitable branch placement decisions.

Outline of Study

The remainder of this research is structured as follows. Chapter two reviews the existing literature on Farm Credit and relevant research on commercial bank structure, lending relationships, credit constraints, and credit supply and demand. Similar models are discussed in comparison with the model used in this study. Chapter three outlines the conceptual framework and relevant hypotheses behind this research. Chapter four discusses data sources, variable descriptions, and descriptive results. Chapter five includes a complete description of econometric procedures. Finally, chapter six concludes the paper with results and implications.

CHAPTER II

LITERATURE REVIEW

The economic impact and financial role of Farm Credit Service has been the subject of much scrutiny since the farm debt crisis in the mid-1980's. The changes in regulatory environment and subsequent restructuring of Farm Credit instigated research into the impact of bank structure and its effect on agricultural banking. Farm Credit's pivotal role in the financing of American production agriculture calls for consideration of credit supply and demand and the factors that determine them. This paper's focus on individual branch loan volume brings to light the importance of borrower-lender relationships in agricultural lending and their possible role in the profitability of both the farmer and lender. The literature reviewed for this study include relevant research on the Farm Credit System's structure and importance, credit supply and demand and their determinants, and lending relationships. In addition, overviews of studies evaluated to ascertain an appropriate model for this project are presented.

Farm Credit Services Structure and Impact

The wide range of financing options available to farmers today sets the stage for a competitive market across which cost in terms of interest rate and degree of agricultural specialization can be compared (Barry, 1980). The Farm Credit System in particular offers competitive rates by benefiting from government sponsorship and a cooperative structure. Some have called into question the viability of continuing government sponsorship, since this status is accompanied by greater lending restrictions than Farm Credit would face as a private enterprise

(Riemenschneider and Freshwater, 1995). However, Farm Credit's large size and national organization allows it to exploit the benefits of economy of size and the ability to specialize in agricultural and rural development lending (Barry, 1980).

A study of the effect of commercial bank structure and borrower characteristics on lending decisions by Bard et al. (2000) utilized a survey to analyze actual responses from agricultural lenders to three case loan applications. Each case farm differed in demographic and farm characteristics. The respondent banks' differ in affiliate dependence, rural or urban location status, size in terms of assets, equity-to-asset ratio, and agricultural loan ratio. Separate models were employed to determine the effects of both bank and borrower characteristics on the credit decisions: Tobit, OLS, and paired comparisons approach respectively. While bank characteristics were not found to have any economically significant impact on the loan decision, borrower characteristics did affect several aspects of the credit terms offered. This result implies that credit terms are affected more by demand factors such as farm size and structure than by supply-side characteristics.

To examine the demand-side factors affecting credit terms, Farley and Ellinger (2007) evaluated the effects of borrowers preferences for lenders on borrowers credit decisions. Farley and Ellinger postulated that the profitability of producers could be affected by borrower-lender relationships through cost and customer service benefits. Like Bard et al. (2000), Farley and Ellinger utilized a survey method to ascertain attitude measures such as price sensitivity and borrower loyalty. Characteristics such as age, education, farm size, tenure, leverage, off-farm income, and sources of credit were regressed against respondent's attitudes towards price sensitivity and loyalty. An interesting result of the study indicated that borrowers of Farm Credit Services are likely to be highly price sensitive and less loyal to a particular lender.

To further investigate the effect of lending relationships, the analysis of single versus multiple lender use by Brewer et al. (2014) is considered. Farm-level data were obtained from the Kansas Farm Management Association and used to determine how farm characteristics affect the

number of lending relationships held. A Poisson regression model was developed with number of lending relationships as a function of the year which the data represents, current ratio, debt-to-asset ratio, age of farm operator, and return on assets for a farm. Results indicated that farmers develop multiple lending relationships as a result of increasing leverage and financial risk. The reason for this may be that spreading debt across multiple institutions may give the appearance of less debt to each institution, and increase the probability of credit approval. Further, a profit margin model indicated that farmers holding more lending relationships showed less profitability than those holding only one relationship. This may be in part because multiple lending relationships increase transaction costs of debt, decreasing profit.

Credit Supply and Demand

The availability of credit is crucial to the profitability of agricultural producers and to the productivity of the agricultural sector as a whole. The extent to which credit constraints impact the agricultural industry can be determined by quantifying the effect of credit constraints on production. Briggeman, Towe, and Morehart (2009) employed a propensity score-matching estimator to determine how credit constraints affect production in both farm and non-farm sole proprietorships. The results of their study suggest that the production of credit constrained sole proprietorships can be significantly lower than those that are not credit constrained. Specifically, credit constrained farm sole proprietorships can face decreases in value of production of approximately $39,000. A similar study by Ciaian, Falkowski, and Kancs (2012) utilized a matching estimator to analyze how farm production, as well as input use, is related to credit availability in the Central and Eastern Europe transition countries. The results of this study indicate that production increases up to 1.9 percent per 1,000 EUR of additional credit. Variable input and capital investments are also increased by additional credit: 2.3 and 29 percent, respectively.

Ahrendsen et al. (1994) determined factors affecting agricultural credit supply in Arkansas commercial banks and identified characteristics that were important to lenders'

6

portfolio decisions, loan funds availability, and loan market size. Risk of farm business income (the creditors' risk aversion), growth in number of farms relative to total population growth, number of banks in the county, and metropolitan status all had a significant impact agricultural loan-to-deposit ratios at the 0.05 level. Loan market size analysis reveals that the value of farmland and property values has a positive significant impact at the 0.01 level. The implication of this result is that higher land values increase agricultural loans outstanding, explainable by the fact that farmland is very commonly used as collateral, creating the opportunity for higher value loans.

In determining which factors affect loan demand, Katchova's (2005) analysis of factors affecting credit use was considered. Agricultural Resource Management Study (ARMS) data were used to determine the significance of farm and personal characteristics on credit use, degree of indebtedness, and degree of loan consolidation for U.S. farms of varying sizes. This analysis is unique in that it considers credit use from the perspective of the borrowers rather than the creditors, essentially analyzing agricultural credit demand. Farm credit use is estimated using Probit models, and truncated Poisson models are used for degree of indebtedness and consolidation. Katchova (2005) determined that farm size, government payments, crop insurance, diversification, land ownership, farm structure, and operator age all impact credit use. Degree of indebtedness is impacted by fewer factors; most importantly, gross farm income and operator age. Degree of consolidation is impacted by gross farm income, crop insurance, and interest rate. It is concluded that higher gross farm income, operator age, and operators risk aversion (indicated by crop insurance use) all affect indebtedness. The relevant implication here is that farmers that own a higher proportion of their farmland are more likely to carry debt than those that rent land for farm use.

Further analysis of the loan demand is conducted by Howley and Dillon (2012) in their study of the role of farming attitudes towards debt accumulation on Irish farms. Farming attitudes were identified as goals for exploiting the social benefits of farming, maximizing profit,

and maximizing production. A survey asking respondents questions to determine their attitudes was sent to 607 farmers. An ordered logit model was developed to determine the effects of respondent characteristics on farm debt holdings. The pertinent result is that profit-oriented farmers are more likely to increase farm debt than output maximizers or lifestyle farmers.

Similar Models

A model of bank branch placement similar to the model in this study was used by Scaletta and Stokes (2003). To determine the optimum number, size, and location of branch locations from a managerial perspective, Scaletta and Stokes assessed three Pennsylvania Agricultural Credit Associations that had recently merged into a single system, AgChoice Farm Credit (ACA). A model was developed using the ACA's loan volume data prior to the merger to serve both motives of an Ag Credit system: profit-maximization and service-maximization. Solutions from the model identified the optimal configuration of the AgChoice Farm Credit system in terms of location and number of branches, personnel at each branch, and loan volume of each branch as well as the entire system. The total loan volume provided by the model, $505.6 million, was very comparable to actual total loan volume of AgChoice in 1999, $528.5 million. This article is similar to the research problem in this paper. While Scaletta's model seeks to maximize profit, the model utilized here determines the marginal impact of a branch in terms of loan volume, which serves to fulfill Farm Credit's mission of providing credit to agricultural farmers.

The spatial modelling techniques used in this study are similar to those used by Roe, Irwin, and Sharp (2002) in their model of the spatial structure of hog production. Changes in the swine industry including a movement to large-scale, specialized production units and increased vertical coordination caused a spatial reorganization of hog production in the U.S. Roe, Irwin, and Sharp look at the effects of spatial concentration, urban encroachment and population characteristics, input availability, firm productivity and specialization, local economic conditions, market access and regulatory stringency variables on hog production location. The effects of

8

these variables are considered on three different aspects of hog population: per county hog inventory in 1997, the change in per county hog inventory from 1992 to 1997, and hog inventory per farm in 1997. These three models account for production, change in production, and production intensity, respectively. The results of the study vary by region and model, but in general, industry infrastructure, as indicated by a spatial lag, are positively and significantly components of hog production location. The authors conclude that counties may hold some power in determining future levels of hog production through policies that affect tax rate and environmental regulations in the western counties, and human population levels and building activity in the eastern counties. The spatial lag and centroid-to-centroid distance measures used in Roe, Irwin, and Sharp's were adopted in the formulation of the model for this research.

