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DOES MARKET INTEREST RATE IMPACT BANK PROFITABILITY AND RISK?

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Abstract. Over the past four decades, interest rates in the United States fluctuated considerably. The benchmark Federal funds rate, for instance, fell from 11.4% in summer 1984 to 3% in early 1993, increased to 6.5% in 2000, fell back to 1% in 2004, increased again to 5.25% in 2007, and bounced back and forth between 0.00% and 5.25% multiple times. Such interest rate fluctuations impact bank profitability and risk. The Dodd-Frank Act of 2010 also introduced activity restrictions and new capital and liquidity requirements for US banking firms. Using a panel dataset, we examine how US banking firms have maneuvered interest rate fluctuations since 1980. We further study bank profitability and risk behavior in the periods before and after the Dodd-Frank Act. Our findings suggest that in general, bank profitability improves with higher Fed funds rate while bank risk parameters suffer. Results are amplified for large banks.

1. Introduction

Interest rates fluctuated considerably in the United States over the past four decades since early 1980s. These fluctuations were either due to business cycles or the Federal Reserve System's intervention in financial markets, or both. During this period, two major regulatory acts significantly impacted the banking and financial industries: Gramm-Leach-Bliley Financial Modernization Act of 1999 (GLB Act) and the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (Dodd-Frank Act). The purpose and scope of the acts were different from each other. While the first act aimed at reducing restrictions on banking firm activities and was deregulatory in nature, the second one sought greater regulation and reforms in the U.S. banking and financial industries. The acts introduced opportunities as well as challenges in profitability, risk taking behavior and capital requirements for banks.

The GLB Act removed the restrictions on commercial banking activities imposed by the Glass-Steagall Act (GSA) of 1933 and allowed commercial banks to engage in more profit maximizing activities such as investment and brokerage services. The GLB Act is also believed to have led to increased risk in the banking industry (Akhigbe and Whyte 2004; Mamun et al. 2005; Filson and Olfati 2014; and Correa and Goldberg 2022). The Dodd-Frank Act, on the other hand, imposed greater capital and liquidity requirements, and increased oversight for financial stability of banks. The passage of the Dodd-Frank Act resulted in reduced discretionary risk and increased bank capital (Akhigbe et al. 2016).

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Fluctuations in interest rates in the past three decades along with the changes in economic conditions and regulatory environment present implications for bank profitability, risk and capital ratios. Like other for-profit entities, banks must balance profitability for shareholders while managing risk, liquidity, and capital adequacy. The traditional banking model involves accepting deposits and providing loans, with deposits being subject to withdrawal at the discretion of depositors, while loans are generally non-callable by banks. Banks' primary source of income often stems from the spread between interest rates on loans and deposits, known as the net interest margin (NIM). When interest rates fluctuate, they impact this spread and consequently affect banks' earnings. In a high-interest rate environment, banks can increase their income by lending at higher rates, while low-interest rates, though they may stimulate economic activity and loan demand, often compress margins and limit profitability. The nature of the banks necessitates effective liquidity management, and interest rate changes pose further challenges in managing liquidity and profitability. Bank interest rate margins have perhaps the greatest impact on bank profitability and losses. Fluctuations in the levels of interest rates therefore have significant implications for bank interest rate margins.

Literature on banking research suggests that short-term and long-term interest rates directly impact profitability by affecting the spread between what banks pay for deposits and what they earn on loans (net interest margin, or NIM). When interest rates are low, this spread narrows, compressing profitability (Genay and Podjasek 2014; Borio et al. 2017; Hack and Nichols 2021). NIM measures the difference between interest income and interest paid on deposits. It is a key profitability indicator, especially affected by interest rate changes, and is central to bank earnings (Genay and Podjasek 2014; Hack and Nichols 2021).

Extensive literature on bank profitability suggests that bank profitability is positively correlated with risk-taking behavior and negatively correlated with regulatory restrictions (Demirgüç-Kunt and Huizinga 1999; Athanasanoglou et al. 2008; Albertazzi and Gambacorta 2009; Demirgüç- Chronopoulos et al. 2015; Entrop et. al. 2015; Laeven et al. 2016; Anginer et al. 2018; Varotto and Zhao 2018; Martynova et al. 2020).

While the above literature sheds light on many aspects of bank profitability and risk, it is unclear whether bank profitability responds to interest rate fluctuations since 1993 in the United States. This implication is also unclear for large versus small banks, and before and after the Dodd-Frank Act of 2010. We aim to fill this gap in the banking research literature.

