



# A Study of the Impact of Interest Rate Risk on Community Banks

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**MAY 2023**

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As of yesterday, the interest rate stands at more than 5% at a 16-year high affecting economic activity and inflation

# Agenda

**1**

Introduction

**2**

Data Collection

**3**

Exploratory Data Analysis

**4**

Model design, construction and validation

**5**

Conclusion and Discussion





# 1. Introduction

- Hypothesis
- Literature Review
- Study Design

# 1.1 - Hypothesis

- Our research aims to investigate the impact of **interest rate changes** on community banks' performance indicators.
- Additionally, we will explore the correlation between interest rates and **community bank failures**.
- As a result, we hypothesize that certain key factors, influenced by interest rates, could serve as **predictors for bank failures**.

## 1.2 - Literature Review and Model Selection

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Timothy B. Bell, 1997

This study examined the performance of two different effective methodologies in **predicting bank failures, traditional statistical models, and artificial neural networks.**

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Rebel A. Cole and Lawrence J. White, 2012

This study aimed to identify the determinants of bank failures, using a combination of **traditional and portfolio variables identified based on CAMELS framework.**

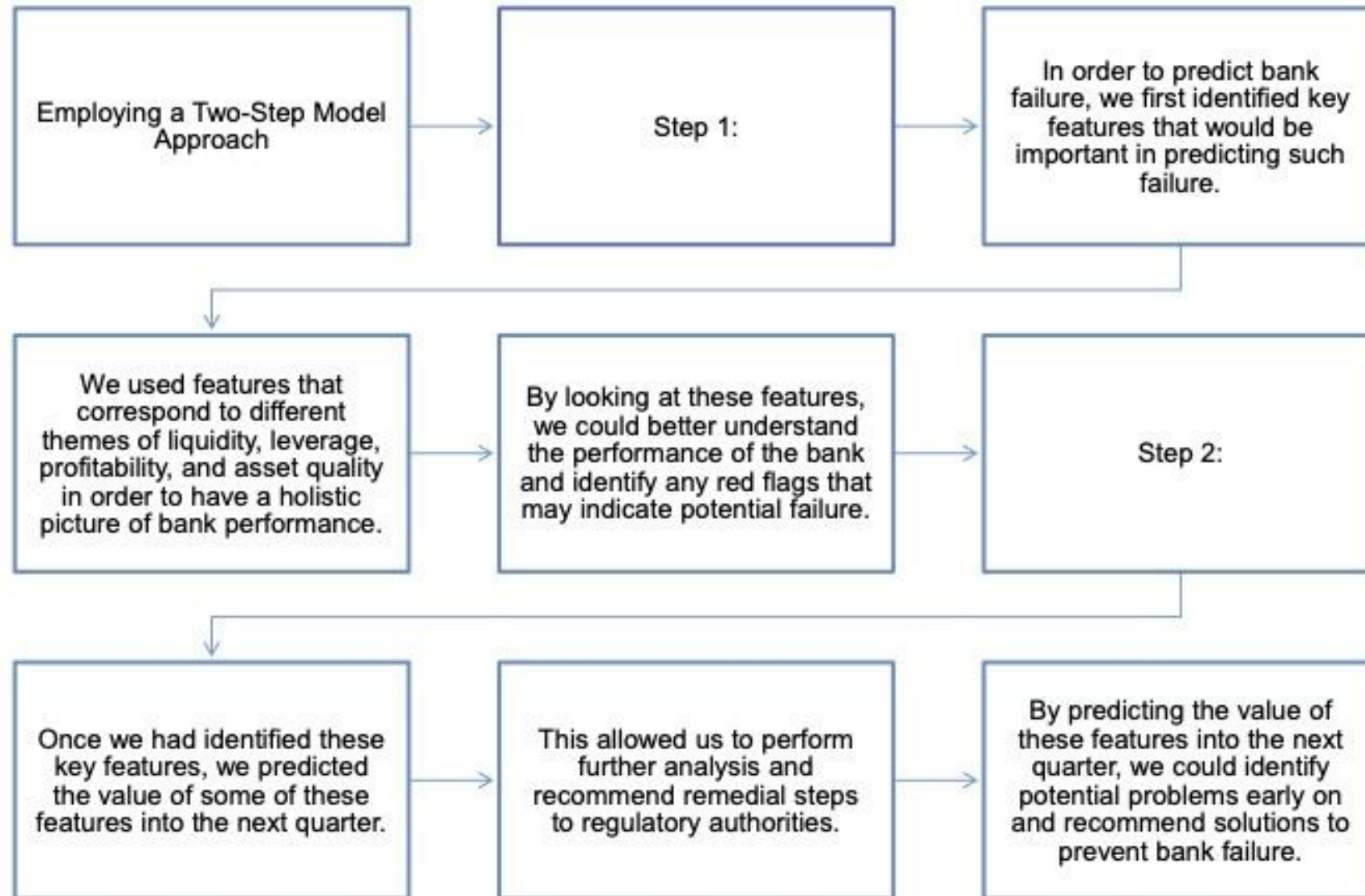
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Justin Yiqiang Jin, Kiridaran Kanagaretnam, and Gerald J. Lobo 2011

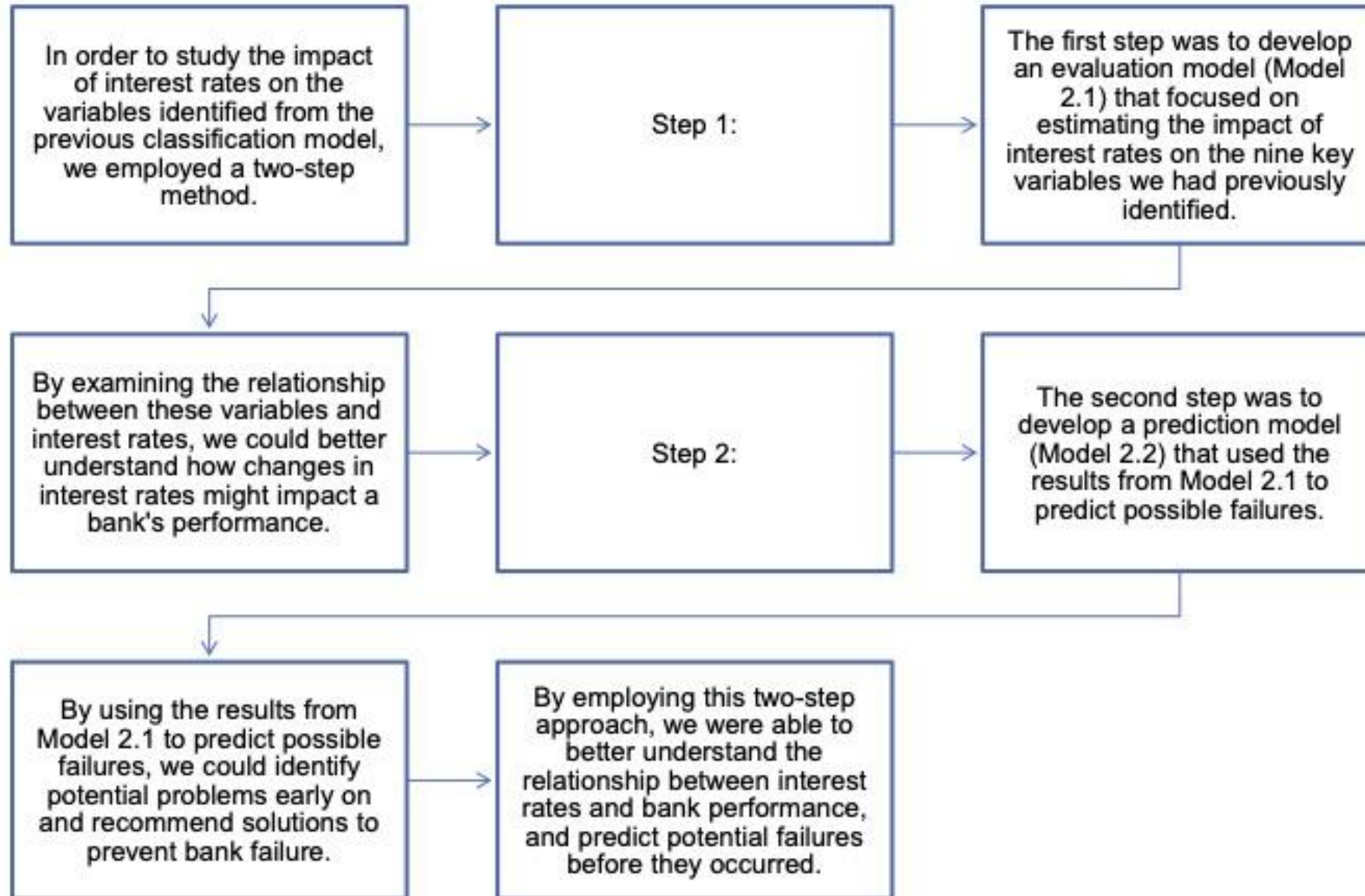
This study identified that bank failure through **auditor type, auditor industry specialization, Tier 1 capital ratio, the proportion of securitized loans, growth in loans, and loan mix.**



