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Model Specification for Bank Failure: A Retrospective Look at Banks in Missouri during the Great Depression

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Abstract

This paper examines banks in Missouri during the Great Depression in order to find the correct model specification for bank failure during economic downturns. The data set controls for a bank's balance sheet, correspondent network, charters and memberships, county characteristics, and market share, and includes both Federal Reserve member and non-member banks. Using a probit model, it is concluded that the contractionary monetary policy employed by the St. Louis Federal Reserve did not help bank survival, as being a member of the Federal Reserve had no significant effect on a bank's probability of survival. Additionally, while an increased network led to higher rates of bank survival, connections to Chicago show evidence of contagion risk. Finally, the paper concludes that for future model specification it is important to capture balance sheet, network, and environment characteristics, as leaving out certain information can lead to omitted variable bias.

Acknowledgements

This work has been made possible with the help, support, and overall encouragement from a variety of individuals.

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I would also like to thank the previous research and graduate assistants who worked countless hours to put together this data set. None of this research could have been completed without their work.

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I. Introduction

The Great Depression was an incredibly severe worldwide economic downturn that originated in the United States during the late 1920s. Unemployment rose to nearly 25 percent, the stock market fell drastically, and nearly 40 percent of banks around the country were suspended. While this disaster occurred nearly a century ago, experts still argue over the true cause of the event. Many blame Black Tuesday in 1929; the culmination of a four-day period in which investors lost over $25 billion and the Dow dropped around 25 percent (Suddath, 2008). While this may have been the tipping point, many other factors played a role in instigating the downturn. Some critics blame the structure of capitalism, and claim recessions are a mandatory part of the economy. Others look to decreases in aggregate demand which lead to output declines. Regardless of the specific explanations, the collapse of the banking system undoubtedly amplified the effects of the downturn (Cecchetti, 1992).

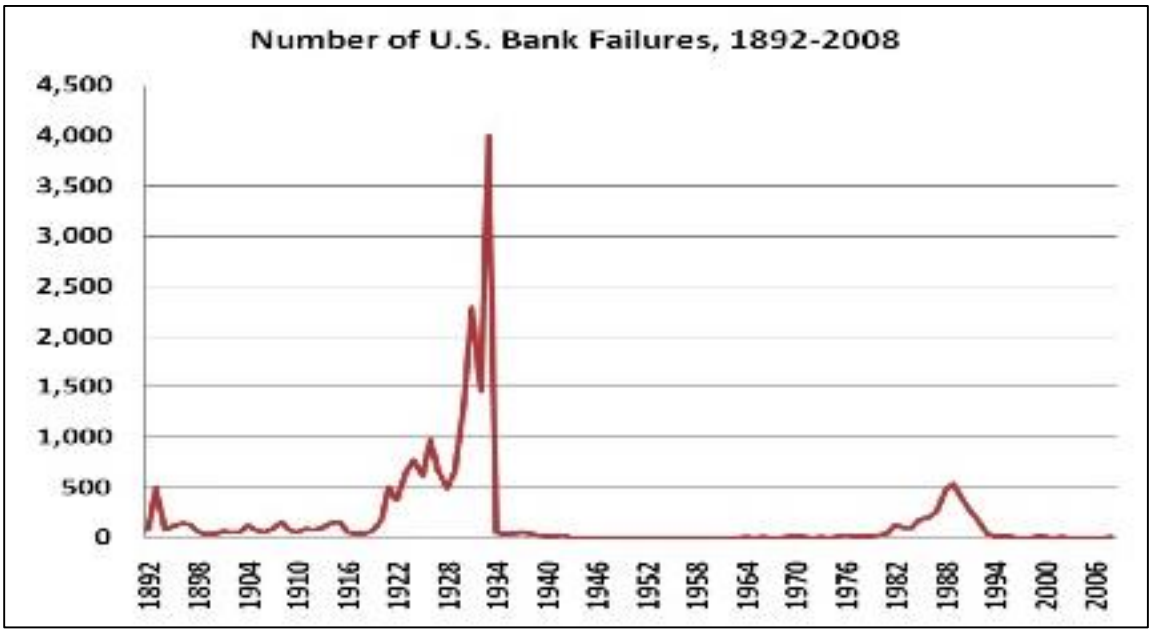

Figure 1: Number of U.S. Bank Failures between 1892 and 2008
Source: (Gorton, 2009)

During the Great Depression, spending decreased as the money supply fell, and it became more difficult for borrowers to repay loans and for banks to make new loans. Default rates skyrocketed, and banks were no longer returned the full outstanding loan amount. Banks rely on depositor confidence, for they hold only a fraction of deposits in reserves, and given that reserves pay no interest banks are incentivized to hold as few reserves as possible. One of the ways banks can satisfy customer demands and survive shaky depositor confidence is through borrowing; either from other banks, or from the Federal Reserve. However, when all banks are experiencing high levels of withdrawal, borrowing can be expensive or even impossible. Failure to meet depositor demand leads to insolvency and bankruptcy (Gorton, 2009). As seen in *Figure 1*, bank failure jumped in the 1930s, peaking at over 4,000 banks in 1934. As more banks fail, existing banks institute tighter lending policies, further restricting the economy.

This paper examines failure rates of banks in Missouri during the Great Depression. Using bank information, financial ratios, and data from the 1930 census, I attempt to determine the proper specification for modelling bank failure during economic downturns. Previous studies of bank failure at this time focus on Federal Reserve member banks, as databases from the Fed are often utilized. This paper includes data from non-member banks, giving a unique perspective into understanding survival factors for all banks. Additionally, it allows for the analysis of the effectiveness of the contractionary policy used by the St. Louis Federal Reserve. As seen during the Great Depression, the failure of the banking system can amplify otherwise concentrated economic problems. With the proper specification for modeling bank failure, individuals could better determine the characteristics most indicative of survival. With this knowledge, individuals could invest

in safer banks, and banks themselves could take on safer practices, decreasing the chance of failing during economic downturns. Furthermore, regulatory policy could focus on factors that help banks survive and lower systematic risk, therefore creating a safer banking system.