The primary purpose of this paper is to investigate how US banks have adapted to major interest rate fluctuations since 1993.Following a profit maximizing banking model subject to capital and liquidity requirements, we hypothesize that under a relatively relaxed regulatory environment (i.e. before the Dodd-Frank Act of 2010), bank profitability does not suffer as banks have more freedom to maneuver adverse interest rate fluctuations. Whereas, under stricter regulation (i.e. under the Dodd-Frank Act), bank profitability with interest rate fluctuations as bank activities are relatively more restricted; bank profitability suffers with adverse interest rate fluctuations. When banks are subject to restrictions on their activities, they may not be able to take advantage of profitable situations. Understanding the dynamics of bank profitability in relation to interest rates is crucial, especially in an era of evolving monetary policies and unpredictable economic conditions, such as those seen during the recent COVID-19 pandemic, which brought rates to historic lows and prompted new policy responses.

This distinct contribution of this paper is the study of bank profitability and liquidity in response to interest rate fluctuations under different bank regulatory environments. It also sheds light on how the Dodd-Frank Act of 2010 impacted profitability and risk-taking behavior of banks in response to interest rate fluctuations. The rest of this paper is organized as follows. In section 2, we review previous studies. In section 3, we discuss data and methodology. In section 4, we discuss the results, and in section 5, we provide a summary and conclusion.

2. Literature Review

Bank interest rate margins[1] have perhaps the greatest impact on bank profitability and losses. Fluctuations in the levels of interest rates therefore have significant implications for bank interest rate margins. Ho and Saunders (1981) were among the first to model and analyze bank interest rate margins and their determinants. They extend the hedging hypothesis[2] and utility maximization hypothesis[3] of banking firms to analyze determinants of bank interest margins. They identified four main determinants of bank interest margins: management risk aversion, market structure, bank size, and interest rate variance. Hanson and Rocha (1986. 79-82) study the determinants of interest rate margins using data for 29 countries over the period 1975-1983 and determine bank profitability and losses to be highly dependent on inflation, scale of economies and market structures.

Demirgüç-Kunt and Huizinga (1999) study the determinants of bank interest rate margins across 80 countries and find that interest rate margins vary across countries and reflect a variety of determinants such as macroeconomic conditions, deposit insurance regulation and taxation. Saunders and Schumacher (2000) study a panel of banks from 7 OECD countries between 1988 and 1995 and find that bank interest rate margins vary widely across countries and more importantly, the size of the margins changes over time. Entrop et al (2015) study the impact of maturity transformation on interest rate margins of German banks between 2000 and 2009 and find that bank interest rate margin is mainly priced based on the asset side of bank balance sheet.

Macroeconomic conditions, such as GDP growth rate and unemployment rate, also play a crucial role in bank profitability. Economic growth positively impacts bank profitability by increasing loan demand and enhancing borrowers' ability to repay loans, thereby reducing defaults. Conversely, higher unemployment raises credit risk and loan defaults, directly affecting bank profits through provisions for bad loans (Genay and Podjasek 2014; Borio et al. 2017).

More recent studies have expanded on the impact of interest rate fluctuations and the regulatory environment on bank profitability. Short-term and long-term interest rates directly impact profitability by affecting the spread between what banks pay for deposits and what they earn on loans (net interest margin, or NIM). When interest rates are low, this spread narrows, compressing profitability (Genay and Podjasek 2014; Borio et al. 2017; Hack and Nichols 2021). NIM measures the difference between interest income and interest paid on deposits. Genay and Podjasek (2014) and Hack and Nichols (2021) demonstrate that NIM is a key profitability indicator, especially affected by interest rate changes, and is central to bank earnings. Windsor et al. (2023) support this view finding a modest decline in NIM with falling rates, partially offset by efficiency gains and lower provisioning. Eggertsson et al. (2024) show that NIM can have substantial effect on bank lending activities. Their study implies that when NIM hits a lower bound, lending activities decline, and bank equity values fall.

While economics theory suggests that interest rates cannot be negative, a few countries implemented such a policy in the past decade. Denmark, Sweden, Switzerland, the Eurozone countries, and Japan introduced negative interest rates policies (NIRP) in various years between 2011 and 2022. López-Penabad et al. (2022) investigate the impact of negative interest rates on 2596 banks from 29 European countries between 2011 and 2019. Their study reveals that negative interest rates reduce margins and ROA, but without prompting greater risk-taking among deposit-dependent banks. Balloch et al. (2022) contribute to the discussion by demonstrating that although negative nominal interest rates may stimulate economic activity, they also compress bank profit margins—given that banks are typically unable to charge negative

[1]Interest rate margin is defined as the difference of interest rates banks charge on loans and interest rates banks pay to finance the loans.

[2]The hedging hypothesis of banking model views banks as firms trying to match the maturity of assets and liabilities to hedge against refinancing risks.

[3]The expected utility maximizing hypothesis is based on microeconomic structure of firms that views bank as firms trying to maximize expected wealth or utility of wealth.

rates on deposits. Beauregard and Spiegel (2020) argue that over prolonged NIRP periods, especially in Europe and Japan, profitability erodes structurally when banks cannot pass on negative rates to depositors.