# 1.3.1 - Study Design



## 1.3.2 - Study Design







## 2. Data Collection

- Data Sources
- Data Collection and Cleaning

## 2.1 - Data Sources



### FDIC Bank Financials

- Approximately 0.7 million rows
- Basic quarterly financial information filed by the banks for the period 2003 - 2022



### FDIC Bank Failures

- Date and Identifiers of community banks failed historically
- Nearly 500 rows for period 1990 - 2022



### Federal Funds Rate

- Historical data of federal funds rate between 1950 to 2022
- Averaged for each quarter



## 2.2 - Data Collection/Cleaning



Step 1: Obtained data .csv files from the sources. Scraped FDIC Bank Financials for Community Banks using Python and HTTP get requests.



Step 2: Cleaned and summarized each of the datasets before combining using Python and Jupyter Notebooks



Step 3: Combined all the datasets using Python and visualized them

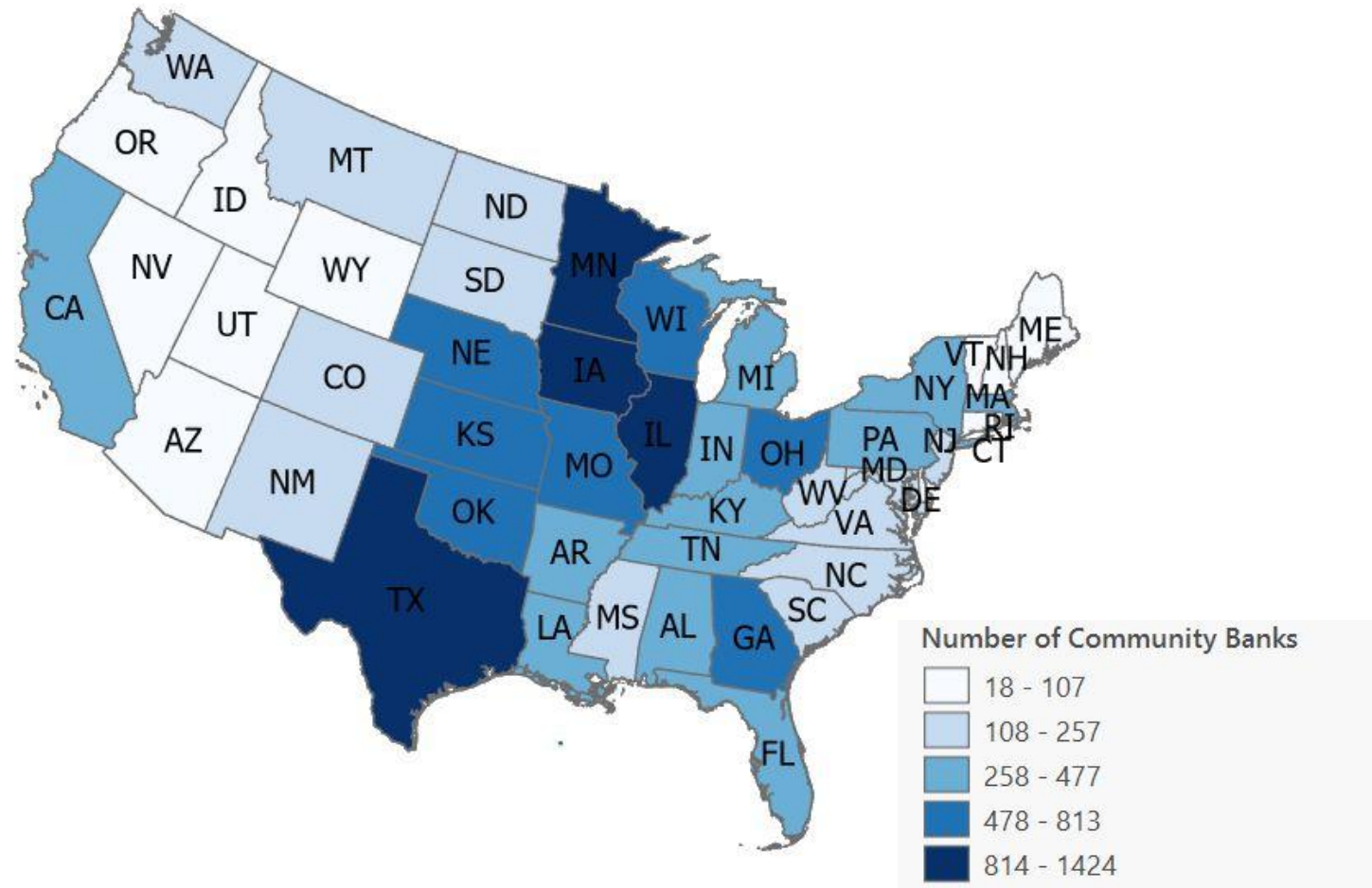




## 3. Exploratory Data Analysis

# 3.1 - Community Banks are heavily concentrated in 4 states

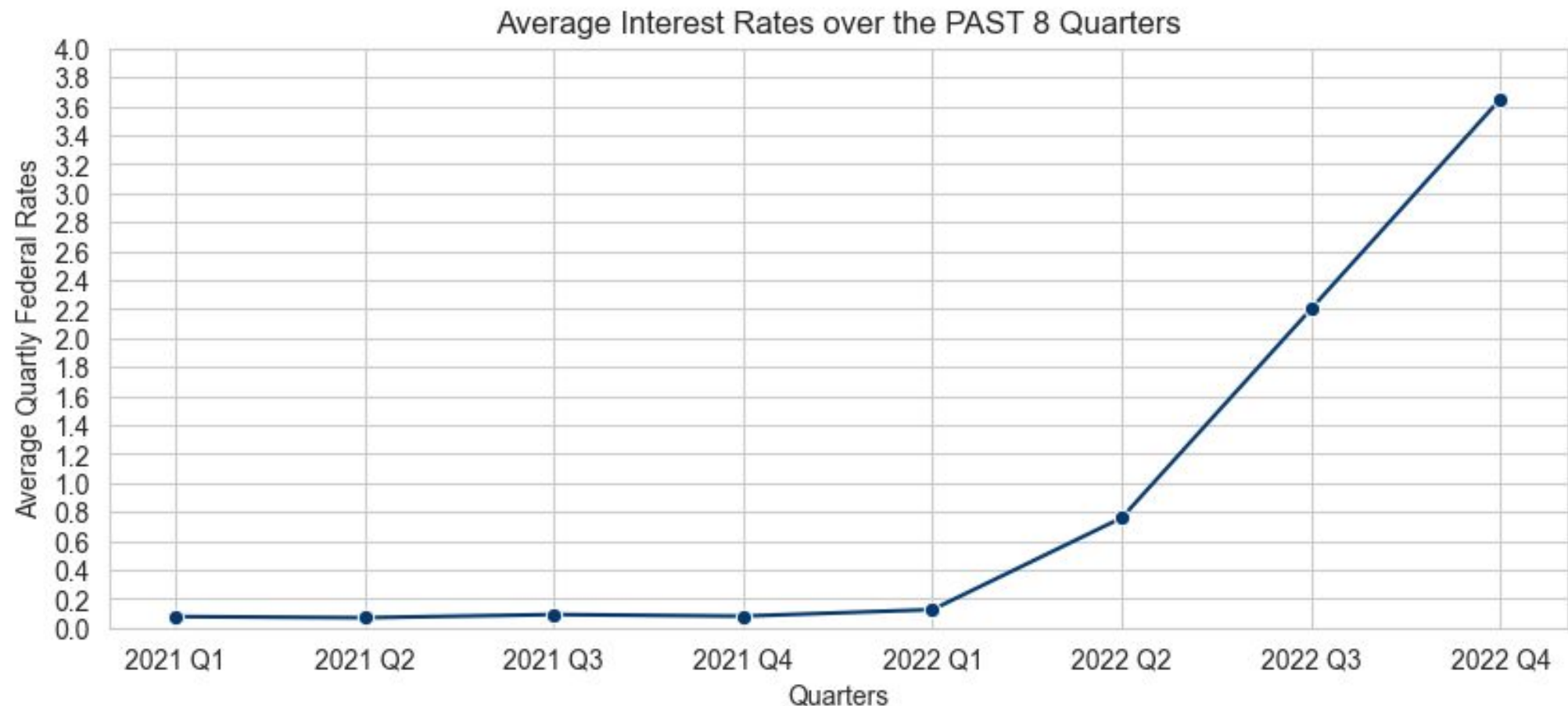
- There are **4,750 community banks** in the country with more than 29,000 branches
- Community banks are heavily concentrated in **Texas, Illinois, Minnesota and Iowa**
- States along the **East Coast** tend to have a higher number of community banks in contrast to the West coast





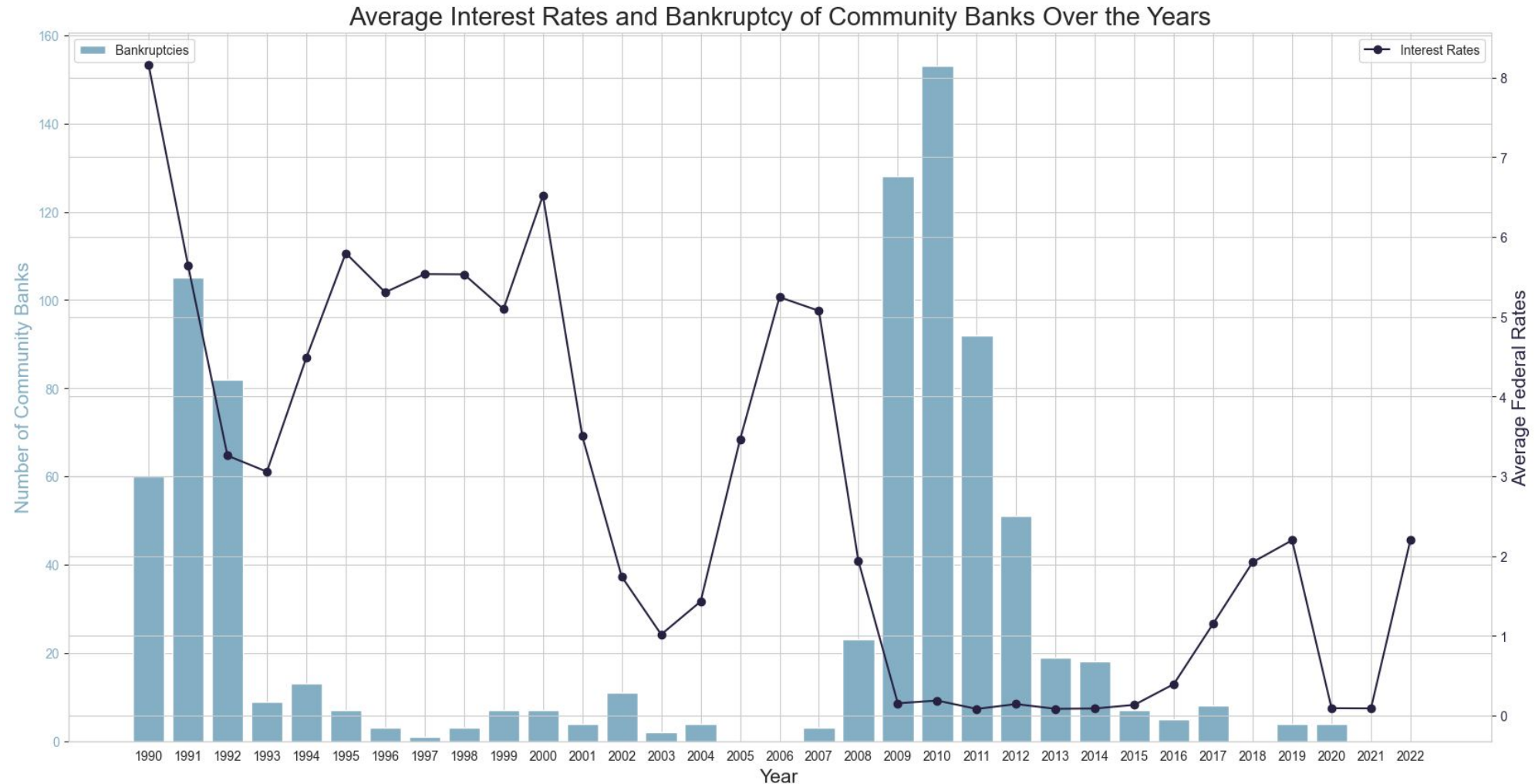
## 3.2 - Average Interest Rates have seen a steep rise from 2022 Q2


Interest Rates, stable until 2022 Q1, tends to be increasing steeply since 2022 Q2