The dataset for this project has both time series and cross sectional aspects. The model used in Barry et al. (2001) used farm-level data from the Illinois Farm Business Farm Management Association with similar structure. Barry et al. sought to determine the effects of farm structural characteristics, location, market information, and age of operator on the variability of net farm income. Econometric analysis involved the employment of two models: a cross sectional model that used 17-year averages of dependent and independent variables, and a time-series cross sectional model that used three-year moving averages of the variables over the entire 17-year-time period. Results from both models were obtained, but only the TSCS model showed significance in the size variable. This implies that changes in size over time impacts income variability, rather than just size alone. This notion was utilized in the development of the model for this research, so that data is analyzed on a per year basis, rather than strictly cross-sectional.

The previously discussed article by Bard et al. (2000) also contributed to the development of a model. While Bard et al. used loan-level data to estimate the granted loan amount based on case loan applications, the model for this research uses empirical data at the individual loan level to predict loan volume.

CHAPTER III

METHODOLOGY

Conceptual Framework and Hypotheses

The addition of a new Farm Credit branch or field office in East Central Oklahoma is expected to increase the annual new loan volume of FCECO by increasing convenience to borrowers through lower transportation costs and opportunity costs. It is hypothesized that annual new loan volume of FCECO in a particular county is a function of the county's proximity to an office, total cash receipts for crops, total cash receipts for livestock, acres rented, value of agricultural real estate, and operator age. The estimated effects of each variable are discussed below.

Behavioral Model

It is assumed that producers minimize costs of obtaining financing. Financing costs inherent to producers' financing decisions include interest rates, transportation costs, creditor fees, and search costs, among several others. The objective function for minimizing cost of borrowing can be expressed as

(2) $\min_{B_i \epsilon B} COB = COB(rate(B), dist(B), fees(B), Other(B))$

where *COB* is the cost to a producer of borrowing capital; *rate(B)* are interest rates available at various banks; *dist(B)* are the distances from the borrower to various banks, *fees(B)* are the fees that a borrower would pay at the various banks; and *Other(B)* are other factors (e.g., search costs)

affecting borrow costs. By solving (2) for the optimal B_i individual borrowers' demand for loans

for each bank in set B can be derived. The sum of all borrowers' derived demand within a county

will equal the county derived demand for borrowing at bank i.

Suppose a farmer in a particular county currently has to drive over an hour to the nearest

Farm Credit office. This would presumably discourage the farmer from using Farm Credit for

their financing needs by increasing both transportation and search costs. Now suppose a new

office is placed within 10 minutes of the farmer. If the farmer was not using Farm Credit because

of the inconvenience, expense of the traveling distance and visibility, he/she is now more likely to

use Farm Credit for future credit needs. It is expected that the distance between offices and

potential borrowers plays a significant role in the loan volume of a branch. The distance from the

centroid of a county to the nearest branch or field office is used as a proxy for the average

distance from farmers in the county to a lending office.   Distance between the centroid of a

county and a lending office is expected to be negatively related to loan volume for that county.

That is, the shorter the distance, the greater the predicted loan volume. This hypothesis is

supported by Farley and Ellinger (2007) who found that farmers who obtain credit from Farm

Credit Services tend to be highly price sensitive. It is reasonable to assume Farm Credit

borrowers would also be sensitive to other costs related to borrowing, including the cost of

transportation and search for credit providers to a distant branch.

Although distance is the variable of interest in this paper, other factors may also affect the

loan volume of FCECO. In order to more accurately estimate loan volume, this study also

considers market and demographic variables that affect the credit needs of producers in each

county. These factors include cash receipts for crops and livestock, acres rented, and value of

agricultural real estate and each is discussed below.

Cash Receipts for Crops and Livestock

Because farming requires significant cash investment with delayed income, operating

lines of credit are often taken by farmers to pay for costs such as planting and harvesting for a

crop farm, and purchasing and feeding, for a livestock operation. Operating notes are then paid

by the income from operations. Cash receipts are used to measure the income of a farm. As a

firm receives additional income, their need for credit to finance operations may decrease.

However, larger farms may have higher financing requirements. So, in net, the impact cannot be

signed *a priori*.

Acres Rented

In Katchova (2005) analysis of factors affected credit use, it was found that if rural

resident farmers own a higher proportion of their farmland, they are more likely to carry farm

debt. Conversely, if farmers rent land rather than own it, they have no need for real-estate loans,

which are typically larger than operating and machinery loans. So, acres rented is expected to be

negatively related to predicted loan volume.

Value of Agricultural Real Estate

The greatest credit requirement of farmers is the purchase of land, which is often also the

most valuable asset a farmer owns. Ahrendsen et al. (1994) found that as farmland and property

values increase, agricultural loans outstanding for Arkansas commercial banks also increase.

Higher property values allow for higher collateral values, increasing security for lenders and loan

amounts for borrowers. This concept is considered through the incorporation of the total value of

agricultural real estate (including buildings) in each county. The value of real estate in a county

is expected to be positively related to predicted loan volume for that county.

Data Sources and Considerations

Loan volume data were provided by Farm Credit Services of East Central Oklahoma.

The sample included observations (loans) in 51 counties in Oklahoma[1]. Annual new loan amounts

for each of the 51 counties in the region from 1993 to 2012 were computed by summing across

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[1] Cleveland County is in the East Central region, but the data did not include any loan volume for this county. It is assumed there was no loan activity in Cleveland County. Alfalfa County loans were included in the original data but there were only two loans in the data and Alfalfa County is not in the East Central (FCECO) territory. So, observations from Alfalfa County were deleted.

individual loans. FCECO currently has ten branch offices and 26 field offices. A branch office is defined as an established location with three to five loan officers working full time. A field office is often a single office rented from a local business with one loan officer working on a part-time basis. The market boundary of the East Central Region as well as the locations of the existing branch and field offices including those added in 2012 are represented in Figure A-1. All branches excepting the Ardmore and Poteau branches have been open for the entire study time range (Poindexter, 2014). There have been some changes in field office locations during the 20-year time period of this study. In 2004, a field office was opened in Ardmore, OK, in Carter County. In 2010, a field office was opened in Poteau, OK in LeFlore County. In 2011, the field office that was in Tonkawa, OK, (Kay County) was closed and a new office opened in Blackwell, OK, (also in Kay County). The Ardmore and Poteau field offices were open through 2012 until the opening of the new branches in these locations in 2013, which is outside the time range of this study. All changes in location through time are reflected in the distance variables. County-level market characteristics used to predict loan volume are represented by the total annual cash receipts for crops and livestock, acres of agricultural land rented from others, value of agricultural real estate per acre, and operator age. Acres rented and value of agricultural real estate were obtained from USDA's National Agricultural Statistics Service, and cash receipts for crops and livestock were obtained directly from the Bureau of Economic Analysis regional data on farm income and expenses. The change in value of money over time is accounted for by adjusting all dollar variables to 2012 dollars using the unadjusted annual Producer Price Index for farm products (Bureau of Labor Statistics, 2014).

Distance measures were obtained through ArcMap10.1 (ESRI, 2012) by determining the distance in miles from the centroid of each county in the region to the nearest existing branch or

field office.[2] These explanatory variables were chosen as indicators of collateral value, farm income, and land ownership within a county, which are hypothesized to be important factors in predicting loan volume. The data provided by FCECO was at the individual loan level. The specific data used for this study included the date the loan was opened, the original amount, and the county in which the borrowers address resides. Annual new loan volume is calculated as the sum of new loans across borrowers by year and county. Loan volume is predicted as a function of distances, cash receipts from crops and livestock, acres rented, and value of agricultural real estate.

Table III-1 presents the descriptive statistics of each variable. Total new loan volumes by county range from zero to over $22 million, with a county annual average of $1.8 million. On average, the closest branch is 30.5 miles from the centroid of a county, and is within a range of two to nearly 80 miles. The larger number of field offices implies that they are generally more available to borrowers, confirmed by an average distance of 16 miles and a range from less than one to 42 miles. The sample mean of cash receipts for crops and livestock is $77.7 million and is within a range of $11 million to nearly $320 million. Acres rented and value of agricultural real estate are 103,541 acres and $576 million, respectively. Because of the very large size of the market demographic variables relative to the distance variables, all variables are scaled appropriately, as described in the variable descriptions below.

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[2] Addresses were geocoded for use in ArcMap10 and most were successfully identified. However, the addresses of the Vinita and Kingfisher branches did not exactly match any address recognized by ArcMap10. For these branches, the centroid of the town was used.

Table III-1. Descriptive Statistics for Dependent and Independent Variables

Variable	Mean	Std. Dev.	Minimum	Maximum
LV ($M)[*]	$1.8	$2.2	0	$22.0
DB (miles)	30.5	15.3	2.0	78.1
DFO (miles)	15.5	10.8	0.1	41.6
CASH($M)	77.7	59.8	10.7	319.9
RENT (1,000 acres)	104	60	24	396
VAL ($100M)	$5.8	$2.3	$1.5	$18.0
LV1 ($M)	$1.7	$2.2	0	$22.0

[*] LV is annual new loan volume for county i; DB is the distance from the centroid of county i to the nearest branch; DFO is the distance from the centroid of county i to the nearest field office; CASH is the sum of total cash receipts for crops and total cash receipts for livestock in county i; RENT is the total acres rented in county i; VAL is the total value of agricultural real estate in county i; and LV1 is annual new loan volume for county i in year t-1.