Other researchers such as Boungou (2020) and Bongiovanni et al. (2021) counter concerns about NIRP-induced fragility, showing reduced risk-taking under NIRP for well-capitalized banks which supports the conditional nature of monetary transmission to bank risk in general. Campmas (2020) notes that stronger capital buffers help banks navigate low-rate profitability challenges. Bottero et al. (2022) complements the discussion by arguing that under NIRP, banks rebalance from safe assets to more credit exposure, increasing loan supply and firm investment despite lower margins. While interest rate margins play a central role in bank profitability, credit risk, particularly non-performing loans (NPLs), is another significant factor. Increasing NPLs raises the need for provisions, directly lowering profitability. Hack and Nichols (2021) document that in periods of economic downturn or in low-interest environments, NPLs often rise. Bank-specific characteristics, such as bank size and funding structure, also influence profitability. Larger banks tend to have more diversified income streams and more advanced risk management techniques, making them less vulnerable to interest rate changes. In contrast, smaller banks are more sensitive to these changes (Genay and Podjasek 2014). Banks with a greater reliance on deposit-based funding are more affected by interest rate changes since they have less flexibility to adjust deposit rates (Hack and Nichols 2021). Operational efficiency, as measured by the cost-to-income ratio, also plays a role; a lower cost-to-income ratio, indicating greater efficiency, enhances profitability by allowing banks to better absorb the impact of interest rate fluctuations. Heider et al. (2021) emphasize that deposit-heavy banks face greater NIM compression, often adjusting lending volumes and asset composition accordingly. Brandão-Marques et al. (2024) synthesize global findings and highlight institutional and macroeconomic conditions as mediating factors.

Other related studies on interest rate margins, bank capital, profitability, and losses have been conducted by Athanasoglou et al. 2008; Albertazzi and Gambacorta 2009; Bolt et al. 2012; Gambacorta and Mistrulli 2014; Chronopoulos et al. 2015; DeAngelo and Stulz 2015; Saghi-Zedek and Tarazi 2015; Anginer et al. 2018; Saif-Alyousfi 2022; Al-Matari 2023. The consensus is that bank profitability, in the macro sense, not only depends on interest rates, but also on the regulatory environment, tax codes, and economic conditions such as GDP growth and financial crises. In this paper, we take into account the regulatory environment and economic conditions but ignore tax codes, as our sample is based on U.S. banking firms, and therefore all banks are presumed to be subject to the same tax code. While the above studies greatly contribute to the banking research literature and address important questions, how bank profitability and risk have responded to interest rate fluctuations in the U.S. have not been adequately investigated, especially for the period that encompasses the Dodd-Frank Act. We intend to fill this gap in the banking research literature.

3. Data and Methodology

3.1. **Data.** Data on bank capital and financial ratios comes from the Reports of Condition and Income (Call reports) and is available from the Federal Financial Institutions Examination Council (FFIEC) and Federal Deposit Insurance Corporation (FDIC). Data on interest rates comes from the Federal Reserve System. The period of our study is from the first quarter of 1980 to the last quarter of 2023. Our dataset consists of unbalanced panel data of 95335 quarterly observations with 2083 publicly listed banks.

We use the return on equity as the primary profitability measure. While other profitability measures such as operating profits or returns on assets can be utilized, they can be misleading for a banking firm as deposits make a large portion of its total assets. On the other hand, return on equity captures operating profits. Therefore, we use return on equity as the primary profitability measure and include operating income as an independent variable instead of a

dependent variable. For risk level measures, we use Tier-1 capital ratio and bank z-score. Tier-1 capital ratio is based on Basel Accords[4] and reflects banks' ability to absorb losses. It is the primary measure of risk and liquidity. For robustness, we also consider bank z-score as an alternative measure of bank risk. Following Bertay et al. (2013), we use bank Z-score instead of the Altman Z-score. Bank Z-score is defined as (ROA+(equity/assets))/sd(ROA)[5].

For interest rates, we use the Federal funds rate as the benchmark rate. Other interest rates such as the Wall Street Journal Prime Rate, the 48-month consumer-loan rate and the standard 30-year mortgage rate are highly correlated to the Fed funds rate. For instance, the correlation between the Fed funds rate and the prime rate is 0.992 and the correlation between Fed funds rate and the 48-month consumer loan rate is 0.941. Due to these high correlations, we use the Fed funds rate as our primary interest rate benchmark. Table 1 presents summary statistics for the interest rates and their correlations.

TABLE 1. Summary statistics and correlation matrices of interest rate benchmarks for the period: 1980q1–2023q4

Panel A. Summary statistics for interest rate benchmarks

Benchmarks	**Observations**	**Mean (%)**	**Min (%)**	**Max (%)**	**Std. Dev.**
Federal funds	176	4.40	0.06	17.78	3.98
Prime	176	7.16	3.25	20.32	3.62
48-Month Consumer	176	8.50	4.00	17.36	3.31
30-Year Mortgage	176	7.51	2.76	17.74	3.47

Panel B. Correlation coefficient matrix for interest rate benchmarks

Benchmarks	**Federal funds**	**Prime**	**48-Month Consumer**	**30-Year Mortgage**
Federal funds	1			
Prime	0.9921	1		
48-Month Consumer	0.9411	0.9288	1	
30-Year Mortgage	0.9418	0.9267	0.9804	1

Further, we conduct our analysis in two sub-periods, the pre-Dodd-Frank period from 1980q1-2009q4 and the post-Dodd-Frank period from 2010q1 to 2023q4. Table 2 provides summary statistics for our sample.