# 3.3 - Trend between Rising Interest Rates and Community Bank Failures





## 4. Model design, construction and validation

# 4.1 - Overall Methodology

1. Given the CSBS role, Which is important to look at?
2. What is the impact of IR?
3. Can we predict what is important?



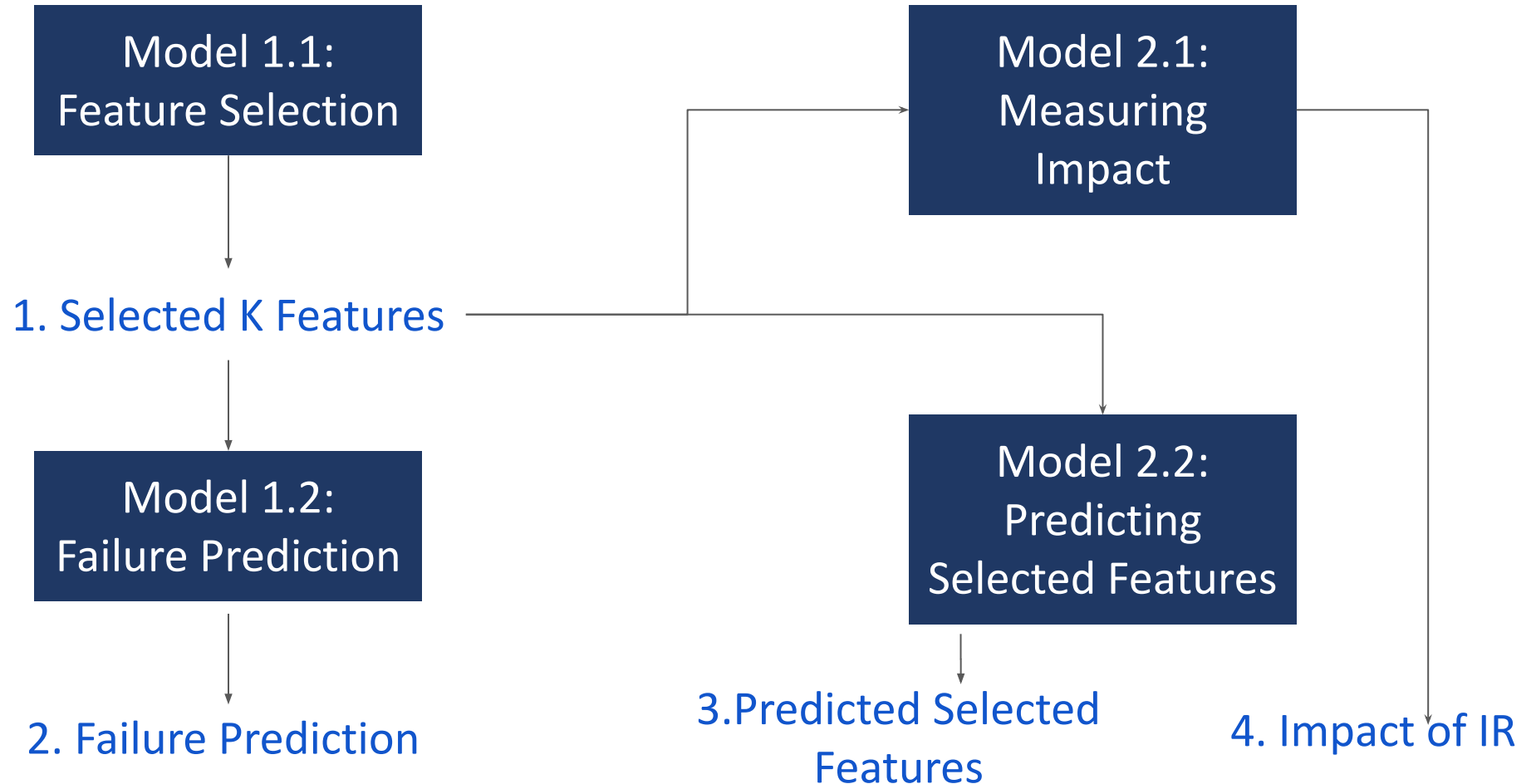
## Question

Given the CSBS role, Which is important to look at?

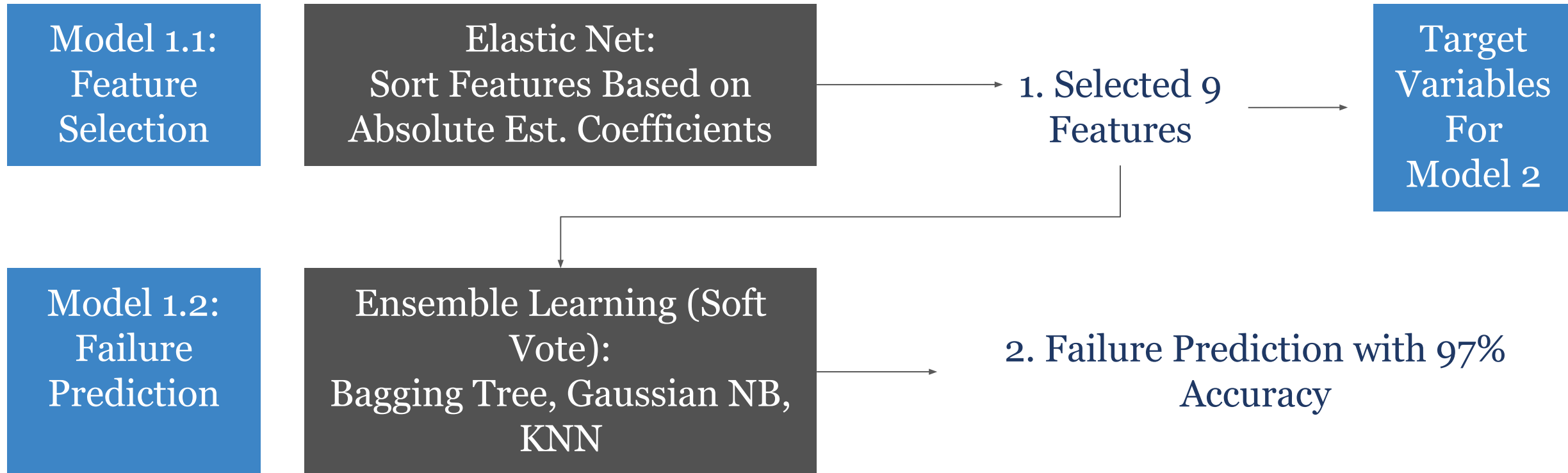
What is the impact of IR?  
Can we predict what is important?

## Model

## Result



# Model 1 Which is important to look at?



# Input Data for Model 1.1

Bank with Failure Record					
	2003/01 -----2022/12				
Bank A	6 Quarters		Failure		
Bank B				6 Quarters	Failure
Bank C	6 Quarters		Failure		
Bank D		6 Quarters	Failure		
Bank E			6 Quarters	Failure	
Bank F		6 Quarters	Failure		
Bank without Failure Record					
	2003/01 -----2022/12				
Bank A	Random Selected Continuous 6Q				
Bank B				Random Selected Continuous 6Q	
Bank C		Random Selected Continuous 6Q			
Bank D			Random Selected Continuous 6Q		
Bank E		Random Selected Continuous 6Q			
Bank F				Random Selected Continuous 6Q	