II. History and Current Literature

Early Banking System

Since the 18th Century, the banking industry has been instrumental in controlling the flow of money across the United States. In the mid-19th Century, with the country preparing for the Civil War, Congress passed the National Banking Acts of 1863, 1864, and 1865. The initial purpose of these Acts was to raise revenue for the upcoming war, and unify the national currency, which was accomplished by requiring banks to invest a certain portion of their capital into government bonds. Additionally, banks now had reserve requirements, with reserves either held with the bank itself or with correspondents (Sylla, 1969).

In the United States at the time, most banks were legally prevented from operating branch systems, and instead the National Banking Act led to an inverted pyramid structured reserve system. Country banks, the third tier, held deposits with banks in reserve cities, sometimes up to three-fifths of their total reserves. These reserve city banks made up the second tier, and would generally hold almost half of their reserves with banks in the top tier, ones that resided in central reserve cities like New York City and Chicago. Banks were incentivized to hold the maximum amount of reserves with correspondents, both because these balances satisfied reserve requirements and due to the 2 percent interest compared to 0 percent on traditional reserves (Bernstein et. al, 2009). In this way, funds were able to flow throughout the country without the branch system that is used today.

In the early 1900s a large percentage of the economy focused on agriculture. Banks were utilized to finance the planting of cotton in the South, and wheat and corn in the Great Plains. Therefore, there was significant seasonal demand from these country banks as they

financed the planting and were repaid during the harvest. Carlson and Wheelock (2015) analyzed the magnitude of this problem by looking at changes between call report dates in deposits with national banks. They determined that country banks would generally increase their deposits with city banks by 25 percent following the harvest, and pull out at a similar rate prior to the harvest. This seasonal pressure on the system could cause crises when shocks drove up the need for liquidity from country banks. For example, in 1907 country bank deposits decreased by 38 percent between May and December, and the increased stress on the banks in reserve cities lead to the Panic of 1907. Seasonal pressures regularly put stress on the banking system, and often led to banking panics (Carlson and Wheelock, 2015).

According to Carlson and Wheelock (2017), the other significant issue facing the banking system was the problem of contagion. Initially, the idea of an interbank network was thought to help shield banks from illiquidity concerns, as these issues could be spread across the correspondent networks. If banks faced pressure, they could draw on their reserves held with a correspondent in a region not experiencing a panic. However, this interconnectedness led to the amplification of regional panics. In the previous example, extreme seasonal pressure could drive up liquidity stress in a few regions, which all drew from central reserve cities in New York and Illinois. These financial hubs faced simultaneous pressure from around the country, and began restricting cash and limiting lending. This amplified the effects even further, and passed the issue along to regions who did not face the initial panic. Correspondent networks and the interbank market played a role in distributing money across the country, but at the same time amplified the effects of small shocks. (Carlson and Wheelock, 2017).

Establishment of the Federal Reserve

The Federal Reserve was created to ease the burden on the central reserve city banks, and halt any economic fallouts that occurred during these shocks. Established in the early 1900s, the Fed was initially tasked with solving the both the seasonality and contagion issues faced by banks (Carlson and Wheelock, 2015).

Following the creation of the Federal Reserve, banks now had the ability to meet liquidity demands by using the discount window for loans. Carlson and Wheelock (2015) examined the patterns of this discount window, and noticed that demand from country banks was decidedly seasonal, indicating a reduction in seasonal demands between banks. Following the harvest, country banks increased their deposits with correspondent cities by

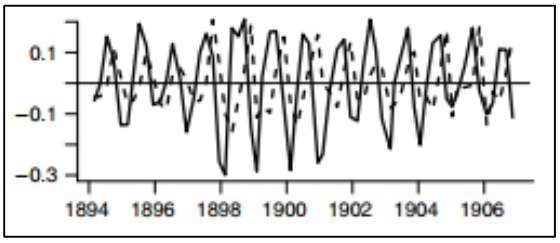

Figure 2: First two principal components of due from National Banks from Country Banks (1894 – 1906)
Source: (Carlson and Wheelock, 2015)

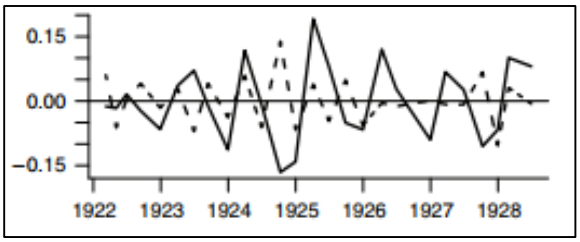

Figure 3: First two principal components of due from National Banks from Country Banks (1922 – 1928)
Source: (Carlson and Wheelock, 2015)

less than 10 percent, further proving the discount window decreased seasonal pressures in the banking system. *Figure 2* and *Figure 3* illustrate the change in seasonal demand between banks before and after the establishment of the Federal Reserve (Carlson and Wheelock, 2015).

While the Federal Reserve succeeded in mitigating the issue of seasonality, there is considerable discussion over the extent of contagion risk. Under the Federal Reserve Act, national banks could no longer use correspondent balances to satisfy their reserve

requirements. Carlson and Wheelock (2017) argued that this helped lower the exposure to shocks surrounding correspondents. To measure this, they used a system that compares an