3.2. **Hypotheses.** The primary purpose of this paper is to study the impact of interest rate levels on bank profitability and risk in the United States since 1980. The secondary purpose is whether Tier-1 capital requirements affect bank profitability. Corollary questions are whether the Dodd-Frank Act of 2010 introduced shifts in bank profitability and risk pertaining to interest rate fluctuations. To investigate these research questions, we set the following hypotheses:

Hypothesis I: Interest rate fluctuations have no impact on bank profitability.

Hypothesis II: Interest rate fluctuations have no impact on bank risk.

Corollary Hypothesis I: The Dodd-Frank Act of 2010 has no impact on bank profitability response to interest rate fluctuations.

Corollary Hypothesis II: The Dodd-Frank Act of 2010 has no impact on bank risk taking behavior in response to interest rate fluctuations.

[4]The Basel Accords refer to Basel I, Basel II and Basel III accords, which are set of recommendations prescribed by the Bank for International Settlements in an attempt to standardize bank regulations across countries.

[5]The Altman Z-score that is used as a measure of probability of bankruptcy for traditional firms is Z = (1.2 x working capital/total assets) + (1.4 x retained earnings/total assets) + (3.3 x EBIT/total assets) + (0.6 x market value of equity/total liabilities) + (1.0 x sales/total assets).

TABLE 2. Summary Statistics. The table summarizes the quarterly data for all banks in our sample from 1980q1 to 2023q4. The sample consists of banks that filed Consolidated Report of Condition and Income (Call report) with the FDIC and were listed in NYSE or NASDAQ. Panel A shows summary statistics, while Panel B presents the percentage change in the means from the pre-Dodd-Frank period (1980q1–2009q4) to the post-Dodd-Frank period (2010q1–2023q4).

Panel A: Summary Statistics for all banks from 1980q1 to 2023q4, inclusive.

Variable	Obs.	Mean	Median	Std. Dev.	Min	Max
Return on Equity (%)	79668	11.02	10.13	31.80	-2870.63	3706.23
Total Non-Interest Income ($m)	67097	154.59	2.2460	1013.63	-13258.25	31698.01
Current Operating Earnings ($m)	17444	195.90	19.6985	771.13	-22517.3	14288.94
Net Interest Income ($m)	69747	188.88	10.27	965.43	-634.76	21966.10
Debt Ratio	33515	0.8951	0.8999	0.0437	0.0775	1.2686
Tier 1 Ratio (%)	59728	11.86	11.40	4.30	-13.48	146.90
Bank Z-score	17391	0.0001	0.0001	0.0001	-0.0062	0.0004
Size (log of Total Assets)	80149	7.6106	7.3195	1.8821	1.2453	15.1904
Assets - Total	80151	34890.1	1509.4	210377.8	0.0120	3954687
Cash Ratio (Cash/Assets)	78196	0.0548	0.0381	0.0518	-0.0013	0.9462
Federal Funds Rate (%)	95339	3.9628	3.9800	3.1715	0.0600	17.7800
30 Year Mortgage Rate (%)	95340	7.1278	6.9638	2.7179	2.7607	17.7357
Prime Rate (%)	95340	6.7729	6.9087	2.8478	3.2500	20.3203
48 Month Consumer Rate (%)	95338	8.1933	7.9500	2.6660	4.0000	17.3600

Panel B: Mean Ratios and Percentage Changes for Small-to-Medium, Large, and All Banks