Empirical Model

The equation used to estimate the effects of branch location, producer cash flows, land ownership, and real estate values on loan volume has the following functional form:

(1) $LV_{it} = \beta_0 + \beta_1 D1_i + \beta_2 D2_i + \beta_3 LV1_{it-1} + \beta_4 CASH_{it} + \beta_5 RENT_{it} + \beta_6 VAL_{it}$

$$+ \sum_{j=0}^{18} \beta_{7+j} Yr_j + e_{it}$$

where $i \in \{1,.., 51\}$ denotes county; $t \in \{1993,\ldots, 2012\}$ denotes year; LV_{it} denotes total new loan volume (2012 \$10M) for county i in year t; $D1_i$ denotes distance from center of county i to the nearest branch (natural log of miles); $D2_i$ denotes distance from center of county i to the nearest field office (natural log of miles); $LV1_{it-1}$ denotes the total new loan volume (2012 \$10M) for county i in year t-1; $CASH_{it}$ denotes the sum of total cash receipts for crops and total cash receipts for livestock (natural log of 2012 dollars) in county i in year t; $RENT_{it}$ denotes agricultural land rented from others (millions of acres in county i in year t; VAL_{it} denotes value of agricultural real estate including buildings (2012 \$Billions) in county i in year t; $YR_t \in \{0,1\}$ is a binary variable indicating the year of each observation $t \,\varepsilon\{1994,\ldots,2011\}$; and e_{it} is an error term.

A Linear-Log functional form allows for the relationship of loan volume to distance to decrease at a decreasing rate[3]. Binary variables are included for each year to capture any variability due to time.

The wide range and uneven distribution of observed values of loan volume is likely a source of heteroscedasticity. Because real estate loans can be high in relation to operational loans, a county may have few loans but a relatively high loan volume if they are real estate loans. A plot of the residuals against predicted values reveals that residuals increase as predicted loan volume increases (Figure A-1). In addition, the Breush-Pagan test revealed heteroscedasticity to be

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[3] Both a linear and quadratic model produced very similar regression estimates, the Linear-Log form allows for a parabolic shape without the unrealistic results of increasing loan volume at very high distances.

caused by the market variables: CASH, RENT, and VAL. The model for variance is estimated as follows:

(2) $\hat{S}^2 = V_0 + V_1\beta_3 + V_2\beta_4 + V_3\beta_5 + V_4\beta_6$

where β_3 is the relationship between LV_{it-1} and estimated loan volume; β_4 is the relationship between $CASH_{it}$ and estimated loan volume; β_5 is the relationship between $RENT_{it}$ and estimated loan volume; and β_6 is the relationship between VAL_{it} and estimated loan volume. By estimating variance as a function of the variables known to cause the heterescedasticity, homoscedasticity is obtained (Greene, 1997).

CHAPTER IV

RESULTS

Regression Diagnostics

The model for predicting loan volume specified in Chapter III was estimated using the PROC NLMIXED procedure in SAS (SAS Institute Inc., 2012),which is a non-linear maximum likelihood estimation method with both discrete and continuous variables. Diagnostic tests were performed to detect heteroscedasticity and multicollinearity. The Breush-Pagan test for heteroscedasticy reveals significant differences in error variance due to cash revenue (*CASH*), acres rented (*RENT*), value of agricultural real estate (*VAL*), and lagged loan volume (*LV1*). To correct for heteroscedasticy, a variance equation was estimated as a function of these variables as discussed in Chapter III.

Variance Inflation Factors are determined for each variable to test for multicollinearity (Table A.4). A VIF greater than five indicates a multicollinearity problem with a variable (Neter et al., 1989). Since all variables have VIF values less than five and the correlation matrix does not reveal any covariance greater than 0.8, no further action was taken to correct for multicollinearity.

Regression Results

Parameter estimates for each variable described in Chapter III are presented in Table IV-1. Standard errors, p-values, and test statistics are also reported. All variables except the year

dummies, the intercept, and CASH are significantly different from zero at $p \leq 0.05$, with distance to the nearest branch, lagged loan volume, and value of agricultural real estate significant at $p \leq 0.01$. Results of the variance estimation equation are presented in Table V-2, as well as the standard errors, p-values, and test statistics for these coefficients.

Distance Variables (D1 and D2)

The regression coefficients for the distance from the centroid of county *i* to both the nearest branch and nearest field office are negative and statistically significant. This implies that as the travel distance for customers in county *i* increases, new loan volume for county *i* decreases. These results confirm the hypothesis that adding a new office will increase the new loan volume of the surrounding counties as well as for the entire FCECO region.

Cash Receipts for Crops and Livestock (CASH)

The regression coefficient for cash receipts for crops is not statistically significant. The insignificance of this seemingly important variable is possibly due to the offsetting effects of the variable. High cash receipts could indicate higher sales prices reducing credit needs, but also higher replacement cost of breeding livestock. Additionally, larger farms may receive high crop income and may not need operating notes, but have high financing requirements for equipment and land.

Acres Rented (RENT)

The regression coefficient for acres rented is negative and significant, confirming the hypothesis that if more producers in county *i* rent land for production, there will be fewer real estate loans, decreasing loan volume for county *i*. Conversely, if more acres in a county are owned, FCECO is likely to capture more loan volume through land purchases.

Value of Agricultural Real Estate (VAL)

The regression coefficient for value of agricultural real estate is positive and significant, indicating that a county with high real estate values will also have high new loan volume. This

19

confirms the hypothesis that higher real estate values increase new loan volume through higher collateral values and increased security for FCECO.

Lagged Loan Volume (LV1)

The regression coefficient for lagged loan volume is positive and significant. This implies that a county that had high new loan volume in the previous year will also have high new loan volume in the current year.

Annual Dummy Variables

The binary annual dummy variables are included in the model to account for any variability due to time. However, by adjusting all dollar variables to real 2012 dollars, much of the variability is eliminated. The dummy variables serve, then, to capture any other variability that may be due to the entrance and exit of competitors in the market or other changes in the market environment across time. The general insignificance of the annual dummies indicates that little variability is captured through their inclusion.

Variance Estimation Model

All variables that were expected to cause heteroscedasticity within the model were significant to the variance estimation model at $p \leq 0.01$ and positively related to estimated variance.

Marginal Effects

The actual coefficients produced from the regression are meaningless other than in sign because of the scaling that was necessary for the model to run. Significant parameters are interpreted into actual marginal effects of a one unit (acre or dollar) change in the market variable on loan volume and reported in Table IV-3. These effects can be interpreted as the dollar change in loan volume that will occur by a unit change in. Specifically, for every acre rented in a county, loan volume in that county decreases by $2.90. It is important to note that these marginal effects are very small because of the very large size of the variables, with the largest (VAL) in the billions. The interpretation of the variables that were in natural log form is more complex. The

derivative of estimated loan volume with respect to the variable x is the parameter β divided by

the variable x at a certain point. Table IV-4 illustrates this change in marginal effect at several

levels of distance for both D1 and D2.

Table IV-1. Regression Results for Loan Volume Estimation Equation

Variable	Coefficient	Standard Error	Test Statistic	Pr > |t|
Intercept	0.23	0.20	1.13	0.26
D1	-0.31^{***}	0.10	-3.08	<0.01
D2	-0.14^{**}	0.06	-2.42	0.02
LV1	0.22^{***}	0.03	6.94	<0.01
CASH	-0.01	0.12	-0.06	0.95
RENT	-0.31^{**}	0.15	-2.1	0.04
VAL	0.18^{***}	0.05	3.21	<0.01
Y94	-0.01	0.04	-0.27	0.79
Y95	-0.04	0.04	-0.92	0.36
Y96	0.03	0.04	0.66	0.51
Y97	-0.05	0.04	-1.22	0.22
Y98	0.00	0.04	0.08	0.94
Y99	-0.05	0.04	-1.2	0.23
Y00	-0.06	0.04	-1.4	0.16
Y01	0.04	0.04	1.05	0.29
Y02	0.04	0.04	0.92	0.36
Y03	0.03	0.04	0.73	0.46
Y04	-0.04	0.04	-0.94	0.35
Y05	0.01	0.04	0.15	0.88
Y06	-0.05	0.04	-1.17	0.24
Y07	0.03	0.04	0.84	0.40
Y08	0.06	0.04	1.56	0.12
Y09	-0.01	0.04	-0.31	0.76
Y10	-0.04	0.04	-0.9	0.37
Y11	-0.02	0.04	-0.51	0.61

***Significant at $p \leq 0.01$
**Significant at $p \leq 0.05$.
*Significant at $p \leq 0.10$.
Note: D1 is the natural log of the distance from the centroid of county i to the nearest branch; D2 is the natural log of the distance from the centroid of county i to the nearest field office; CASH is the natural log of the sum of total cash receipts for crops and total cash receipts for livestock in county i.; RENT is the total acres rented in county i.; VAL is the total value of agricultural real estate in county i.; LV1 is annual new loan volume for county i in year t-1; and Y_t is a binary variable indicating the year of the observation $t \, \varepsilon \{1994, . . ., 2011\}$.