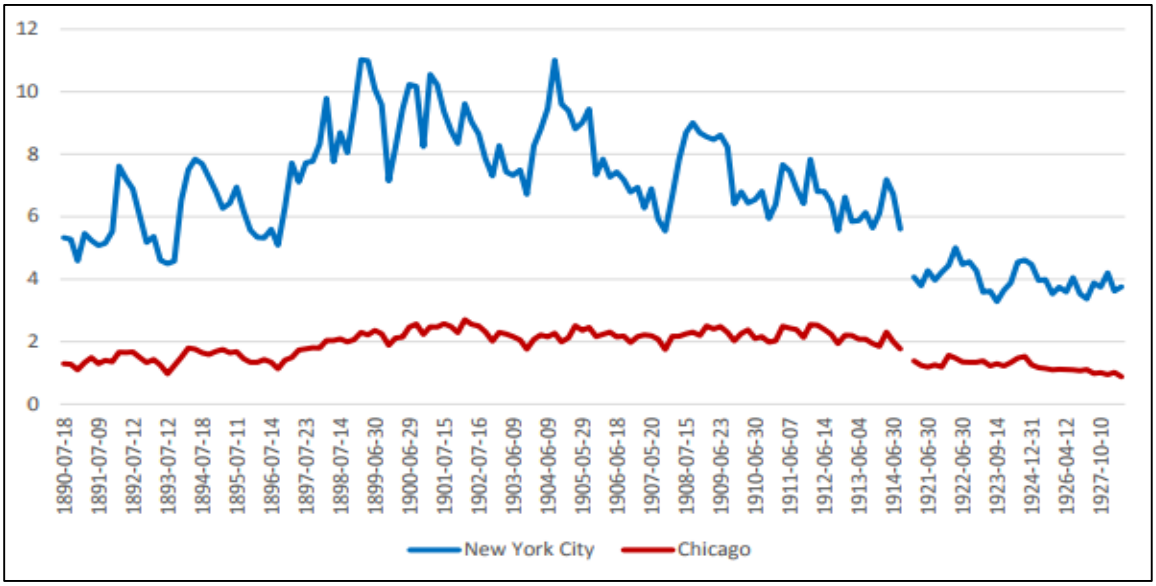

Figure 4: Average vulnerability of country banks to a solvency shock in central reserve city
Source: (Carlson and Wheelock, 2017)

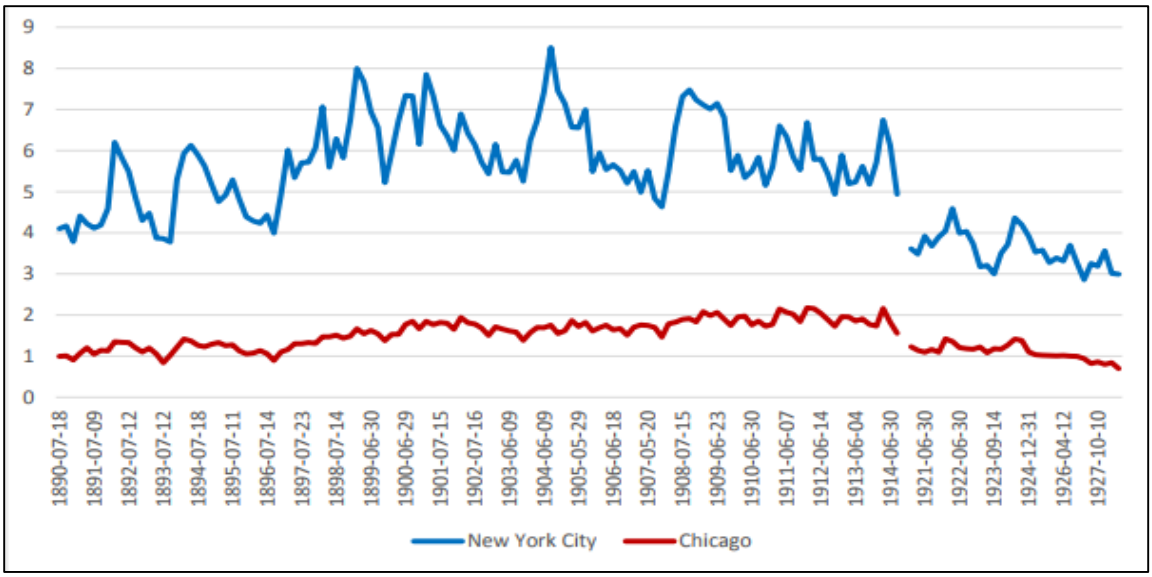

Figure 5: Average vulnerability of reserve city banks to a solvency shock in central reserve city
Source: (Carlson and Wheelock, 2017)

index of contagion risk to the index of the average vulnerability of country banks. *Figure 4* plots the average vulnerability of country banks to a solvency shock originating in a

central reserve city, and *Figure 5* plots the same factor but for reserve city banks. The lower the ratio, the less vulnerable the group of banks are to shocks in the respective city. According to their study, the Federal Reserve greatly decreased the risk of contagion for country banks and reserve city banks (Carlson and Wheelock, 2017).

Calomiris and Mason (1994) supported Carlson and Wheelock's (2017) findings by focusing on banks in Chicago during the Great Depression. In June of 1932, Chicago experienced an extreme concentration of bank failures, resulting in what is now known as the Chicago Banking Panic. Of the 49 banks that failed in June in Illinois, 40 were in Chicago, and 26 were during one week. While it would be easy to attribute this concentrated failure to contagion, Calomiris and Mason (1994) argued this was not the case. They compared the market-to-book value of equity, estimated probability of duration of survival, composition of date, rates of withdrawal of debt, and interest rates paid on debt between banks that failed and those that survived. The banks that failed during this period were similar to ones that failed in other periods, and different from those that survived during the Great Depression. These results led to their conclusion that contagion was not the leading factor, and instead the failures were the result of a common weakness in certain asset values (Calomiris and Mason, 1994).

Mitchener and Richardson (2016) developed a study arguing the opposite; that contagion was an issue and amplified the impact of the Great Depression. In 1929 Federal Reserve member banks held a combined $3.7 million in interbank deposits, which made up 60 percent of aggregate reserves. Excess reserves held at the Fed were insignificant compared to these interbank deposits. Additionally, over 40 percent of the aggregate interbank balances were held in Chicago and New York City, indicating the high level of

concentration in these central reserve cities. In the study, it is estimated that there was an overall 15 percent decline in lending solely because of these interbank connections, providing evidence that contagion was still an issue during the Great Depression (Mitchener and Richardson, 2016).

A previous study, by Calomiris and Mason (2003) helps put this number into perspective regarding the total impact on the Great Depression. In their study, the two authors utilized loan-supply shocks to estimate an aggregate decline in bank credit, and linked this to income growth to measure the magnitude of the effect. They found that a one standard deviation decrease in loan-supply growth can decrease income growth by anywhere from 7 to 9 percent (Calomiris and Mason, 2003).

This study contributes to the ongoing discussion about contagion risk by including three correspondent variables in the data set. The analysis of these variables will indicate whether contagion was an issue for banks in Missouri at the time.