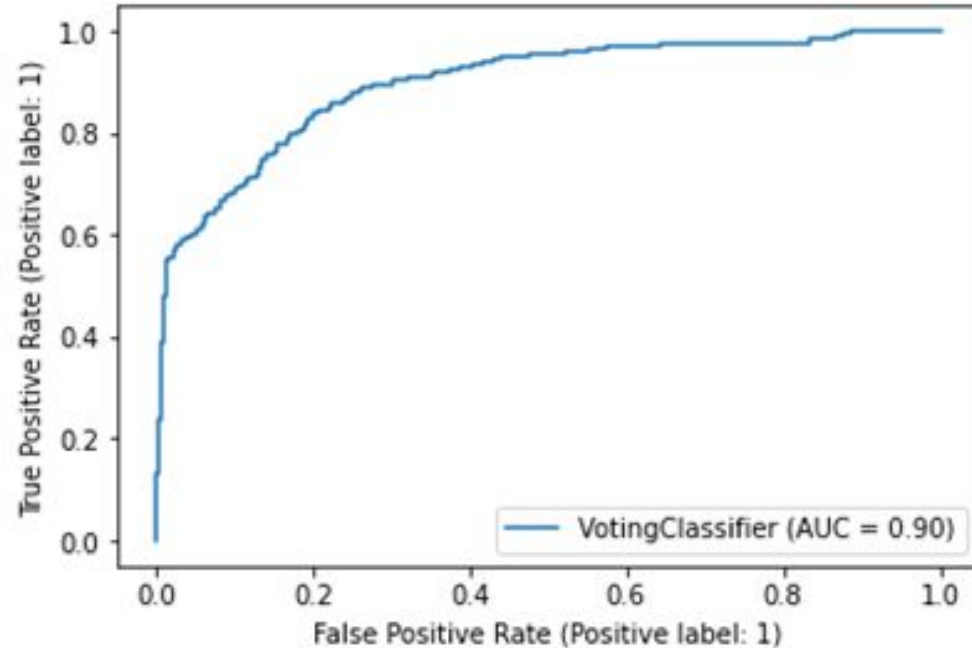


## 4.2 - Model 1.1: Outcome

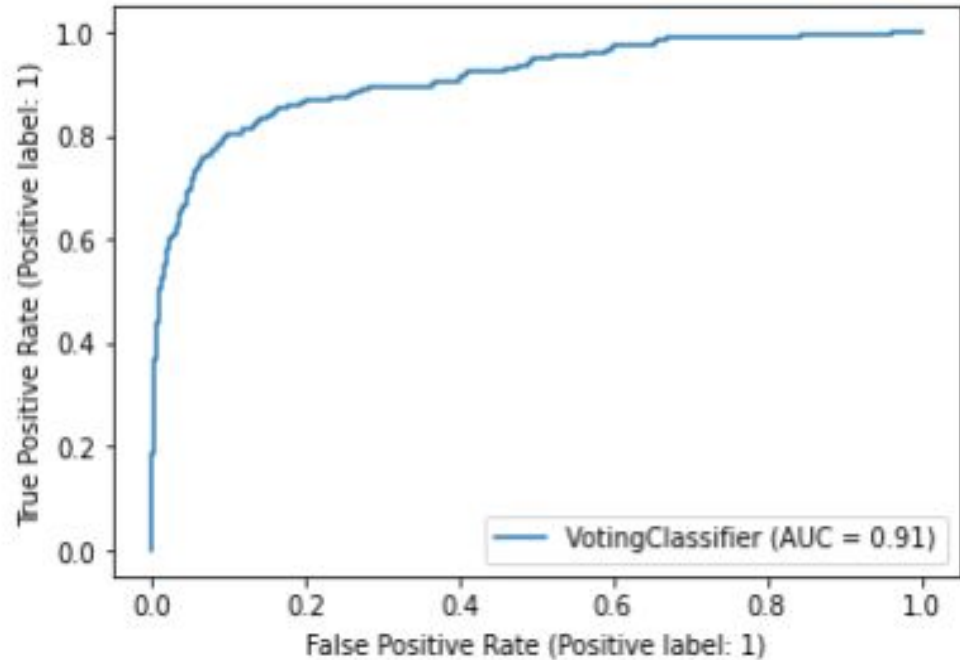
Features that can best predict bank failures in 6 quarters with 97% accuracy.

Feature Type	Feature Selected	Feature Name
Profitability	ROA	Return on Asset
Security	SCMTGBKR	Mortgage-backed securities, ratio
Asset	ASSTLTR	Long-Term Assets (5+ years) - QBP Ratio
Loan & Credit Risk Managent .	LNATRES	Allowance for Loans Loss Adjusted
	RB2LNRESR	Allowance for Loans and Leases in Tier 2 Ratio
	ILNDOMQR	Domestic Office Loans, Domestic, Quarterly Ratio
	LNLSNETR	Loans and Leases-Net Ratio
Leverage or Debt Levels.	RBC1AAJ	Leverage Ratio-Primary Component Analysis
	total_loans_equity	Total Loans / Equity

# Model 1.2: Diagnostics - ROC curve



ROC when quarter=6



ROC when quarter=12

## 4.2 - Model 2

- Identify Bank health metrics which are significantly affected by interest rate
- How well can we predict the selected metrics from model 1 based on various financial metrics.



# Model 2 - What is the impact of IR? Can we predict what is important?

Model 2.1:  
Measuring  
Impact

GLM with Time Fixed Effect and Clustered SE for Time:

$$Y_{it+1} = \alpha + \beta_1 * IR_t + \beta_2 * \Delta IR_t + \beta_3 * Bank_{it} + \beta_4 * Year + \epsilon_{it}$$

Selected 9 Features

Model 2.2:  
Predicting  
Selected Features

GLM with Time and State Fixed Effects:

$$Y_{it+1} = \alpha + \beta_1 * IR_t + \beta_2 * \Delta IR_t + \beta_3 * Bank_{it} + \beta_4 * Year + \beta_5 * St + \epsilon_{it}$$

# Model 2.1 Five features significantly impacted by IR

GLM with Time Fixed Effect and Clustered SE for Time:

$$Y_{it+1} = \alpha + \beta_1 * IR_t + \beta_2 * \Delta IR_t + \beta_3 * Bank_{it} + \beta_4 * Year + \epsilon_{it}$$

Y	Independent	Coefficient	SE	Z	P> Z
RBC1AAJ	AVG_IR	0.1257	0.05	2.507	0.012
ILNDOMQR	AVG_IR	0.1507	0.02	7.432	0
LNLSNETR	AVG_IR	-1.5926	0.27	-5.906	0
ASSTLTR	DELTA_IR	0.5573	0.173	3.215	0.001
ROA	AVG_IR	-0.0578	0.015	-3.941	0

# Model 2.2 Three features can be predicted

GLM with Time and State Fixed Effects:

$$Y_{it+1} = \alpha + \beta_1 * IR_t + \beta_2 * \Delta IR_t + \beta_3 * Bank_{it} + \beta_4 * Year + \beta_5 * St + \epsilon_{it}$$

Dependent Variable	R-square on Training Dataset	MSE on Testing Dataset	R-squared on Testing Dataset
LNATRES (Allowance for Loans Loss Adjusted)	86%	15271431.56	0.833
RB2LNRESR (Allowance for Loans and Leases in Tier 2 Ratio)	53.09%	0.04	0.439
LNLSNETR (Loans and Leases Net Ratio)	94.66%	217.86	0.329