Table IV-2. Regression Results for Variance Estimation Equation

Variable	Coefficient	SE	Test Statistic	Pr > |t|
Intercept	0.00	0.09	-0.04	0.96
LV1	0.75***	0.02	37.36	<0.01
CASH	0.62***	0.00	654.50	<0.01
RENT	0.59***	0.03	20.91	<0.01
VAL	0.38***	0.02	23.79	<0.01

***Significant at $p \leq 0.01$;

Note: CASHC is total cash receipts for crops in county i; RENT is the total acres rented in county i; VAL is the total value of agricultural real estate in county i; and LV1 is annual new loan volume for county i in year $t-1$.

Table IV-3. Marginal Effects of Significant Linear Market Variables

Variable	Marginal Effect	Pr > |t|
RENT	-3.10	0.04
VAL	0.0018	<0.01
LV1	0.22	<0.01

Table IV-4. Marginal Effects of Distance Variables

Miles	Marginal Effect	
	D1	D2
1	310,000	140,000
2	155,000	70,000
…		
10	31,000	14,000
20	15,500	7,000
…		
90	3,444	1,556
100	3,100	1,400

Predictions

To determine the change in the new loan volume of FCECO that is caused by an additional lending office, predictions are estimated for 19 counterfactual offices. Counterfactual offices are placed in the town centroid of the county seat of each county that did not already have a branch or a field office as of 2012. In addition, counterfactual branches are placed in Ardmore and Poteau, to compare FCECO's decisions to the results of this model. The Ardmore and Poteau counterfactual locations were treated only as branch offices, but all other locations were treated once as a branch and once as a field office. Each of the 21 counterfactual branches and 19 counterfactual field offices are added individually to determine the isolated impact of each office. All predictions are made as in 2012 dollars, assuming the existing office locations and demographic information in that year. Since the predictions are made at a single point in time, the only variables that change given the addition of a branch are the distance variables. Further, the addition of a branch office in a particular county will only affect the distance variables in that county and some of the surrounding counties. Predictions are made for each county affected by the new branch. The change in loan volume before and after the new branch for each affected county is summed to determine the total marginal impact of the new branch on FCECO. The same procedure is applied assuming the counterfactuals are field offices rather than branches.

The results of all 21 counterfactual predictions are reported in appendix tables 1 and 2, but those that produced the top five highest marginal impacts are presented in Tables IV-5 and IV-6. The initial estimate prior to the addition of the counterfactual branch is reported for each county affected as well as the total estimates for the entire FCECO region. The new estimates for the entire region after the addition of the new branch are reported for each counterfactual branch. The change in loan volume is calculated for both the counties affected and the entire region. Additionally, confidence intervals around the marginal impacts are reported. These confidence intervals are calculated using the coefficient and standard errors of the D1 and D2 variables for the branch and field office counterfactuals respectively. To determine if the region-wide

24

estimates of annual new loan volume were realistic, the initial estimate are compared to the

Association's 2014 New Loan Volume Target (Farm Credit of East Central Oklahoma, 2014).

The Association's new loan goal for 2014 is $105 Million. Considering this target includes the

Ardmore and Poteau branches and is two years ahead of the estimates produced by the model, an

estimate of annual new loan volume of $93 Million is reasonable.

Table IV-5. Prediction Results for Top Five Impacting Branch Counterfactuals

New Branch	Counties Affected	Initial Estimate	New Estimate	Confidence Intervals α=.05 Lower Bound	Upper Bound	Change LV
Bartlesville						
	Nowata	$ 1,408,822	$ 1,534,002	$ 45,560	$ 204,798	$ 125,180
	Osage	$ 1,738,066	$ 1,955,527	$ 79,147	$ 355,774	$ 217,461
	Washington	$ 1,289,272	$ 2,145,267	$ 311,549	$ 1,400,442	$ 855,995
	Total	$ 92,854,071	$ 94,052,707	$ 436,257	$ 1,961,014	$ 1,198,636
Hugo						
	Choctaw	$ 1,492,260	$ 2,423,328	$ 338,873	$ 1,523,263	$ 931,068
	McCurtain	$ 1,173,151	$ 1,361,283	$ 68,473	$ 307,791	$ 188,132
	Pushmataha	$ 918,890	$ 1,018,764	$ 36,350	$ 163,399	$ 99,874
	Total	$ 92,854,071	$ 94,073,146	$ 443,696	$ 1,994,453	$ 1,219,074
Sallisaw						
	Adair	$ 1,584,765	$ 1,687,684	$ 37,459	$ 168,380	$ 102,919
	Haskell	$ 1,498,432	$ 1,666,872	$ 61,306	$ 275,574	$ 168,440
	LeFlore	$ 2,022,475	$ 2,155,152	$ 48,289	$ 217,065	$ 132,677
	Sequoyah	$ 1,669,693	$ 2,423,724	$ 274,438	$ 1,233,624	$ 754,031
	Total	$ 92,854,071	$ 94,012,140	$ 421,492	$ 1,894,645	$ 1,158,067
Tahlequah						
	Adair	$ 1,584,765	$ 1,853,854	$ 97,938	$ 440,241	$ 269,089
	Cherokee	$ 1,700,174	$ 2,606,829	$ 329,987	$ 1,483,321	$ 906,655
	Sequoyah	$ 1,669,693	$ 1,750,934	$ 29,569	$ 132,914	$ 81,241
	Total	$ 92,854,071	$ 94,111,056	$ 457,494	$ 2,056,476	$ 1,256,985
Wewoka						
	Hughes	$ 1,665,710	$ 1,870,203	$ 74,428	$ 334,559	$ 204,493
	Okfuskee	$ 1,587,790	$ 1,817,663	$ 83,665	$ 376,081	$ 229,873
	Pottawatomie	$ 1,551,661	$ 1,655,954	$ 37,958	$ 170,627	$ 104,293
	Seminole	$ 1,435,171	$ 2,028,216	$ 215,845	$ 970,245	$ 593,045
	Total	$ 92,854,071	$ 93,985,775	$ 411,896	$ 1,851,511	$ 1,131,704

Note: LV is annual new loan volume for county *i;* the total of the initial estimates and new estimates are for the entire region before and after the addition of the new branch; and the total change is the estimated impact of the new branch on the entire region and is equal to the sum of the estimated changes on each affected county.

Table IV-6. Prediction Results for Top Five Impacting Field Office Counterfactuals

New Office	Counties Affected	Initial Estimate	New Estimate	Lower Bound	Upper Bound	Change LV
				Confidence Intervals α=.05		
Bartlesville						
	Nowata	$ 1,408,822	$ 1,500,271	$ 17,189	$ 165,708	$ 91,449
	Washington	$ 1,289,272	$ 1,586,165	$ 55,805	$ 537,980	$ 296,893
	Total	$92,854,071	$ 93,242,413	$ 72,994	$ 703,688	$ 388,342
Hugo						
	Choctaw	$ 1,492,260	$ 1,873,716	$ 71,700	$ 691,211	$ 381,456
	Pushmataha	$ 918,890	$ 925,818	$ 1,302	$ 12,555	$ 6,928
	Total	$92,854,071	$ 93,242,455	$ 73,002	$ 703,766	$ 388,384
Nowata						
	Nowata	$ 1,408,822	$ 1,633,790	$ 42,286	$ 407,650	$ 224,968
	Washington	$ 1,289,272	$ 1,355,899	$ 12,523	$ 120,730	$ 66,627
	Total	$92,854,071	$ 93,145,666	$ 54,809	$ 528,380	$ 291,595
Sallisaw						
	Sequoyah	$ 1,669,693	$ 1,914,624	$ 46,038	$ 443,824	$ 244,931
	Total	$92,854,071	$ 93,099,003	$ 46,038	$ 443,824	$ 244,931
Tahlequah						
	Cherokee	$ 1,700,174	$ 2,079,625	$ 71,323	$ 687,579	$ 379,451
	Total	$92,854,071	$ 93,233,522	$ 71,323	$ 687,579	$ 379,451

Note: LV is annual new loan volume for county i; the total of the initial estimates and new estimates are for the entire region before and after the addition of the new field office; and the total change is the estimated impact of the new field office on the entire region and is equal to the sum of the estimated changes on each affected county.

CHAPTER V

CONCLUSIONS

The results of this study suggest that FCECO can utilize market and spatial datasets to increase loan volume by selective branch placement. Although Ardmore and Poteau were not one of the top five impacting counterfactual offices, the branch placement decisions recently made by FCECO align with the results of the distance and lagged loan volume variables. The Ardmore branch was built because the existing field office was highly productive (Sutterfield and Burk, 2014). It was assumed that the high loan volume of the field office was indicative of high loan volume in the following years. This is confirmed by the positive coefficient for lagged loan volume. The Poteau branch was added because there was a gap in the market coverage in that area that was being encroached upon by competitors (Sutterfield and Burk, 2014). By placing a new branch in Poteau, the transportation costs to borrowers in that area is reduced, and loan volume for LeFlore, Haskell, and Sequoyah counties is predicted to increase. This decision is supported by the results of the distance variables.