Structure and Policy of the Federal Reserve System

While the Federal Reserve succeeded in mitigating some of the existing issues, it was created without the goal of uniting monetary policy. The Federal Reserve Act divided the United States into 12 distinct regions, constructed based on economic conditions. Originally, it was assumed that these regions would operate independently, and set their own discount rates, as there was limited support for setting a national economic policy (Federal Reserve). Therefore, neighboring regions could have vastly differing policies, as was the case in St. Louis and Atlanta. In their study, Richardson and Troost (2009) examine these two polar Federal Reserve Districts; Atlanta (6^{th}) and St. Louis (8^{th}). The Atlanta Federal Reserve was a leader in money activism, using a rule coined by Walter

Bagehot that during financial downturns, central banks should extend credit to institutions facing illiquidity problems. The goal would be to prevent increased withdrawal rates from driving banks into bankruptcy. The St. Louis Federal Reserve accepted the idea that the supply of credit should contract during recessions, as the lower level of economic activity and production required less credit. During periods of panic, the St. Louis Fed limited lending and contracted the money supply, and even sometimes required double collateral on loans. Mississippi sat at the midpoint of the 6th and 8th Federal Reserve Districts, and during the formation of the regions was split evenly between the two. This formation

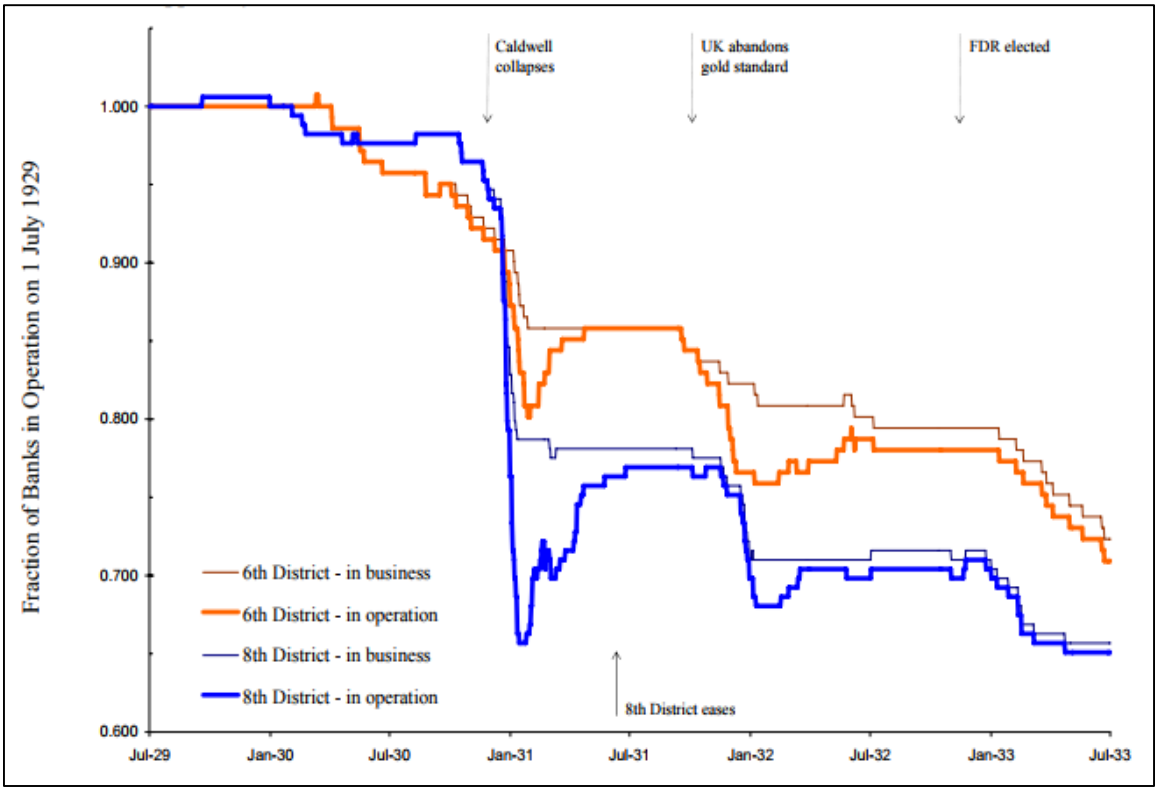

Figure 6: Percentage of Banks in Business and in Operations in the 6th and 8th Districts
Source: (Richardson and Troost, 2006)

created the setting for Richardson and Troost to compare the two policies in terms of bank failure in a single state. During the first three weeks of the crisis, the Atlanta Fed increased discounts to member banks by $2,800,000, and credit to member banks increased by over

$8,000,000. Comparatively, the St. Louis Fed discounts and credit declined by $2,100,000 and $11,800,000 respectively. As seen in *Figure 6*, banks in Mississippi within the 6th District survived at significantly higher rates than those in the 8th District. Additionally, the study finds that banks in the Atlanta region began an earlier recovery, and had less financial contraction compared to banks in the St. Louis region (Richardson and Troost, 2009).

In this study, I focus on banks within Missouri, which all lie in the jurisdiction of the St. Louis Federal Reserve (the 8th District). Part of the reason for this arises from data limitations; compiling data from the entire country would take years. However, the more important motive behind this is because of the specific policies mentioned above. The St. Louis region enforced the most conservative monetary policy during the Great Depression, and therefore experienced a large portion of the bank failures across the country. Focusing on Missouri helps control for the specific monetary policy experienced by banks. Additionally, Missouri provides a surprisingly impressive model for the entire United States. Missouri contains a strong financial center in St. Louis (similar to New York for the country), but also a wide variety of city and country banks. Therefore, any takeaways for Missouri can provide insights about the entire country, while controlling for monetary policy that differed at the time. This paper contributes to Richardson and Troost's study by examining all banks in Missouri and further investigating the effectiveness of the conservative monetary policy deployed by the St. Louis Federal Reserve. The inclusion of banks that were not members of the Federal Reserve allows for the comparison of member and non-member banks, and the analysis of a Federal Reserve member variable. A positive and significant variable would indicate the St. Louis Federal Reserve succeeded in

mitigating bank failure, while an insignificant variable would support Richardson and Troost's (2009) findings above.

This study most closely follows one published in 2013 regarding the effectiveness of the Reconstruction Finance Corporation. While I do not discuss any effects from the RFC, there are some key ideas used in the 2013 study that are utilized in this one. The paper focuses on bank survival in the state of Michigan, citing the importance of the Michigan banking crisis of 1933. The study employs a probit regression model, using survival as a binary variable (0=failure, 1=survival), which is the model used in this study. Additionally, many of the variables utilized in the paper are similar to ones outlined in *Table 1* in the next section. The number of correspondents, county population in 1930, and the national bank indicator are a few of the variables that will be consistent across the two studies. The number of correspondents variable, along with a few variations, helps measure the level of interconnectedness for each bank, similar to the study done by Mitchener and Richardson (2016). The study finds that the number of correspondents was significant and positive in determining survival rates (and probability of an RFC loan) while the number of correspondents in New York and Chicago variable was insignificant. (Calomiris et. al, 2013).