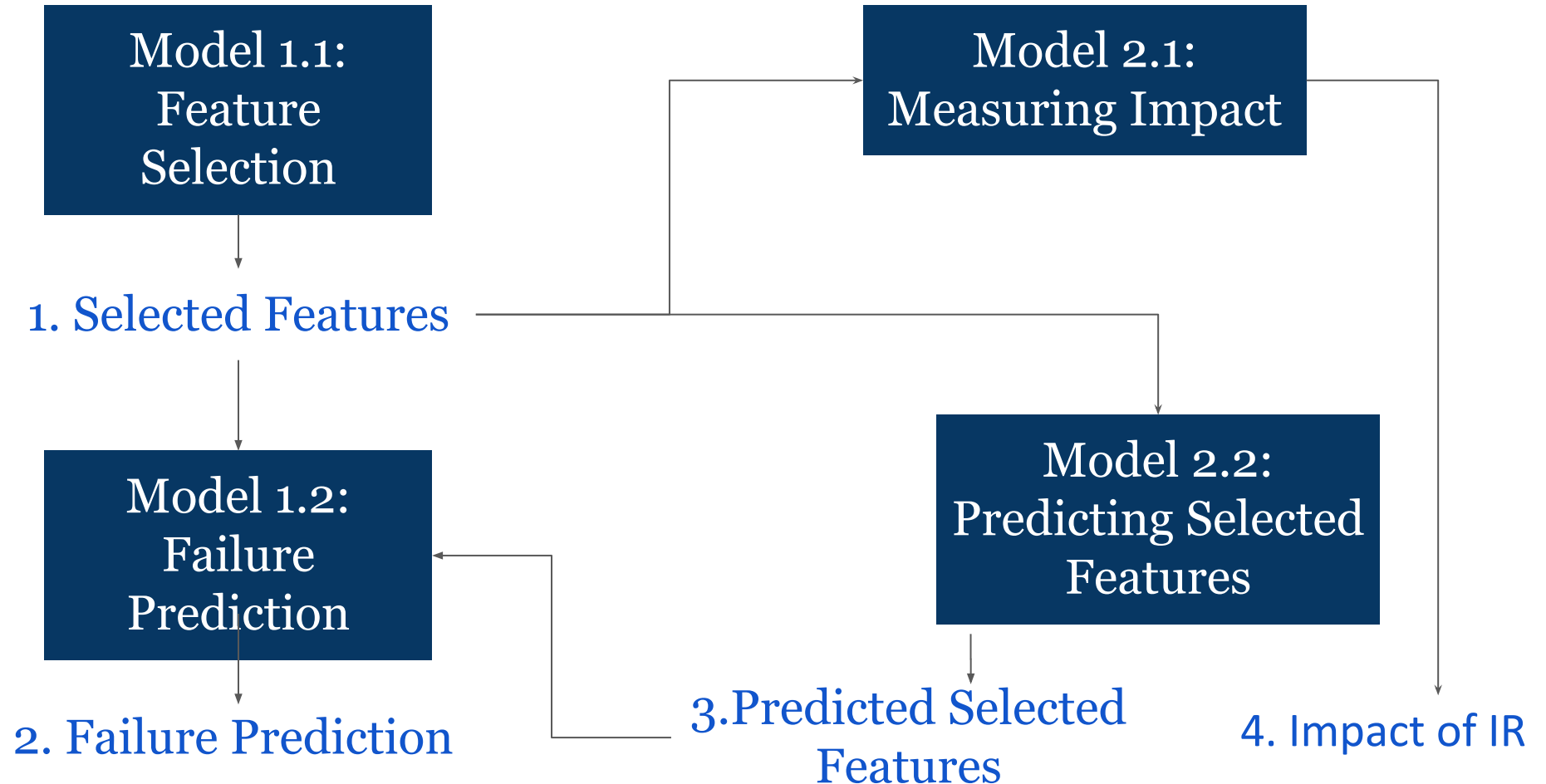
Question

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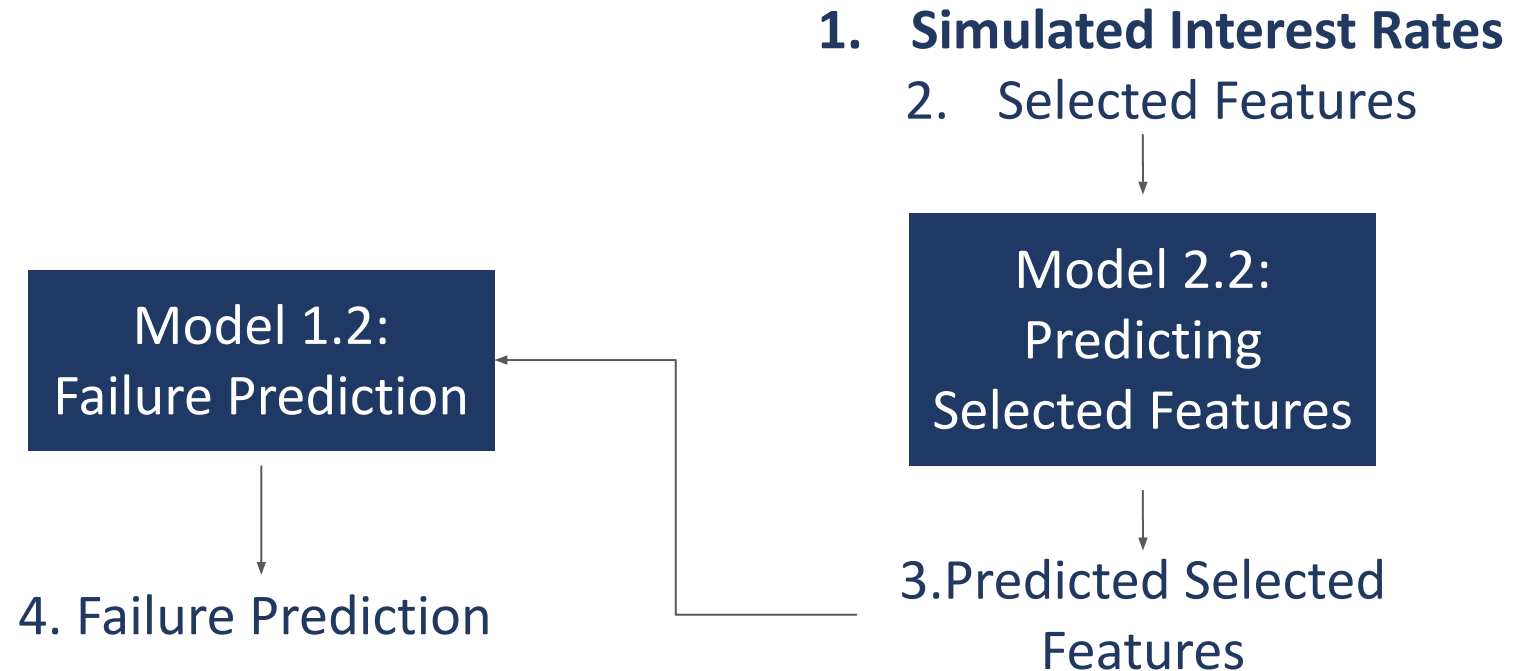
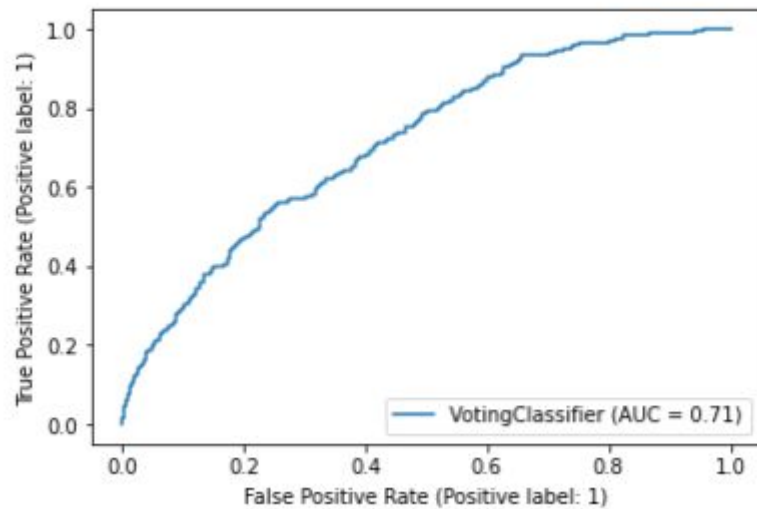
What is the impact of IR?  
Can we predict what is important?

Model

Result



# 1. Predicting Failures Based on Predicted Features and 2. Simulating the IR Impact on Failure





## 5. Conclusion & Discussion



# 5.1 Limitation for current work

## Data Collection

- **In-depth information about individual banks** can provide valuable insights.
  - cash flow analysis
  - managerial data
  - business model
  - external market factors

## Computational Ability

- Leveraging **cloud computing** can facilitate modeling of high-dimensional data for advanced exploratory analysis.