Variables	Small-to-Medium Banks			Large Banks			All Banks		
	Pre-2010	Post-2010	% Change	Pre-2010	Post-2010	% Change	Pre-2010	Post-2010	% Change
Return on Equity (%)	11.70	10.26	-12.31%	17.42	12.17	-30.14%	12.40	10.53	-15.08%
Total Non-Interest Income	6.9455	11.5599	66.39%	1487.86	1841.19	23.77%	90.2183	272.6927	202.27%
Net Current Op. Earnings	13.6755	28.0813	105.34%	305.06	1086.12	256.04%	90.5619	832.7235	819.30%
Net Interest Income	18.8242	30.9754	64.54%	1362.22	2162.26	58.75%	112.1354	337.9021	201.44%
Debt Ratio	0.9054	0.8876	-1.97%	0.9206	0.9048	-1.71%	0.9074	0.8901	-1.91%
Tier 1 Ratio (%)	11.36	13.16	15.85%	8.91	12.32	38.27%	11.18	13.04	16.64%
Z-score	0.0001	0.0001	0.00%	0.0001	0.0001	0.00%	0.0001	0.0001	0.00%
Size	6.9946	7.6041	8.71%	11.2954	12.0217	6.44%	7.3422	8.2474	12.33%
Assets - Total	2631.75	3808.49	44.73%	175414.2	515331.5	193.81%	16593.26	78294.4	372.01%
Cash Ratio	0.0508	0.0551	8.46%	0.0785	0.0792	0.89%	0.0531	0.0587	10.55%
Federal Funds Rate	4.7482	0.5963	-87.45%	4.7482	0.5963	-87.45%	4.7482	0.5963	-87.45%
30 Year Mortgage Rate	7.7650	4.0458	-47.91%	7.7650	4.0458	-47.91%	7.7650	4.0458	-47.91%
Prime Rate	7.5836	3.7238	-50.89%	7.5836	3.7238	-50.89%	7.5836	3.7238	-50.89%
48-Month Consumer Rate	8.8748	4.9995	-43.68%	8.8748	4.9995	-43.68%	8.8748	4.9995	-43.68%

Other corollary hypotheses of this paper are whether interest rate fluctuations impact small-to-medium banks differently than large banks or whether large banks' profitability and risk respond differently to interest rate fluctuations than smaller banks'. For simplicity, we avoid explicitly writing these hypotheses as they may deviate from the focus of our study. Nonetheless, we present plenty of data and discuss them throughout the paper.

4. Results and Discussion

4.1. **General trends in interest rates, bank profitability, bank capital and risk.** Interest rates are highly correlated to each other and move in tandem. For instance, the correlation between the Federal funds rate and the Wall Street Journal Prime rate is 0.992 and with the 48-month consumer loan rate is 0.941 for our sample period. Due to these high correlations, we use the Federal funds rate as the benchmark rate in our analysis. The Fed funds rate is

also perhaps the most important rate for US banking firms as it determines the rate they earn in the overnight interbank lending market and on their excess capital at the Federal Reserve. Interest rates have generally been lower in the Dodd-Frank period (2010-2023) compared to the pre-Dodd-Frank period. The rate has fallen from a mean of 4.75% in the pre-Dodd-Frank period to an average of 0.596% in the Dodd-Frank period accounting for a decrease of 87.45%. It is important to note that the Fed funds rate has increased considerably to above 5% since 2022 in response to the high inflation. However, the period has been relatively short compared to over a decade of low rates since 2010.

Bank profits, measured by return on equity, exhibit 15.08% deterioration for the sample of banks in the Dodd-Frank period from pre-Dodd-Frank period (from 12.40% to 10.53%). For large banks, it has been a 30.14% deterioration from 17.42% to 12.17%. For small-to-medium banks, return on equity declined by 12.31% from 11.70% to 10.26% over the period. Bank profits have been particularly volatile over the study period with a standard deviation of 31.80%.

Bank capital ratio (i.e. Tier-1 ratio) averaged 11.86% during the study period for the sample. We observe the ratio increased by 16.64% for all banks, whereas for large banks, it increased by 38.27% from the pre- to the post-Dodd-Frank period. This finding is consistent with the Systematically Important Financial Institutions (SIFIs) designation of largest banks by the Financial Stability Oversight Council as part of the Dodd-Frank Act that requires stricter regulation and liquidity. Bank Z-scores have remained relatively unchanged for the study period for both small-to-medium and large banks. Cash ratio, a more stringent ratio of liquidity and risk, slightly improved for the US banks from the pre- to the post-Dodd-Frank period. The ratio increased from 5.08% to 5.51% for small-to-medium banks, and from 7.85% to 7.92% for large banks increases of 8.46% and 0.89%, respectively. Table 2 summarizes the rest of the trends[6].

4.2. **Regression analysis of bank profitability.** To understand whether bank profitability depends on bank capital, risk level and interest rate fluctuations, we conduct the following model to analyze bank profitability.

$$\begin{aligned}\mathrm{ROE}_{it} = \beta_0 + \beta_1 \mathrm{FF}_{it} + \beta_2 \mathrm{Tier1}_{it} + \beta_3 \mathrm{Cash}_{it} + \beta_4 \mathrm{NOE}_{it} + \beta_5 \mathrm{NonII}_{it} \\ + \beta_6 \mathrm{NII}_{it} + \beta_7 \mathrm{Debt}_{it} + \beta_8 \mathrm{Size}_{it} + \varepsilon_{it}, \quad \text{for } i = 1, \ldots, N;\ t = 1, \ldots, T \quad \text{(Model 1)}\end{aligned}$$

Where, ROE is returns on equity, FF is the Federal funds rate, Cash is cash ratio, NOE is net operating earnings, NonII is noninterest income, NII is net interest income, Debt is debt ratio, and Size is size measured by log of total assets. GDP has been considered as an independent variable in other papers studying bank profitability measured by interest rate margins. We omit this variable from our model as we find it highly correlated with net interest rate income (NII), and Fed funds rate. To capture the effect of GDP and possible shifts in variances due to business cycles and/or other dynamics over the period, we use robust standard errors when determining the significance of coefficients. We use panel data regression with random effect model based on Hausman test results. Table 3 summarizes the regression results.