The branches added in 2012 may not be one of the top five impacting branches because there were already field offices in these locations for some or all of the relevant time period. The marginal impact on loan volume of adding a branch in these locations is not as great as a location with nothing in that location. The loan volume in Carter and Le Flore counties was already being captured by the existing field offices, so replacing the field offices with branches did not produce the full marginal impact that it would have if the branch were added in a location with no existing

offices. The implications of this study suggest that FCECO could maximize the marginal impact of an added branch or field office by placing new offices in areas with high crop income, low acres of land rented (or high land ownership), and high value of agricultural real estate. The counterfactual branch that is estimated to produce the highest marginal impact is in Tahlequah, OK, which is in Cherokee County. Figures A-3 through A-5 geographically represent the explanatory variables significant to the model. Figures A.3 and A.4 show that Cherokee county is in the highest class of cash receipts for crops and the lowest class of acres rented. In addition, there is a significant gap in market coverage in this area. The counterfactual field office that is estimated to produce the highest marginal impact is in Hugo, OK in Choctaw County. Although Choctaw County is not outstanding in any of the significant market variables, it is in a significant gap in market coverage (Figure A-1). It is likely the distance variables that cause Hugo to be a top-impacting field office.

Limitations

Several limitations apply to the results of this study. First, predictions are for made for long term average loan volume and the time it will take for that level of establishment is unknown. Further research could determine the dynamic adjustment period required to compare predictions with out-of-sample observations to test the model's predictive power. Since no new branches were established within the relevant time period, this was not possible in this study. Secondly, the model is only applicable for East Central Oklahoma and the Farm Credit System. Further research could utilize this model with data from different lending institutions as well as different geographic regions. Thirdly, this model does not account for any variability due to competitor activity since these data are not readily available. Similarly, the effect of Farm Credit's brand name and reputation is not considered in this model. Including the number and location of competitors may provide insight into the impact on loan volume of being a part of the Farm Credit System as opposed to retail lending institutions.

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APPENDICES

Table A-1 shows the prediction results for all counterfactual branches, the estimated changes on

each affected county, and the total change on the entire FCECO region.

Table A-1. Prediction Results for Branch Counterfactuals

New Branch	Counties Affected	Initial Estimate	New Estimate	Confidence Intervals α=.05		Change LV
				Lower Bound	Upper Bound	
Antlers						
	Atoka	$ 2,180,454	$ 2,263,295	$ 30,151	$ 135,530	$ 82,841
	Choctaw	$ 1,492,260	$ 1,868,453	$ 136,919	$ 615,465	$ 376,193
	McCurtain	$ 1,173,151	$ 1,318,279	$ 52,821	$ 237,435	$ 145,128
	Pushmataha	$ 918,890	$ 1,153,240	$ 85,294	$ 383,406	$ 234,350
	Total	$92,854,071	$ 93,692,583	$ 305,186	$ 1,371,837	$ 838,512
Ardmore						
	Carter	$ 2,066,961	$ 2,376,436	$ 112,637	$ 506,314	$ 309,475
	Jefferson	$ 1,199,810	$ 1,298,442	$ 35,898	$ 161,366	$ 98,632
	Love	$ 1,465,698	$ 1,856,107	$ 142,094	$ 638,724	$ 390,409
	Total	$92,854,071	$ 93,652,588	$ 290,629	$ 1,306,404	$ 798,516
Bartlesville						
	Nowata	$ 1,408,822	$ 1,534,002	$ 45,560	$ 204,798	$ 125,180
	Osage	$ 1,738,066	$ 1,955,527	$ 79,147	$ 355,774	$ 217,461
	Washington	$ 1,289,272	$ 2,145,267	$ 311,549	$ 1,400,442	$ 855,995
	Total	$92,854,071	$ 94,052,707	$ 436,257	$ 1,961,014	$ 1,198,636
Claremore						
	Mayes	$ 1,810,550	$ 1,924,724	$ 41,555	$ 186,793	$ 114,174
	Rogers	$ 3,111,734	$ 3,528,966	$ 151,856	$ 682,608	$ 417,232
	Washington	$ 1,289,272	$ 1,341,838	$ 19,132	$ 86,000	$ 52,566
	Total	$92,854,071	$ 93,438,044	$ 212,543	$ 955,401	$ 583,972
Coalgate						
	Atoka	$ 2,180,454	$ 2,430,095	$ 90,860	$ 408,423	$ 249,641
	Choctaw	$ 1,492,260	$ 1,618,587	$ 45,978	$ 206,675	$ 126,327
	Coal	$ 1,073,008	$ 1,653,300	$ 211,204	$ 949,381	$ 580,292
	Pontotoc	$ 2,218,298	$ 2,228,290	$ 3,637	$ 16,348	$ 9,992
	Total	$92,854,071	$ 93,820,323	$ 351,678	$ 1,580,826	$ 966,252

Eufaula									
	Haskell	$	1,498,432	$	1,630,695	$	48,139	$	216,388	$	132,263
	LeFlore	$	2,022,475	$	2,039,553	$	6,216	$	27,941	$	17,078
	McIntosh	$	1,409,732	$	1,869,799	$	167,446	$	752,687	$	460,067
	Okfuskee	$	1,587,790	$	1,637,136	$	17,960	$	80,732	$	49,346
	Total	$92,854,071	$	93,512,826	$	239,761	$	1,077,747	$	658,754
Hugo									
	Choctaw	$	1,492,260	$	2,423,328	$	338,873	$	1,523,263	$	931,068
	McCurtain	$	1,173,151	$	1,361,283	$	68,473	$	307,791	$	188,132
	Pushmataha	$	918,890	$	1,018,764	$	36,350	$	163,399	$	99,874
	Total	$92,854,071	$	94,073,146	$	443,696	$	1,994,453	$	1,219,074
Madill									
	Carter	$	2,066,961	$	2,091,583	$	8,962	$	40,283	$	24,622
	Johnston	$	2,270,283	$	2,404,679	$	48,915	$	219,877	$	134,396
	Love	$	1,465,698	$	1,630,928	$	60,137	$	270,323	$	165,230
	Marshall	$	1,221,710	$	1,719,485	$	181,171	$	814,379	$	497,775
	Total	$92,854,071	$	93,676,094	$	299,184	$	1,344,861	$	822,023
Marietta									
	Carter	$	2,066,961	$	2,181,432	$	41,663	$	187,279	$	114,471
	Jefferson	$	1,199,810	$	1,284,466	$	30,812	$	138,502	$	84,656
	Love	$	1,465,698	$	2,073,025	$	221,043	$	993,610	$	607,327
	Total	$92,854,071	$	93,660,526	$	293,518	$	1,319,391	$	806,454
Norman									
	McClain	$	1,822,181	$	1,979,157	$	57,133	$	256,818	$	156,976
	Oklahoma	$	1,203,041	$	1,331,981	$	46,929	$	210,950	$	128,940
	Pottawatomie	$	1,551,661	$	1,629,820	$	28,447	$	127,870	$	78,159
	Total	$92,854,071	$	93,218,145	$	132,509	$	595,638	$	364,075
Nowata									
	Nowata	$	1,408,822	$	1,841,988	$	157,656	$	708,676	$	433,166
	Osage	$	1,738,066	$	1,803,363	$	23,766	$	106,829	$	65,297
	Rogers	$	3,111,734	$	3,125,624	$	5,055	$	22,724	$	13,890
	Washington	$	1,289,272	$	1,614,118	$	118,231	$	531,461	$	324,846
	Total	$92,854,071	$	93,691,270	$	304,708	$	1,369,690	$	837,199
OKC									
	Oklahoma	$	1,203,041	$	1,655,185	$	164,563	$	739,725	$	452,144
	Total	$92,854,071	$	93,306,216	$	164,563	$	739,725	$	452,144
Pawnee									
	Kay	$	1,330,577	$	1,406,034	$	27,463	$	123,451	$	75,457
	Osage	$	1,738,066	$	1,909,765	$	62,492	$	280,906	$	171,699
	Pawnee	$	1,033,818	$	1,498,944	$	169,288	$	760,963	$	465,126
	Total	$92,854,071	$	93,566,353	$	259,243	$	1,165,320	$	712,282