## 5.2 Scope for Future work

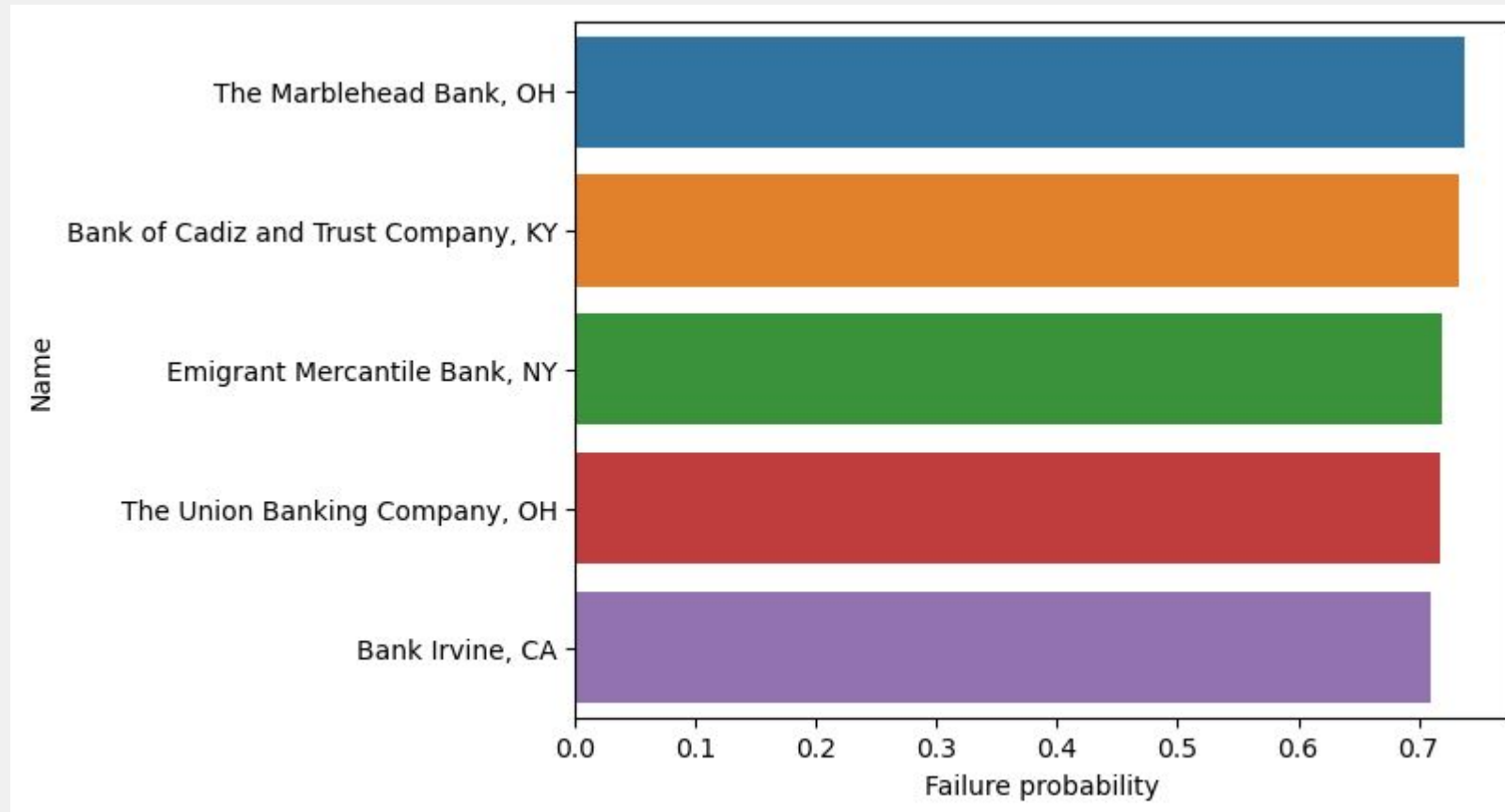
- Explore other method to study interest rate impact
  - Difference in Differences
  - Regression Discontinuity
- Improvements for the existing models
  - Expansion of the period of training data for the model
  - Adding features for the dataset
- Other implementation for the current model
  - Identifying the period during which the bank's financial stability is at its weakest.

## 5.3 Conclusion

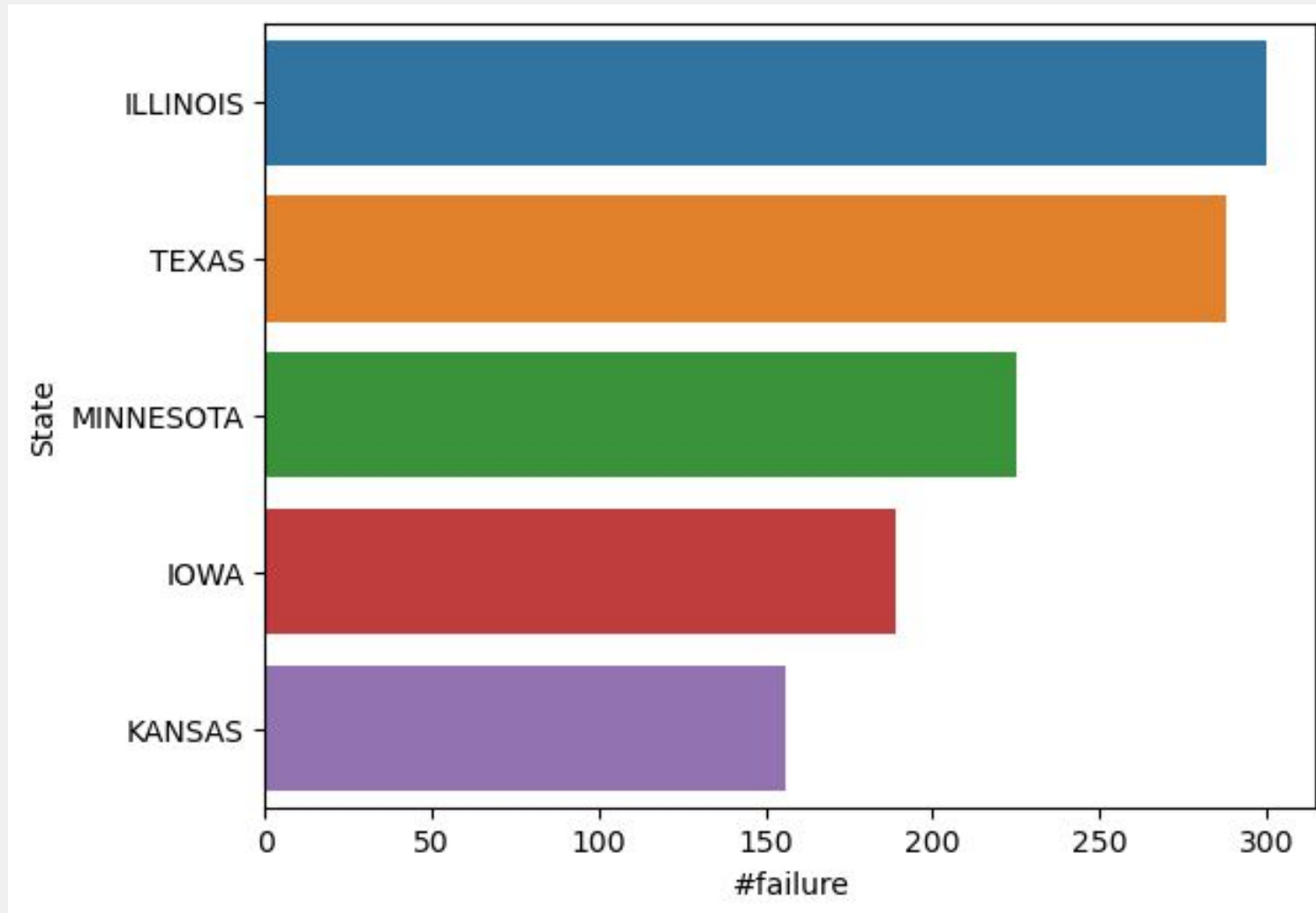
- We are able to identify the key variables to predict bank failure
- 3 bank features that are significantly affected by the interest rate.
- We summarized the states with most number of failed banks post our final classification step and the banks with most likely risk of failures.
- We can look at the change of the key variables impacted by interest for the banks with the highest predicted probability of failure.
- We will chart the design of a survival model that will help identify failure window horizon as a future step