While the model and variables will be similar, my paper contributes to the original study by examining both Federal Reserve member and non-member banks. Calomiris et al. (2013) used data from the Federal Reserve, and therefore was restricted solely to member bank data. This gives the present study a much more diverse look at bank survival during the period, and allows for greater analysis in looking at factors for survival across all banks.

III. Data

The purpose of this analysis is to determine the relevant characteristics for examining bank failure during recessions. Data limitations have restricted many studies of the Great Depression. As mentioned previously, this study uses data including non-Federal Reserve member banks as well as members, which allows for analysis of the entire banking population. The data set I will be using includes individual bank data from banks in Missouri in 1929 and 1935, along with town and county characteristics. *Table 1* identifies the variables and their respective definitions.

Bank Survival	Dummy Variable for bank survival in 1935 (1=open, 0=closed)
Age	Age of the bank in 1935
Banks in Same Town	Number of banks in the same town
Correspondents	Total number of correspondent relationships with other banks
New York Correspondents	Total number of correspondent relationships with banks in New York
Illinois Correspondents	Total number of correspondent relationships with banks in Illinois
Federal Reserve Member	Dummy Variable indicating if the bank is a Federal Reserve member
Deposits	Natural log of the total deposits at the bank
% of Town Deposits	Percentage of deposits the bank holds in the town
Loans / Deposits	Loans divided by total deposits
Cash / Deposits	Cash divided by total deposits
Loans / Assets	Loans divided by total assets
Bonds / Assets	Bonds divided by total assets
Cash / Assets	Cash divided by total assets
Liabilities	Natural log of the total liabilities at the bank
Capital / Liabilities	Capital divided by total liabilities
Deposits / Liabilities	Deposits divided by total liabilities
Leverage	Surplus profits divided by (surplus profits plus capital)
Town Population	Natural log of the population of the town
Retail Sales	Natural log of the amount of retail sales in the county
Cropland	Natural log of the total acres of cropland in the county

Table 1: Variable Definitions

The data can be split into three subtypes: bank information, financial information, and county information. Bank information includes the age, charter, number of competitors in the town, and network information. Financial data includes deposits and

liabilities, along with a variety of ratios to indicate the current standing and health of the bank. This information was collected from the *Rand McNally Bankers' Directory*; a biyearly book that compiled data from bank call reports, and included relevant financial information, and a list of correspondents.[1] These books were one of the only means to access this information at the time, and were utilized to identify which banks individuals wanted use for their own purposes. Bank survival is the dependent variable, comparing the 1929 *Rand McNally Banker's Directory* with the 1935 version and identifying which banks are no longer in existence. The three correspondent variables demonstrate the network for each bank, and explain its interconnectedness with other banks and with major money centers in the United States. These three variables will help address the idea of whether a large number of correspondents contributed to bank survival, or increased the risk of contagion. The variety of other economic variables focus on the financial standing of the bank.

The specific county information comes from the 1930 census. The census is completed every 10 years, making the 1930s census closest to estimating county information for 1929. The Census Bureau places a statutory 72-year restriction on the data, which is what allows the of the access data from the 1930s census (National Archives). Census data was downloaded from the University of Michigan Library Research Guide (University of Michigan). This data allows for the examination of the economic structure and environment of each bank's county. This information will help determine the vulnerability of banks in the city versus out in the country. *Table 2* outlines the summary statistics for all of the banks in the study.

[1] Data originally acquired and digitalized by Dr. Angela Vossmeyer

The sample size includes 1,288 banks in Missouri in 1929. Of these banks, 48 percent of those alive in 1929 no longer existed in 1935. This is significantly more than the estimated 40 percent of banks that suspended across the country, and is consistent with the thought that the tight monetary policy enacted by the St. Louis Fed was detrimental to the banking system in Missouri.

	Mean	Median	Standard Deviation	Maximum	Minimum	Count
Bank Survival	0.52	1.00	0.50	1.00	0.00	1288
Age	33.19	30.00	19.57	135.00	6.00	1288
Banks in Same Town	5.52	2.00	12.42	56.00	1.00	1288
Correspondents	2.58	2.00	1.46	21.00	0.00	1288
New York Correspondents	0.27	0.00	0.60	7.00	0.00	1288
Illinois Correspondents	0.52	0.00	0.64	4.00	0.00	1288
Federal Reserve Member	0.14	0.00	0.35	1.00	0.00	1288
Deposits	12.38	12.22	1.23	18.86	9.03	1288
% of Town Deposits	0.62	0.59	0.36	1.00	0.00	1288
Loan / Deposits	0.85	0.82	0.83	25.83	0.16	1288
Cash / Deposits	0.22	0.19	0.14	2.57	0.00	1288
Loans / Assets	0.65	0.67	0.15	1.00	0.13	1288
Bonds / Assets	0.13	0.09	0.14	0.70	0.00	1288
Cash / Assets	0.17	0.15	0.09	0.70	0.00	1288
Liabilities	12.61	12.44	1.19	19.01	10.00	1288
Capital / Liabilities	0.10	0.09	0.06	0.74	0.01	1288
Deposits / Liabilities	0.80	0.82	0.09	0.95	0.03	1288
Leverage	0.40	0.39	0.19	0.91	0.00	1288
Town Population	6.93	6.46	1.95	13.65	3.37	1288
Retail Sales	15.51	15.22	1.23	19.72	13.27	1288
Cropland	11.86	11.95	0.44	12.68	10.04	1288

Table 2: Summary Statistics for all banks

On average there were 6 banks in each town, but this was inflated by the 56 banks in St. Louis in 1929. Most banks had between two and three correspondents, with twice as many

being linked to banks in Illinois than New York. In total, 14 percent of the banks in this study were Federal Reserve member banks. *Table 3* and *Table 4* provide summary statistics for Federal Reserve member banks and non-member banks respectively.