Perry									
	Kay	$	1,330,577	$	1,409,299	$	28,652	$	128,792	$	78,722
	Noble	$	1,658,056	$	1,942,699	$	103,599	$	465,688	$	284,643
	Total	$92,854,071	$	93,217,437	$	132,251	$	594,480	$	363,365
Poteau									
	Haskell	$	1,498,432	$	1,593,701	$	34,674	$	155,864	$	95,269
	LeFlore	$	2,022,475	$	2,520,316	$	181,195	$	814,487	$	497,841
	Sequoyah	$	1,669,693	$	1,757,649	$	32,013	$	143,900	$	87,956
	Total	$92,854,071	$	93,535,138	$	247,882	$	1,114,251	$	681,066
Purcell									
	McClain	$	1,822,181	$	2,335,478	$	186,820	$	839,774	$	513,297
	Pottawatomie	$	1,551,661	$	1,642,064	$	32,903	$	147,902	$	90,403
	Seminole	$	1,435,171	$	1,447,912	$	4,637	$	20,845	$	12,741
	Total	$92,854,071	$	93,470,512	$	224,361	$	1,008,521	$	616,441
Sallisaw									
	Adair	$	1,584,765	$	1,687,684	$	37,459	$	168,380	$	102,919
	Haskell	$	1,498,432	$	1,666,872	$	61,306	$	275,574	$	168,440
	LeFlore	$	2,022,475	$	2,155,152	$	48,289	$	217,065	$	132,677
	Sequoyah	$	1,669,693	$	2,423,724	$	274,438	$	1,233,624	$	754,031
	Total	$92,854,071	$	94,012,140	$	421,492	$	1,894,645	$	1,158,067
Sulphur									
	Carter	$	2,066,961	$	2,174,866	$	39,274	$	176,538	$	107,905
	Jefferson	$	1,199,810	$	1,202,262	$	892	$	4,012	$	2,452
	Johnston	$	2,270,283	$	2,319,802	$	18,023	$	81,016	$	49,519
	Love	$	1,465,698	$	1,519,068	$	19,424	$	87,315	$	53,370
	Murray	$	2,066,892	$	2,526,056	$	167,118	$	751,210	$	459,164
	Pontotoc	$	2,218,298	$	2,300,956	$	30,085	$	135,233	$	82,658
	Total	$92,854,071	$	93,609,141	$	274,816	$	1,235,323	$	755,068
Tahlequah									
	Adair	$	1,584,765	$	1,853,854	$	97,938	$	440,241	$	269,089
	Cherokee	$	1,700,174	$	2,606,829	$	329,987	$	1,483,321	$	906,655
	Sequoyah	$	1,669,693	$	1,750,934	$	29,569	$	132,914	$	81,241
	Total	$92,854,071	$	94,111,056	$	457,494	$	2,056,476	$	1,256,985
Wagoner									
	Adair	$	1,584,765	$	1,596,104	$	4,127	$	18,551	$	11,339
	Cherokee	$	1,700,174	$	1,736,707	$	13,296	$	59,769	$	36,533
	Wagoner	$	1,590,774	$	1,789,440	$	72,307	$	325,026	$	198,666
	Total	$92,854,071	$	93,100,609	$	89,730	$	403,346	$	246,538

Wewoka						
	Hughes	$ 1,665,710	$ 1,870,203	$ 74,428	$ 334,559	$ 204,493
	Okfuskee	$ 1,587,790	$ 1,817,663	$ 83,665	$ 376,081	$ 229,873
	Pottawatomie	$ 1,551,661	$ 1,655,954	$ 37,958	$ 170,627	$ 104,293
	Seminole	$ 1,435,171	$ 2,028,216	$ 215,845	$ 970,245	$ 593,045
	Total	$92,854,071	$ 93,985,775	$ 411,896	$ 1,851,511	$ 1,131,704

Note: LV is annual new loan volume for county *i;* the total of the initial estimates and new estimates are for the entire region before and after the addition of the new branch; and the total change is the estimated impact of the new branch on the entire region and is equal to the sum of the estimated changes on each affected county.

Table A-2 shows the prediction results for all counterfactual field offices, the estimated changes on each affected county, and the total change on the entire FCECO region.

Table A-2. Prediction Results for Field Office Counterfactuals

New Branch	Counties Affected	Initial Estimate	New Estimate	Confidence Intervals α=.05		Change LV
				Lower Bound	Upper Bound	
Antlers						
	Choctaw	$ 1,492,260	$ 1,633,164	$ 26,485	$ 255,322	$ 140,904
	Pushmataha	$ 918,890	$ 984,117	$ 12,260	$ 118,194	$ 65,227
	Total	$92,854,071	$93,060,202	$ 38,745	$ 373,516	$ 206,131
Bartlesville						
	Nowata	$ 1,408,822	$ 1,500,271	$ 17,189	$ 165,708	$ 91,449
	Washington	$ 1,289,272	$ 1,586,165	$ 55,805	$ 537,980	$ 296,893
	Total	$92,854,071	$93,242,413	$ 72,994	$ 703,688	$ 388,342
Claremore						
	Nowata	$ 1,408,822	$ 1,418,746	$ 1,865	$ 17,983	$ 9,924
	Rogers	$ 3,111,734	$ 3,243,591	$ 24,784	$ 238,930	$ 131,857
	Wagoner	$ 1,590,774	$ 1,602,397	$ 2,185	$ 21,061	$ 11,623
	Total	$92,854,071	$93,007,475	$ 26,969	$ 259,991	$ 143,480
Coalgate						
	Coal	$ 1,073,008	$ 1,214,369	$ 26,571	$ 256,152	$ 141,361
	Total	$92,854,071	$92,995,433	$ 26,571	$ 256,152	$ 141,361
Eufaula						
	McIntosh	$ 1,409,732	$ 1,583,125	$ 32,592	$ 314,194	$ 173,393
	Muskogee	$ 1,699,574	$ 1,715,784	$ 3,047	$ 29,373	$ 16,210
	Total	$92,877,980	$93,042,683	$ 35,639	$ 343,567	$ 189,603
Hugo						
	Choctaw	$ 1,492,260	$ 1,873,716	$ 71,700	$ 691,211	$ 381,456
	Pushmataha	$ 918,890	$ 925,818	$ 1,302	$ 12,555	$ 6,928
	Total	$92,854,071	$93,242,455	$ 73,002	$ 703,766	$ 388,384

Madill					
	Marshall	$ 1,221,710	$ 1,397,255	$ 32,996	$ 318,094	$ 175,545
	Total	$92,854,071	$93,029,616	$ 32,996	$ 318,094	$ 175,545
Marietta					
	Love	$ 1,465,698	$ 1,559,737	$ 17,676	$ 170,402	$ 94,039
	Total	$92,854,071	$92,948,111	$ 17,676	$ 170,402	$ 94,039
Norman					
	McClain	$ 1,822,181	$ 1,836,092	$ 2,615	$ 25,207	$ 13,911
	Total	$92,854,071	$92,867,982	$ 2,615	$ 25,207	$ 13,911
Nowata					
	Nowata	$ 1,408,822	$ 1,633,790	$ 42,286	$ 407,650	$ 224,968
	Washington	$ 1,289,272	$ 1,355,899	$ 12,523	$ 120,730	$ 66,627
	Total	$92,854,071	$93,145,666	$ 54,809	$ 528,380	$ 291,595
OKC					
	Oklahoma	$ 1,203,041	$ 1,335,435	$ 24,885	$ 239,902	$ 132,394
	Total	$92,854,071	$92,986,465	$ 24,885	$ 239,902	$ 132,394
Pawnee					
	Noble	$ 1,658,056	$ 1,682,930	$ 4,675	$ 45,073	$ 24,874
	Pawnee	$ 1,033,818	$ 1,223,569	$ 35,666	$ 343,835	$ 189,751
	Payne	$ 1,989,057	$ 2,003,323	$ 2,681	$ 25,849	$ 14,266
	Total	$92,854,071	$93,082,962	$ 43,023	$ 414,758	$ 228,891
Perry					
	Noble	$ 1,658,056	$ 1,828,065	$ 31,956	$ 308,062	$ 170,009
	Total	$92,854,071	$93,024,080	$ 31,956	$ 308,062	$ 170,009
Purcell					
	McClain	$ 1,822,181	$ 1,990,566	$ 31,650	$ 305,119	$ 168,385
	Total	$92,854,071	$93,022,456	$ 31,650	$ 305,119	$ 168,385
Sallisaw					
	Sequoyah	$ 1,669,693	$ 1,914,624	$ 46,038	$ 443,824	$ 244,931
	Total	$92,854,071	$93,099,003	$ 46,038	$ 443,824	$ 244,931
Sulphur					
	Murray	$ 2,066,892	$ 2,297,615	$ 43,368	$ 418,078	$ 230,723
	Total	$92,854,071	$93,084,794	$ 43,368	$ 418,078	$ 230,723
Tahlequah					
	Cherokee	$ 1,700,174	$ 2,079,625	$ 71,323	$ 687,579	$ 379,451
	Total	$92,854,071	$93,233,522	$ 71,323	$ 687,579	$ 379,451
Wagoner					
	Cherokee	$ 1,700,174	$ 1,702,407	$ 420	$ 4,045	$ 2,233
	Muskogee	$ 1,699,574	$ 1,722,315	$ 4,274	$ 41,207	$ 22,741
	Wagoner	$ 1,590,774	$ 1,756,083	$ 31,072	$ 299,547	$ 165,309
	Total	$92,854,071	$93,044,354	$ 35,766	$ 344,798	$ 190,283

Wewoka					
Seminole	$ 1,435,171	$ 1,521,586	$ 16,243	$ 156,587	$ 86,415
Total	$92,854,071	$92,940,486	$ 16,243	$ 156,587	$ 86,415

Note: LV is annual new loan volume for county *i;* the total of the initial estimates and new estimates are for the entire region before and after the addition of the new field office; and the total change is the estimated impact of the new field office on the entire region and is equal to the sum of the estimated changes on each affected county.