The coefficient of interest in Model 1 is that of the Fed funds rate (β_1.)A statistically significant β_1 would reject Hypothesis I that interest rate fluctuation does not impact bank profitability. Our panel data regression of Model 1 results in a positive and statistically significant coefficient for the Fed funds rate with a p-value of less than 0.0001 as presented in Panel A of Table 3. The result seems to be driven by large banks. The coefficient is also positive for small-to-medium banks, but insignificant. The result is persistent in both the pre- and

[6]We note that the changes for a few of the ratios from the pre- to the post-Dodd-Frank periods for the entire sample seem inconsistent with those for the sub-categories of banks akin to a Simpson's Paradox. For instance, the change for net interest income for small-to-medium banks is 64.54% increase and for large banks is 58.75% while for the entire sample of bank, it is 201.44%. This can be caused by one or more of the factors: the unbalanced nature of the panel dataset, non-linearity of the ratios, and uneven distribution of the ratio within the sub-samples.

TABLE 3. Profitability Regression Results. The table shows regression results for all banks, largest banks (top 10% by assets), and small to medium banks (bottom 90%). Quarterly data, 1980q1–2023q4, from FDIC Call Reports.

Panel A. Profitability performance for the period 1980q1–2023q4

Return on Equity	**All Banks**		**Largest Banks**		**Small to Medium Banks**	
	Coefficients	P-Values	Coefficients	P-Values	Coefficients	P-Values
Federal Funds Rate	0.0026***	0.0000	0.0027***	0.0000	0.0002	0.4680
Tier-1 Capital Ratio	-0.9798	0.6070	-28.2211	0.2570	-3.3792**	0.0240
Cash Ratio	-0.0276	0.3950	-0.0016	0.9620	-0.0212	0.4050
Net Current Operating Earnings	0.0000**	0.0350	0.0000**	0.0360	0.0008***	0.0000
Total Non-Interest Income	0.0000	0.3660	0.0000	0.3250	0.0000	0.4130
Net Interest Income	-0.0000*	0.0540	-0.0000*	0.0610	0.0000	0.8130
Debt Ratio	0.0887	0.2890	0.0595	0.6760	0.1341***	0.0090
Size	-0.0047	0.1490	-0.0114*	0.0560	-0.0317***	0.0000
Constant	-0.0098	0.9200	0.0996	0.5950	0.1737**	0.0160
Prob > Wald Chi-squared	0.0000		0.0000		0.0000	
Adjusted R-squared	0.1594		0.1613		0.8026	

Panel B. Profitability performance before the Dodd-Frank Act (1980q1–2009q4)

Return on Equity	**All Banks**		**Largest Banks**		**Small to Medium Banks**	
	Coefficients	P-Values	Coefficients	P-Values	Coefficients	P-Values
Federal Funds Rate	0.0037***	0.0000	0.0041***	0.0000	-0.0002	0.6050
Tier-1 Capital Ratio	-2.4196	0.2050	1.1245	0.9750	-3.2769	0.1980
Cash Ratio	0.0418	0.1860	0.0382	0.2060	0.0119	0.8580
Net Current Operating Earnings	0.0000***	0.0000	0.0000***	0.0000	0.0008***	0.0000
Total Non-Interest Income	0.0000	0.1530	0.0000	0.2130	0.0000	0.3890
Net Interest Income	0.0000	0.6910	0.0000	0.3790	0.0000	0.9790
Debt Ratio	0.3240***	0.0000	0.3750***	0.0010	0.1518*	0.0950
Size	-0.0119***	0.0000	-0.0183***	0.0070	-0.0317***	0.0080
Constant	-0.1579**	0.0250	-0.1280	0.2570	0.1586	0.2800
Prob > Wald Chi-squared	0.0000		0.0000		0.0000	
Adjusted R-squared	0.3380		0.3917		0.7379	

Panel C. Profitability performance in the Dodd-Frank period (2010q1–2023q4)