	Mean	Median	Standard Deviation	Maximum	Minimum	Count
Bank Survival	0.60	1.00	0.49	1.00	0.00	183
Age	36.71	32.00	22.76	135.00	6.00	183
Banks in Same Town	18.74	4.00	23.32	56.00	1.00	183
Correspondents	3.49	3.00	2.64	21.00	1.00	183
New York Correspondents	0.87	1.00	1.11	7.00	0.00	183
Illinois Correspondents	0.73	1.00	0.74	4.00	0.00	183
Federal Reserve Member	1.00	1.00	0.00	1.00	1.00	183
Deposits	13.90	13.72	1.51	18.86	11.17	183
% of Town Deposits	0.32	0.28	0.29	1.00	0.00	183
Loan / Deposits	0.68	0.67	0.19	1.46	0.16	183
Cash / Deposits	0.20	0.18	0.10	0.67	0.03	183
Loans / Assets	0.54	0.54	0.13	0.82	0.13	183
Bonds / Assets	0.26	0.24	0.15	0.70	0.00	183
Cash / Assets	0.16	0.14	0.08	0.55	0.02	183
Liabilities	14.13	13.94	1.46	19.01	11.60	183
Capital / Liabilities	0.09	0.07	0.05	0.27	0.02	183
Deposits / Liabilities	0.80	0.81	0.08	0.94	0.52	183
Leverage	0.37	0.37	0.17	0.82	0.00	183
Town Population	9.33	8.34	2.78	13.65	5.42	183
Retail Sales	15.67	15.17	1.26	19.72	13.75	183
Cropland	11.93	11.98	0.33	12.68	10.96	183

Table 3: Summary Statistics for Federal Reserve Member Banks

Of the 1,288 banks used in this study, 183 of them were Federal Reserve member banks. Over 60 percent of these banks survived through 1935, which is higher than the 52 percent for the study as a whole. On average, these Federal Reserve member banks were four years older than non-member banks, and had an extra correspondent bank.

	Mean	Median	Standard Deviation	Maximum	Minimum	Count
Bank Survival	0.50	1.00	0.50	1.00	0.00	1105
Age	32.61	30.00	18.94	135.00	6.00	1105
Banks in Same Town	3.33	2.00	7.51	56.00	1.00	1105
Correspondents	2.43	2.00	1.09	7.00	0.00	1105
New York Correspondents	0.16	0.00	0.39	3.00	0.00	1105
Illinois Correspondents	0.48	0.00	0.61	3.00	0.00	1105
Federal Reserve Member	0.00	0.00	0.00	0.00	0.00	1105
Deposits	12.13	12.07	0.98	15.98	9.03	1105
% of Town Deposits	0.67	0.68	0.34	1.00	0.00	1105
Loan / Deposits	0.88	0.84	0.89	25.83	0.19	1105
Cash / Deposits	0.22	0.19	0.14	2.57	0.00	1105
Loans / Assets	0.67	0.69	0.14	1.00	0.17	1105
Bonds / Assets	0.11	0.07	0.13	0.69	0.00	1105
Cash / Assets	0.17	0.15	0.09	0.70	0.00	1105
Liabilities	12.36	12.28	0.92	16.10	10.00	1105
Capital / Liabilities	0.11	0.09	0.07	0.74	0.01	1105
Deposits / Liabilities	0.80	0.82	0.09	0.95	0.03	1105
Leverage	0.40	0.40	0.19	0.91	0.00	1105
Town Population	6.53	6.28	1.43	13.65	3.37	1105
Retail Sales	15.49	15.22	1.22	19.72	13.27	1105
Cropland	11.84	11.92	0.45	12.68	10.04	1105

Table 4: Summary Statistics for Non Federal Reserve Member Banks

Additionally, they were more than five times as likely to be connected to a bank in New York. Generally, Federal Reserve member banks were located in more highly populated cities, with non-member banks serving the countryside and smaller communities. Unsurprisingly, banks connected with the Fed maintained more depositors, but held a lower percentage of market share in the town compared to non-member banks. These banks were also more highly levered, but held a larger percentage of cash.

Non Federal Reserve member banks on average had only three other banks in their town. Surprisingly, they averaged less cropland in the respective counties than Federal Reserve member banks, although this may be due to the sheer size of some of the towns. In this data set, 50 percent of non-member banks survived during the Great Depression, which is much lower than the rate of survival from member banks.

IV. Methods

Probit Model

This paper implements a non-linear model for bank survival because the outcome variable is not continuous. The framework follows a latent utility specification such that

$$y_i^* = x_i'\beta + \epsilon \ .$$

The latent variable, y_i^*, is related to the observed outcome by the link function

$$y_i = \begin{cases} 0 \ if \ y_i^* \leq 0 \\ 1 \ if \ y_i^* > 0 \end{cases}.$$

Specifically, the outcome variable measure as

$$y_i = \begin{cases} 0 \ if \ bank_i \ fails \\ 1 \ if \ bank_i \ does \ not \ fail \end{cases}.$$

The covariates that enter the vector x_i include information on the bank *i*'s balance sheet, correspondent network, charters and memberships, county characteristics, and market share. Several specifications for x_i are considered in a model comparison setting, which is discussed below. It is assumed that $\epsilon \sim N(0,1)$, thus this is a probit model.

The model is estimated by maximum likelihood. The probit likelihood is

$$f(y|\beta) = \prod_{i=1}^{n} \Phi(x_i'\beta)^{y_i}[1 - \Phi(x_i'\beta)]^{1-y_i}$$

and the estimator is as follows

$$\hat{\beta}_{MLE} \equiv argmax \ln f(y|\beta).$$

Marginal Effects

The impact of changing the *j*th covariate x_{i_j} on the outcome probability above can be evaluated by marginal effects. The marginal effect (or derivative) with respect to x_{i_j} is

$$\frac{\partial \Pr(y_i = 1|x_i, \beta)}{\partial x_{i_j}} = \phi(x_i'\beta)\beta_j ,$$

where ϕ is the standard normal pdf. This shows that the effect of changing x_{i_j} depends on the entire vector x_i and all parameters β, and is nonlinear.

Model Comparison

Traditionally, fit measures and testing procedures are based on R^2 values, the sum of the squared residuals, or the adjusted R^2 that penalizes the addition of variables. However, both R^2 and adjusted R^2 are based on the underlying assumption that they are fitting a linear model. As mentioned above, this paper implements a non-linear model because of the binary dependent variable.