# Top 5 risky banks identified



# States with highest risk of bank failure



# Thank you

## Any questions?



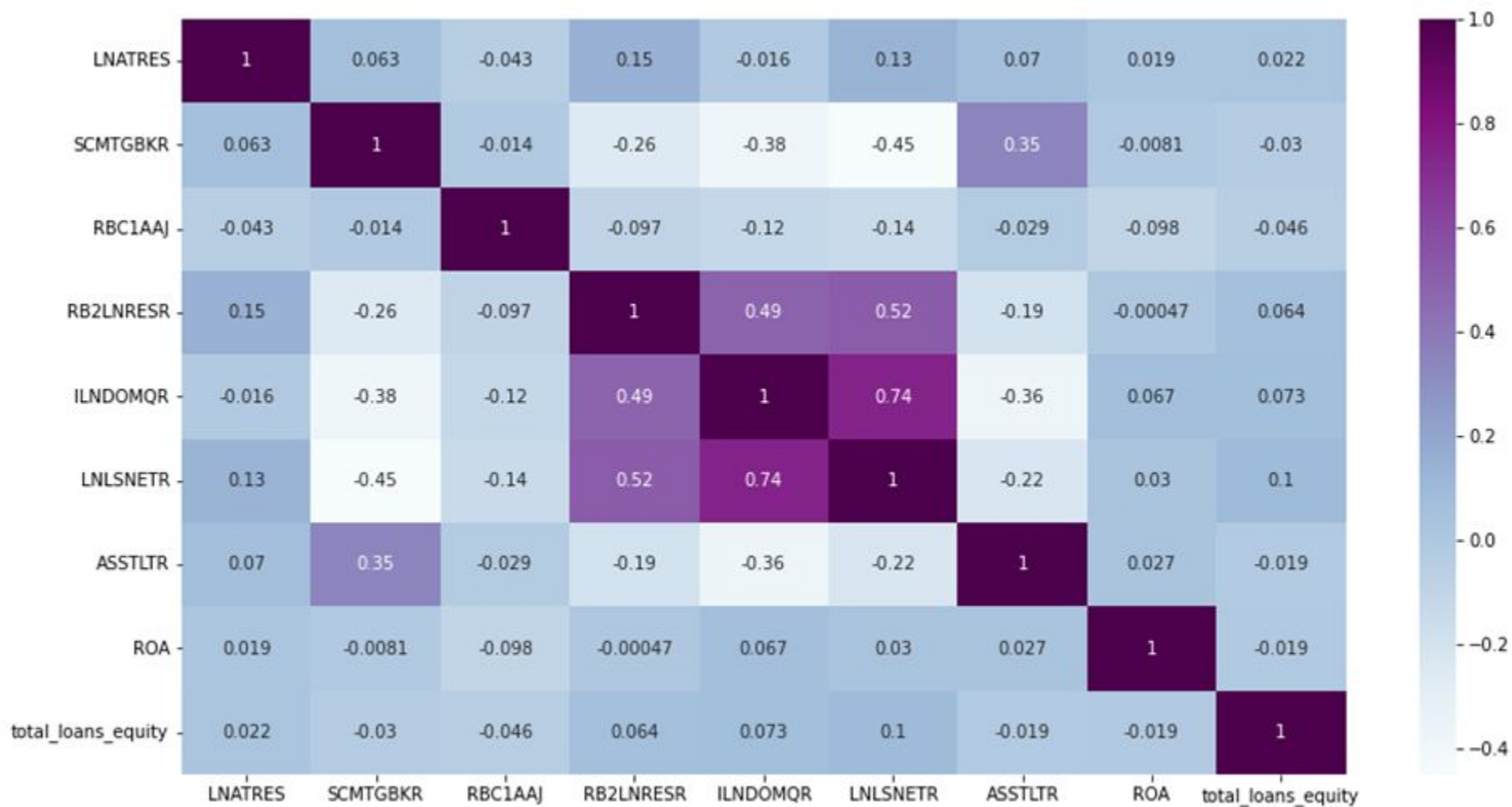
# References

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- Cole, Rebel A., and Lawrence J. White. “Déjà vu All over Again: The Causes of U.S. Commercial Bank Failures This Time Around.” *Journal of Financial Services Research*, vol. 42, no. 1-2, 14 Sept. 2011, pp. 5–29, <https://doi.org/10.1007/s10693-011-0116-9>.
- Glaze, Andrew. “Council Post: How Rising Interest Rates Can Hurt—or Help—Businesses.” *Forbes*, 31 Jan. 2023, [www.forbes.com/sites/forbesfinancecouncil/2023/01/31/how-rising-interest-rates-can-hurt-or-help-businesses/?sh=14fb90a424fo](https://www.forbes.com/sites/forbesfinancecouncil/2023/01/31/how-rising-interest-rates-can-hurt-or-help-businesses/?sh=14fb90a424fo). Accessed 22 Apr. 2023.



# Appendix

# Model 1 Feature Correlation (Quarter = 6)

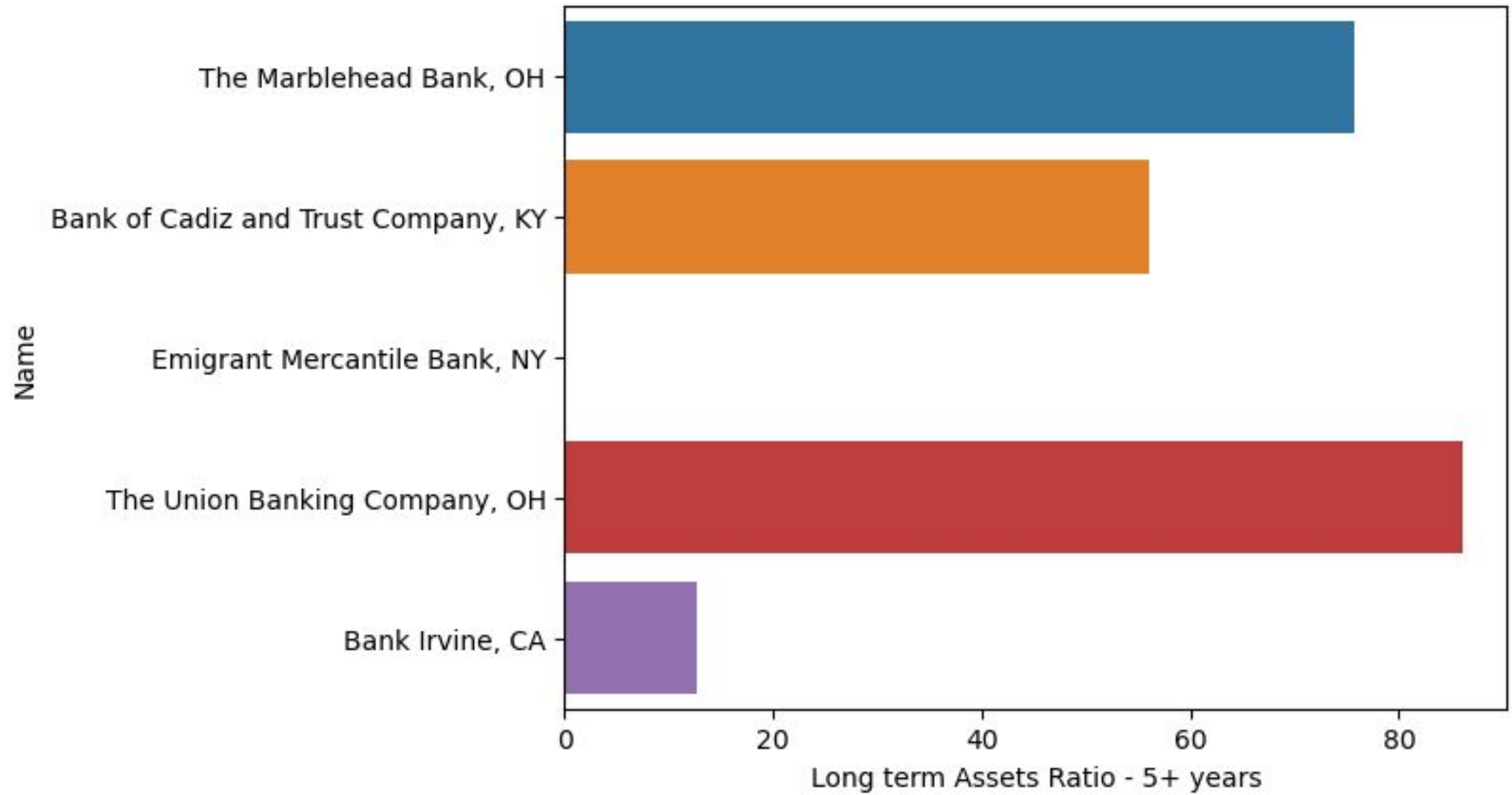




## 8.2 Model 1 Feature Correlation (Quarters = 12)



# Long term assets ratio - Top 5 risky banks



# Return on Assets - Top 5 risky banks