Return on Equity	**All Banks**		**Largest Banks**		**Small to Medium Banks**	
	Coefficients	P-Values	Coefficients	P-Values	Coefficients	P-Values
Federal Funds Rate	0.0020***	0.0060	0.0020**	0.0250	-0.0009	0.3260
Tier-1 Capital Ratio	0.4087	0.8670	-54.4734***	0.0080	-3.1747**	0.0090
Cash Ratio	-0.0331	0.2040	-0.0196	0.4510	-0.0226	0.4420
Net Current Operating Earnings	0.0000	0.1320	0.0000	0.1340	0.0008***	0.0000
Total Non-Interest Income	0.0000	0.1880	0.0000	0.1850	0.0000	0.6860
Net Interest Income	0.0000	0.1220	0.0000	0.1360	0.0000	0.5870
Debt Ratio	-0.0103	0.9420	-0.0548	0.8070	0.1015	0.1240
Size	0.0006	0.8730	-0.0088*	0.0620	-0.0250***	0.0000
Constant	0.0106	0.9380	0.1707	0.4640	0.1490**	0.0150
Prob > Wald Chi-squared	0.0006		0.0000		0.0000	
Adjusted R-squared	0.0957		0.0964		0.9108	

post-Dodd-Frank periods. This finding supports rejecting Hypothesis I but supports its corollary. The finding implies that higher interest rates positively impact bank profitability and is amplified for larger banks.

Consistent with the literature, we also find that Tier-1 capital is inversely related to profitability as higher capital requirements impose higher opportunity costs for banks and thus negatively affect profitability. An important finding of this paper is that bank capital negatively affects profitability of smaller banks compared to large banks. It implies that capital ratio requirements are costlier for smaller banks. The Tier-1 capital coefficient in Panel A of Table 3 is negative and statistically significant at a p-value of 0.024. The same ratio is insignificant for large banks with a relatively large p-value of 0.257. Analyzing the impact of Tier-1 capital on bank profitability in the post-Dodd-Frank period, we find that higher Tier-1 capital affects both small and large banks alike. The coefficient is statistically significant for both small-to-medium and large banks. A notable difference in how Tier-1 capital impacts bank profitability in the pre- and post-Dodd-Frank periods is that bank capital requirements didn't have significant impact on bank profits in the pre-Dodd-Frank period, whereas it carries significant burden for banks in the post-Dodd-Frank period. Panel B and C of Table 3 show the details.

4.3. **Regression Analysis of Bank Risk.** Hypothesis II states that interest rate fluctuation does not impact bank risk. To test this, we estimate the following panel data regression models:

$$\begin{aligned}\text{Tier1Ratio}_{it} = \beta_0 + \beta_1 \text{ROE}_{it} + \beta_2 \text{FF}_{it} + \beta_3 \text{Cash}_{it} + \beta_4 \text{NOE}_{it} + \beta_5 \text{NonII}_{it} \\ + \beta_6 \text{NII}_{it} + \beta_7 \text{Debt}_{it} + \beta_8 \text{Size}_{it} + \varepsilon_{it}, \quad \text{for } i = 1, \ldots, N;\ t = 1, \ldots, T\end{aligned} \tag{Model 2}$$

$$\begin{aligned}\text{BankZScore}_{it} = \beta_0 + \beta_1 \text{ROE}_{it} + \beta_2 \text{FF}_{it} + \beta_3 \text{Cash}_{it} + \beta_4 \text{NOE}_{it} + \beta_5 \text{NonII}_{it} \\ + \beta_6 \text{NII}_{it} + \beta_7 \text{Debt}_{it} + \beta_8 \text{Size}_{it} + \varepsilon_{it}, \quad \text{for } i = 1, \ldots, N;\ t = 1, \ldots, T\end{aligned} \tag{Model 3}$$

Our coefficient of interest is the Fed funds rate coefficient (β_2) in Model 2 and 3. A statistically significant β_2 would imply that interest rate fluctuation alters bank risk profile, providing evidence in rejecting Hypothesis II. Regression results presented in Panel A of Table 4 indicate that the coefficient is negative and statistically significant at approximately 0.01 significance level for the entire study period between 1980q1 and 2023q4. This implies that bank risk measured by Tier-1 capital ratio deteriorates with higher Fed funds rate. The effect is the same for both small-to-medium banks and large banks. This provides support for the rejection of Hypothesis II and its Corollary. Table 4 presents the results of Model 2.

Further investigating the results, we realize that the coefficients in the pre- and post-Dodd-Frank periods are not significant, which supports the null Hypothesis II in the sub-periods. We notice the conflicting results between the entire study period and its two sub-periods. Further investigations reveal that it can happen due to the interaction and dynamics of independent variables in the pre- and post-Dodd-Frank periods. The primary suspect was a multicollinearity issue. Conducting investigation using Variance Inflation Factor (VIF), we found no significant multicollinearity issue in our model. Furthermore, we use robust standard errors when determining the significance of the coefficients to account for variance inflation.

We also use Bank-Z-Scores as an alternative measure of bank risk. We find that the Fed funds rate is positively and significantly correlated with the Bank Z-Score with p-values of less than 0.0001% for large banks but insignificant for small-to-medium banks. It implies that interest rate fluctuation has a significant impact on bank risk for large banks. Since the higher the Bank Z-Score, the lower the bankruptcy risk, higher interest rates correspond to lower risk for banks and lower interest rates correspond to high bankruptcy risk for large banks. Interest rate fluctuation does not seem to have any significant impact on the Bank Z-Score of small-to-medium banks. It also implies that when interest rates are low, large banks do and can take more risk to compensate for lower interest rate margin whereas smaller banks don't or can't. These results are consistent during the entire study periods, as well as during the pre- and

TABLE 4. Risk Regression Results. The table shows regression results for all banks, largest banks (top 10% by assets), and small to medium banks (bottom 90%). Quarterly data from FDIC Call Reports for the period 1980q1–2023q4.