Instead, to perform model comparison, in this paper I utilize the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC),

$$AIC = -2\ln(L) + 2K$$

$$BIC = -2\ln(L) + Kln(n) ,$$

where K is the number of parameters in the model, L is the log likelihood, and n is the sample size. One thing to note is that AIC and BIC are information criteria, not fit measures. For these two criterion "smaller is better", and a smaller AIC and BIC indicate a better-fitting model (Greene, 2016).

V. Results

Table 5 outlines the three main regressions run with the data. Using the model selection procedure detailed above, the middle regression was best at representing the data, recording an AIC of 1635. The full regression (with all 20 control variables) was second, while the parsimonious regression had the worst fit with the data. This indicates that a few controls in each category (location, network, and balance sheet) are necessary to have the

	Full Regression		Middle Regression		Parsimonious Regression	
	Marginal Effects	Standard Error	Marginal Effects	Standard Error	Marginal Effects	Standard Error
Age	0.004	0.030	0.003	0.030		
Banks in Same Town	-0.005 **	0.002	-0.004 **	0.002		
Correspondents	0.030 *	0.017	0.031 *	0.017	-0.001	0.012
New York Correspondents	-0.074 *	0.043	-0.075 *	0.043		
Illinois Correspondents	-0.099 ***	0.028	-0.101 ***	0.028		
Federal Reserve Member	0.008	0.054	0.015	0.054	-0.041	0.050
Deposits	0.888	0.979	0.116 ***	0.027	0.076 ***	0.023
% of Town Deposits	0.105 *	0.060	0.093 *	0.053	0.124 **	0.051
Loans / Deposits	0.106	0.118				
Cash / Deposits	-0.338	0.322				
Loans / Assets	0.136	0.335				
Bonds / Assets	0.979 ***	0.311	0.716 ***	0.126	0.613 ***	0.121
Cash / Assets	1.328 **	0.523	0.651 ***	0.174		
Liabilities	-0.777	0.977				
Capital / Liabilities	2.031 ***	0.516	2.057 ***	0.498	0.859 **	0.338
Deposits / Liabilities	-0.487	1.271	0.576 **	0.272		
Leverage	0.762 ***	0.126	0.777 ***	0.121	0.591 ***	0.098
Town Population	0.007	0.014				
Retail Sales	0.022	0.015	0.020	0.014		
Cropland	-0.093 **	0.036	-0.088 **	0.036	-0.046	0.033
AIC	1643.812		1635.986		1679.81	
BIC	1752.19		1718.56		1726.258	

Table 5: Probit Regressions
Levels of Significance: *** = Significant at the 99% level
** = Significant at the 95% level
* = Significant at the 90% level

best fitting model. Additionally, the inclusion of too many financial variables can lead to overfitting, as seen in the Full Regression. Therefore, the following discussion will focus on the middle regression.

One of the biggest takeaways from the three regressions is the insignificance of the Federal Reserve Member indicator variable. The Federal Reserve was founded as the lender of last resort; with the purpose of preventing panics and limiting any crises that may occur. The Fed mainly acted through discount window lending, but was also given other tools to help act as the lender of last resort (Carlson and Wheelock, 2012). Theoretically, having access to the discount window should have a significant effect on a bank's survival rate. Banks faced enormous pressure from depositors for access to funds, and the Fed should have been able to ease some of this stress. However, being a member of the Federal Reserve had no effect on bank survival in this study. One of the reasons for this could be the restrictive policy pursued by the St. Louis Federal Reserve. As noted earlier, banks in the St. Louis Fed's region failed at higher rates than those in the Atlanta Fed's district, mostly due to the St. Louis Fed's contractionary actions. The insignificance of this variable points to the ineffectiveness of the St. Louis Federal Reserve, and of contractionary monetary policy as a whole, which aligns with conclusions from Richardson and Troost's (2006) paper discussed earlier. If more expansionary monetary policy had been pursued, banks would have theoretically seen a larger benefit for being a member of the Federal Reserve, and more banks may have survived the crisis.

The three correspondents variables represent the interconnectedness of the bank, and are all significant in the middle regression. Increasing the number of correspondents by one would increase a bank's chance of survival by around 3 percent. This indicates that

a larger network can improve survival chances, and that the negatives of contagion may be outweighed by the positives of a strong network. Both New York Correspondents and Illinois Correspondents variables were negative (Illinois at the 99 percent level) indicating that connections with banks in these cities may actually have negative effects on survival rates. By adding another correspondent from Illinois, a bank actually decreased its chances of survival by around 10 percent. This can most likely be explained by contagion from the Chicago Banking Panic in 1932. In their study outlined previously, Calomiris and Mason concluded that contagion played a limited role in bank failures in Chicago during the panic. The findings in *Table 5* somewhat contradict their conclusions, indicating that the panic in Chicago affected corresponding banks outside of the state.

The Banks in Same Town variable had a significant negative correlation with bank survival. The addition of another bank in a town decreased the chances of survival for existing banks by 0.4 percent. This most likely arises from the increased competition as the number of banks rises. Banks are forced to adopt more competitive, and often less profitable, policies, and take on more risk to survive. This conclusion is enforced by the % of Town Deposits variable, which was significant at the 90 percent level and positive, indicating that having higher market share increases probability of survival. Balance sheet data is aligned with expectations, with high levels of significance. Increasing a bank's bond ratio by 10 percent would lead to a 7 percent increase in probability of survival, while a similar increase in the cash to assets ratio would have a 6.5 percent increase. Cash is the most liquid asset on the balance sheets for banks, with bonds a close second, so increasing holdings of these assets would help a bank meet any depositor demands. The largest effect came from the capital to liabilities ratio, where an increase of 10 percent would lead to a

20.5 percent increase in a bank's probability of survival. In this data set, capital represents paid up capital, which was owned by shareholders and can be thought of as a safe liability. Therefore, if a bank experienced a run on the bank, the capital could be used as a buffer against the increased demand for liquidity. One of the most surprising results came from the Leverage variable, which is generally a risk measure, but had a significant and positive relationship with bank survival. In this study, leverage is defined as surplus profits over (surplus profits added to capital), where surplus profits include dividends and contingencies. Therefore, a higher leverage rate can be thought of as an increase in credit worthiness, as a larger dividend leads to more people trusting your bank and investing.