Table A-3. Variance-Covariance Matrix of Dependent Variables

Variance-Covariance
($p<0.01$)

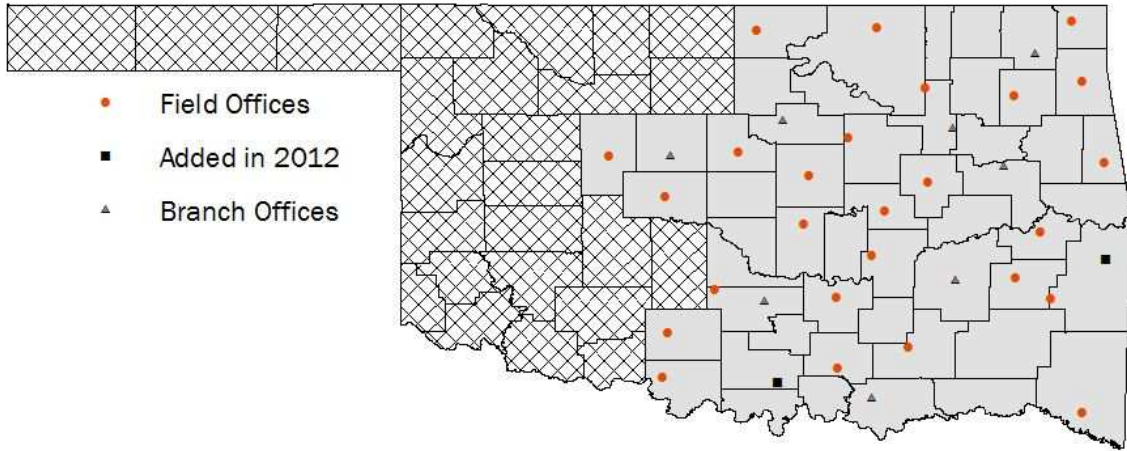|	DB	DFO	CASHC	RENT	VAL
DB	1.00	-0.16	0.26	-0.04	-0.10
		(<0.01)	(<0.01)	(0.27)	(<0.01)
DFO	-0.16	1.00	-0.20	-0.14	-0.18
	(<0.01)		(<0.01)	(<0.01)	(<0.01)
CASHC	0.26	-0.20	1.00	0.29	0.48
	(<0.01)	(<0.01)		(<0.01)	(<0.01)
RENT	-0.04	-0.14	0.29	1.00	0.59
	(0.27)	(<0.01)	(<0.01)		(<0.01)
VAL	-0.10	-0.18	0.48	0.59	1.00
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	

Note: DB is the distance from the centroid of county *i* to the nearest branch; DFO is the distance from the centroid of county *i* to the nearest field office; CASH is the sum of total cash receipts for crops and total cash receipts for livestock in county i; RENT is the total acres rented in county *i*; and VAL is the total value of agricultural real estate in county *i*.

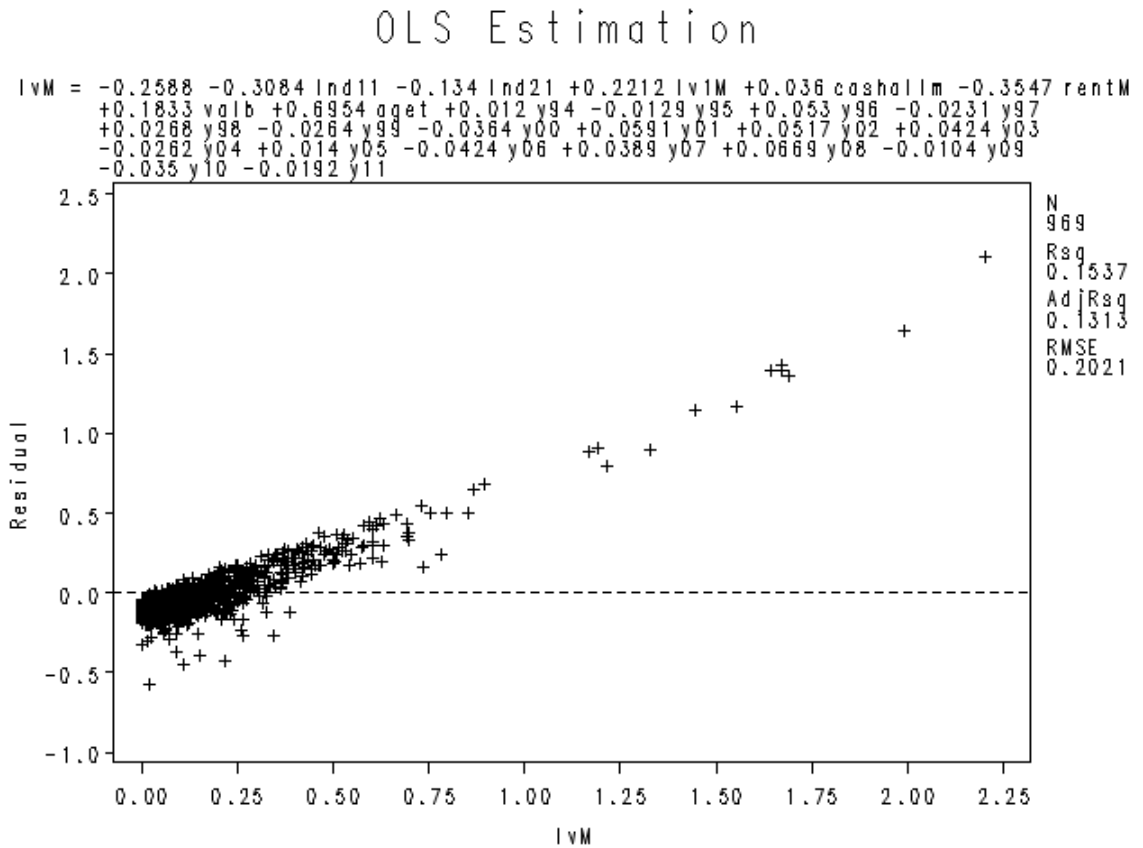### Table A-4. Variance Inflation Factors

Variable	VIF
D1	1.20
D2	1.19
LV1	1.16
CASH	1.87
RENT	2.16
VAL	3.90

Note: D1 is the natural log of the distance from the centroid of county *i* to the nearest branch; D2 is the natural log of the distance from the centroid of county *i* to the nearest field office; CASH is the sum of total cash receipts for crops and total cash receipts for livestock in county i; RENT is the total acres rented in county *i*.; VAL is the total value of agricultural real estate in county *i*.; and LV1 is annual new loan volume for county *i* in year *t-1*.
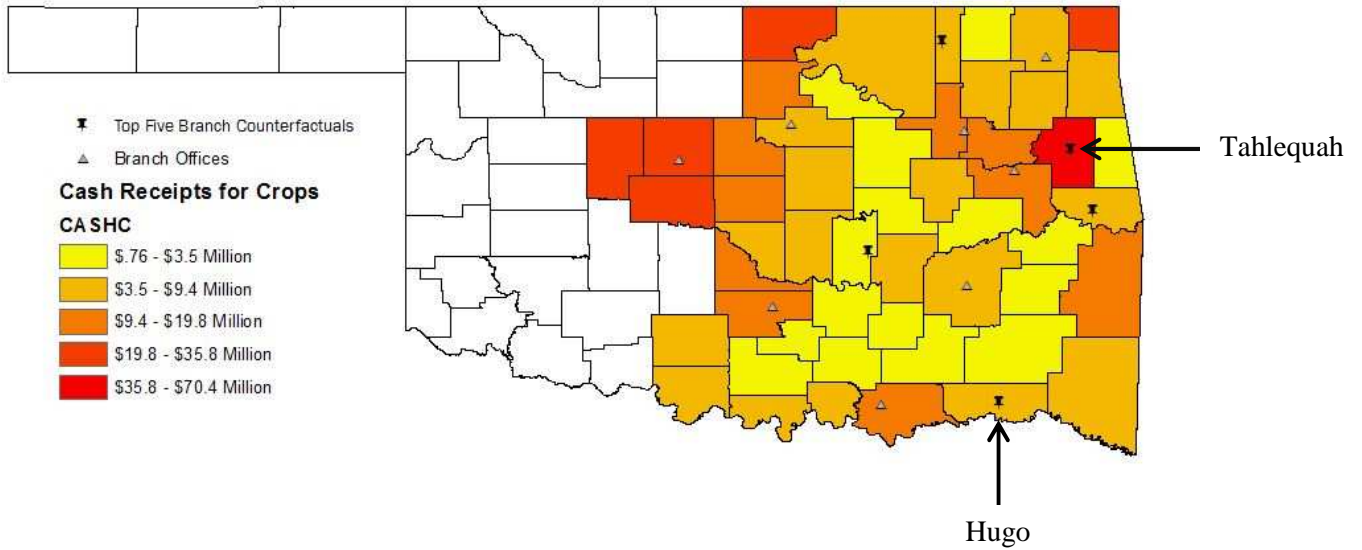
Figure A-1 East Central Region and Existing Offices