Retail Sales in the county were insignificant in predicting bank failure rates, while Cropland was significant at the 95 percent level, but had a negative effect on bank survival. Generally, agricultural stress preceded banking stress, explaining the negative correlation between cropland and bank survival. Additionally, banks in areas with large amounts of cropland were often small country banks, with smaller balance sheets. These banks were therefore more susceptible to shocks, and had an increased risk of failure during the Great Depression.

Additional Considerations

One of the important factors of this regression is the variety of control variables. With the data, the study controls for a bank's balance sheet, correspondent network, charters and memberships, county characteristics, and market share. The purpose of this section is to demonstrate the biases that can occur when categories of these variables are

missing. *Table 6* details three different regressions using only bank information, balance sheet data, and county details in the respective regressions.

	Bank Information Regression		Financial Regression		County Regression	
	Marginal Effects	Standard Error	Marginal Effects	Standard Error	Marginal Effects	Standard Error
Age	0.08120 ***	0.02664				
Banks in Same Town	-0.00003	0.00148				
Correspondents	0.04278 ***	0.01566				
New York Correspondents	-0.00886	0.04006				
Illinois Correspondents	-0.09779 ***	0.02593				
Federal Reserve Member	0.07869 *	0.04549				
Deposits			0.7084	0.9516		
% of Town Deposits			0.1193 **	0.0510		
Loans / Deposits			0.0932	0.1147		
Cash / Deposits			-0.3224	0.3208		
Loans / Assets			0.0938	0.3277		
Bonds / Assets			0.8941 ***	0.3018		
Cash / Assets			1.2896 **	0.5127		
Liabilities			-0.6387	0.9511		
Capital / Liabilities			1.9013 ***	0.5023		
Deposits / Liabilities			-0.1767	1.2289		
Leverage			0.7851 ***	0.1181		
Town Population					0.0202 ***	0.0073
Retail Sales					0.0265 **	0.0122
Cropland					-0.0592 *	0.0339
AIC	1759.932		1658.129		1778.371	
BIC	1796.058		1720.059		1799.014	

Table 6: Categorical Probit Regressions
Levels of Significance: *** = Significant at the 99% level
** = Significant at the 95% level
* = Significant at the 90% level

In a specification with only bank information, half of the variables are significant at the 99% level. Looking at this regression, one would erroneously assume that Federal Reserve membership is significant for determining bank survival, and possibly make the conclusion that the actions taken by the St. Louis Federal Reserve were beneficial for

banks. Due to the data limitations, many studies of the Great Depression fail to include all pertinent information for banks, either excluding certain financial data or environmental characteristics. Failing to include this information could lead to ineffective future monetary policy, as policy makers would erroneously make the conclusion that the conservative monetary policy was successful at mitigating bank failure. This exhibits the omitted variable bias that can occur when a study fails to control for balance sheet data and other information. This specification had an AIC of 1760, which is significantly higher than any of the three regression in *Table 5*, indicating it does a poor job of representing the data.

The second regression only controls for financial information, and is the best of the three specifications in Table 6 according to the Akaike Information Criterion. Despite this, similar problems of omitted variable bias occur in this specification. Deposits (total and as a percentage of liabilities) appear to be insignificant, while in actuality both are significant at the 99 percent level. Regardless of the importance of balance sheet data, this specification shows that other information must be considered beyond financials.

The final regression controls only for county information, and once again, these results would lead to erroneous conclusions. Town population appears to be significant at the 99 percent level, along with Retail Sales at the 95 percent level. We find positive and significant effects from both of these variables, while in actuality they are insignificant, demonstrating an upward bias. Both of these variables are insignificant when controlling for balance sheet data, bank information, and market share data, because bank size is captured separately from town size.

The results in *Table 6* highlight the importance of capturing all elements of bank information. While balance sheet data appears to be the most important, and network information often leads to the most impactful analysis, other factors can play a significant role in bank failure and survival. Many studies only include network models, and fail to control for changes in the county. While data restrictions can often be the cause of these specification limitations, for a true model of bank survival a variety of variables must be considered. This highlights the importance of model comparison in economic studies, as models missing certain information may lead to erroneous results and conclusions.

VI. Conclusions

This paper attempts to find the proper specification for bank failure during economic downturns. The data used in this study includes both Federal Reserve member banks, and non-member banks, and controls for a bank's balance sheet, correspondent network, charters and memberships, county characteristics, and market share. The results and analysis, above, can have important implications for future studies and future policy decisions.

For future studies, accounting for a bank's network is integral for understanding its risk of failure. As seen in the Middle Regression in *Table 5*, a connection with a bank in Illinois had extremely significant negative effects on a bank's survival rate. While the introduction of the Federal Reserve did help mitigate some of the contagion risk, clearly this was still a factor, as the Chicago Banking Panic contributed to bank failures in Missouri. Therefore, when attempting to model bank failure in the future it will be important to account for a bank's network, as this can vastly affect survival rates.

This study also found evidence that confirmed the shortcomings of Federal Reserve policy in the 8th district, originally discussed by Richardson and Troost (2009). Having access to the discount window offered by the Federal Reserve should in theory give a bank an advantage during an economic downturn. Given that this study includes both Fed member and non-member banks, it would be expected that these banks have vastly different survival rates. Instead, results showed an insignificant Federal Reserve member variable, indicating there was no difference between survival rates of these two types of banks. This most likely is a representation of the ineffectiveness of the conservative monetary policy pursued by the St. Louis Fed, and has far-reaching implications for the

Federal Reserve. Clearly, Fed policy during an economic downturn should not be stringent, and should more closely follow actions the taken by the Atlanta Federal Reserve during the Great Depression of extending credit to institutions facing illiquidity problems.

Finally, the regressions shown in *Table 6* display the importance of capturing all elements of a banks environment. It is tempting to solely examine the balance sheet in an attempt to detect future insolvency, but other factors like network collapses and changes in the local area can have significant effects. The absence of this information in the regression leads to nontrivial omitted variable bias, and can have drastic implications on future banking policy. In this study, without controlling for balance sheet information and environmental factors, one would erroneously make the conclusion that the St. Louis Federal Reserve's contractionary monetary policy was beneficial for banks in Missouri. In order to have a better model specification for bank failure, and avoid omitted variable bias, all factors of a bank's environment need to be considered.

VII. References

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