**Figure A-2. Plot of Residuals vs. Predicted Loan Volume**

OLS Estimation

lvM = −0.2588 −0.3084 Ind11 −0.134 Ind21 +0.2212 lv1M +0.036 cashallm −0.3547 rentM
+0.1833 valb +0.6954 aget +0.012 y94 −0.0129 y95 +0.053 y96 −0.0231 y97
+0.0268 y98 −0.0264 y99 −0.0364 y00 +0.0591 y01 +0.0517 y02 +0.0424 y03
−0.0262 y04 +0.014 y05 −0.0424 y06 +0.0389 y07 +0.0669 y08 −0.0104 y09
−0.035 y10 −0.0192 y11

N 969
Rsq 0.1537
AdjRsq 0.1313
RMSE 0.2021

Figure A-3 Average Value of Cash Receipts for Crops by County (1993-2012)
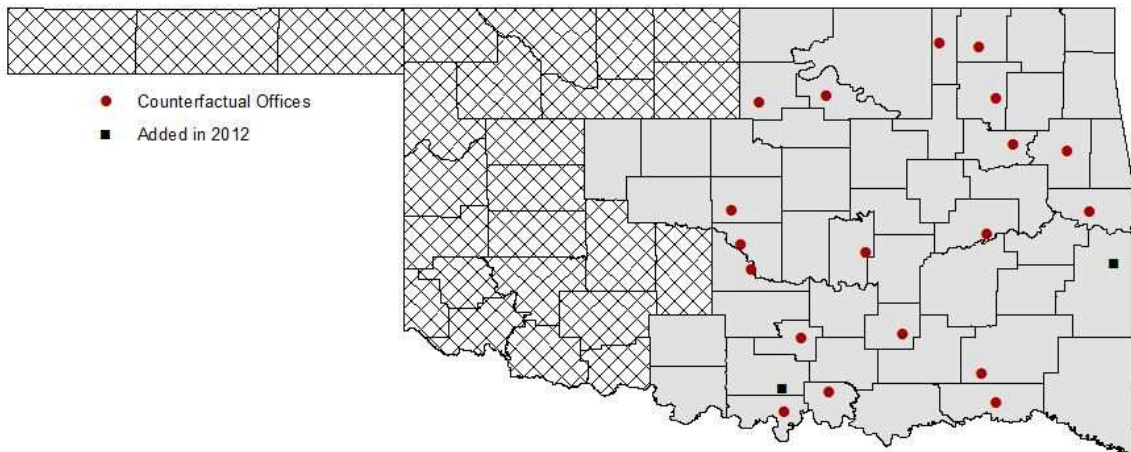
Tahlequah

Hugo

Figure A-4 Average Acres Rented by County (1993-2012)

Tahlequah

Hugo
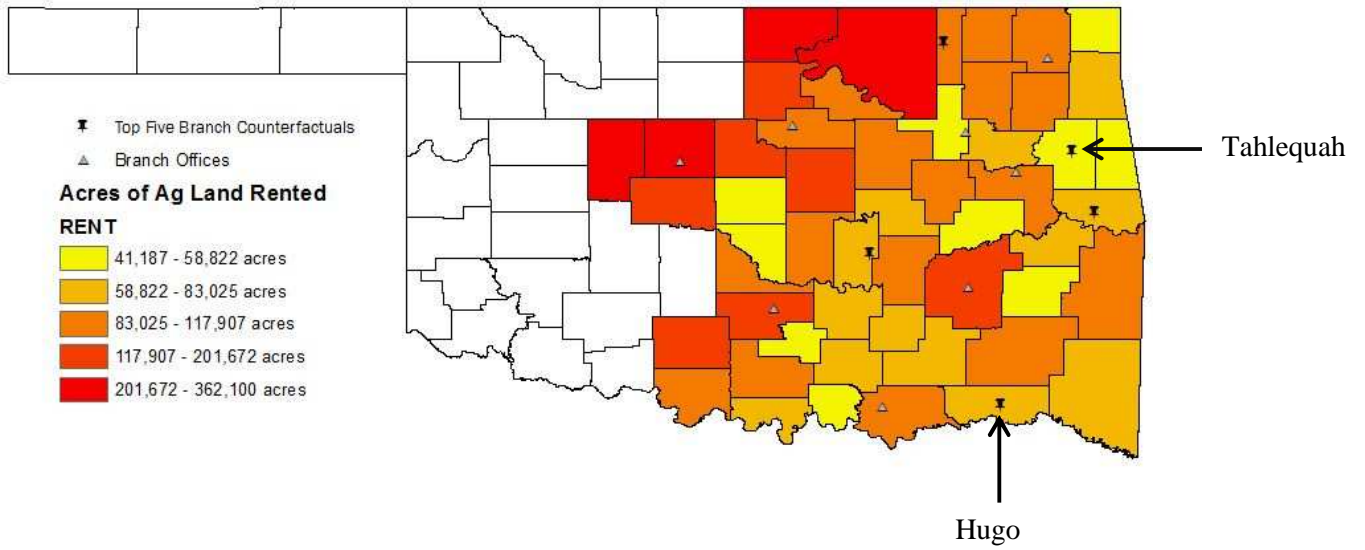
Figure A-5 Average Value of Agricultural Real Estate by County (1993-2012)
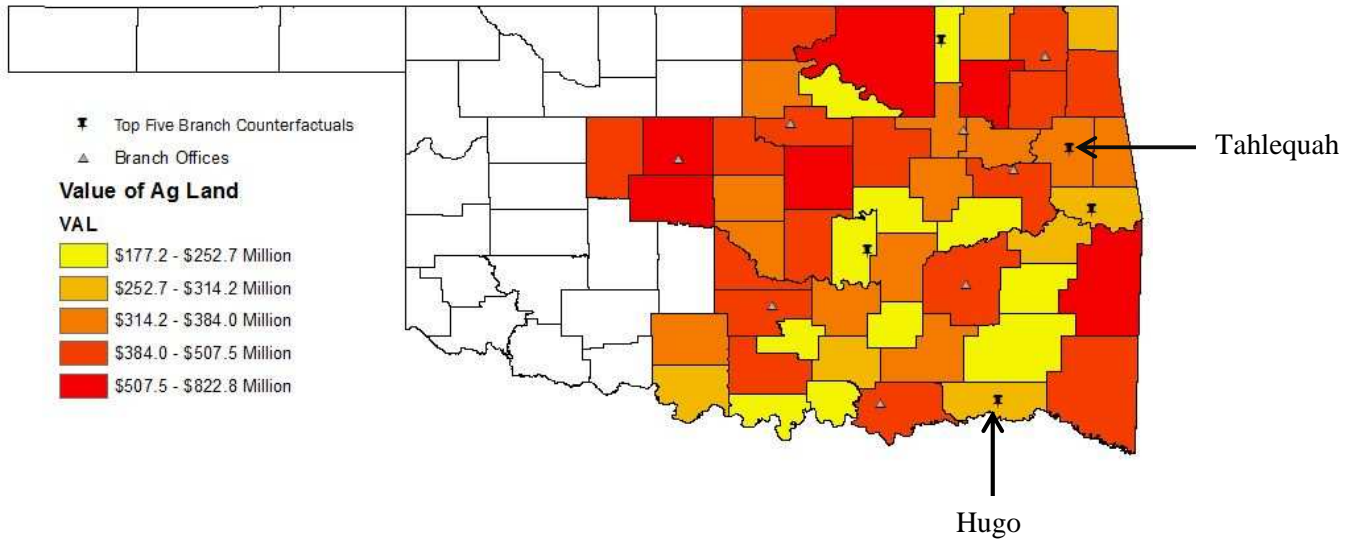
Figure A-6 Counterfactual Offices

Oklahoma State University Institutional Review Board

Date: Thursday, February 20, 2014

IRB Application No   AG142

Proposal Title: An Analysis of Farm Credit Services Borrower Characteristics

Reviewed and   Exempt
Processed as:

Status Recommended by Reviewer(s): Approved   Protocol Expires: 2/19/2017

Principal
Investigator(s):

Tayler Marie Witte   Eric A. DeVuyst
415 Ag Hall   530 Ag Hall
Stillwater, OK 74078   Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☐ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title, PI advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Dawnett Watkins 219 Cordell North (phone: 405-744-5700, dawnett.watkins@okstate.edu).

Sincerely,

Shelia Kennison, Chair
Institutional Review Board

VITA

Tayler Witte

Candidate for the Degree of

Master of Science

Thesis: DETERMINING THE IMPACT OF A NEW FARM CREDIT BRANCH IN EAST
            CENTRAL OKLAHOMA

Major Field: Agricultural Economics

Biographical:

        Education:

        Completed the requirements for the Bachelor of Science in Agricultural Economics at
        Oklahoma State University, Stillwater, OK in 2013.

        Experience:
Graduate Research Assistant. Oklahoma State University, Department of Agricultural
Economics, Stillwater, OK. August 2013 – Present.

Teaching and Research Assistant. Oklahoma State University, Department of Agricultural
Economics, Stillwater, OK. August 2012 – May 2013.

Intern. Oklahoma State Bank, Vinita, OK. May 2012– August 2012

Intern. Welch State Bank, Welch, OK. June 2010 – August 2011