Panel A. Tier-1 Capital Ratio (1980q1–2023q4)

Tier 1 Ratio	**All Banks**		**Largest Banks**		**Small to Medium Banks**	
	Coefficients	P-Values	Coefficients	P-Values	Coefficients	P-Values
Return on Equity	-0.0001	0.3360	0.0000	0.1400	-0.0007	0.5220
Federal Funds Rate	-0.0000188**	0.0190	-0.00000528**	0.0050	-0.000054***	0.0010
Cash Ratio	0.0003365*	0.0940	0.0001222**	0.0410	-0.0002	0.6940
Net Current Operating Earnings	1.55e-08**	0.0240	3.79e-09**	0.0290	0.0000	0.5960
Total Non-Interest Income	0.0000	0.1380	1.52e-09*	0.0740	0.0000	0.9190
Net Interest Income	4.69e-08***	0.0050	1.27e-08***	0.0060	0.0000	0.1110
Debt Ratio	-0.0011	0.2170	-0.0010175***	0.0000	-0.006025***	0.0040
Size	-0.0004002***	0.0000	-0.0001299***	0.0000	-0.001418***	0.0000
Constant	0.0065437***	0.0000	0.0025938***	0.0000	0.0208332***	0.0000
Prob > Wald Chi-squared	0.0000		0.0000		0.0000	
Adjusted R-squared	0.4001		0.7439		0.7475	

Panel B. Tier-1 Capital Ratio before the Dodd-Frank Period (1980q1–2009q4)

Tier 1 Ratio	**All Banks**		**Largest Banks**		**Small to Medium Banks**	
	Coefficients	P-Values	Coefficients	P-Values	Coefficients	P-Values
Return on Equity	0.00001	0.9730	0.00001	0.8780	0.00064	0.2770
Federal Funds Rate	-0.00001	0.3790	0.00000	0.1120	-0.00001	0.2570
Cash Ratio	0.00066	0.2540	0.00019***	0.0000	0.00177***	0.0020
Net Current Operating Earnings	0.00000	0.6060	0.00000	0.7040	0.00000	0.1470
Total Non-Interest Income	0.00000	0.8390	0.00000	0.2190	1.18e-06*	0.0910
Net Interest Income	5.61e-08***	0.0000	1.86e-08***	0.0000	0.00000	0.6800
Debt Ratio	-0.00243	0.1910	-0.00004	0.9110	-0.01074***	0.0000
Size	-0.00036***	0.0000	-0.00013***	0.0000	-0.00145***	0.0000
Constant	0.0071***	0.0010	0.00171***	0.0000	0.02496***	0.0000
Prob > Wald Chi-squared	0.0027		0.0000		0.0000	
Adjusted R-squared	0.3716		0.7731		0.7564	

Panel C. Tier-1 Capital Ratio in the Dodd-Frank Period (2010q1–2023q4)

Tier 1 Ratio	**All Banks**		**Largest Banks**		**Small to Medium Banks**	
	Coefficients	P-Values	Coefficients	P-Values	Coefficients	P-Values
Return on Equity	-0.000031	0.5450	-0.0000386	0.1820	-0.003268	0.3550
Federal Funds Rate	-0.000007	0.2920	-4.77e-06*	0.0820	-0.000017	0.6950
Cash Ratio	5.25e-04**	0.0240	0.0001000	0.1810	-0.000325	0.6700
Net Current Operating Earnings	1.30e-08**	0.0190	3.60e-09**	0.0380	0.000003	0.2500
Total Non-Interest Income	0.000000	0.8890	0.0000000	0.6890	0.000001	0.3440
Net Interest Income	3.46e-08*	0.0630	1.09e-08*	0.0620	4.93e-06**	0.0390
Debt Ratio	0.000394	0.8190	-9.75e-04**	0.0020	-0.001640	0.6650
Size	-5.04e-04***	0.0000	-1.41e-04***	0.0000	-2.05e-03***	0.0000
Constant	6.12e-03***	0.0000	2.72e-03***	0.0000	2.19e-02***	0.0000
Prob > Wald Chi-squared	0.0006		0.0000		0.0000	
Adjusted R-squared	0.4859		0.7540		0.8501	

post-Dodd-Frank sub-periods. Bank Z-scores seem to be driven primarily by operating income and debt ratio. Table 5 presents the results for Model 3.

TABLE 5. Bankruptcy Risk Regression Results. The table shows regression results for all banks, largest banks (top 10% by total assets), and small to medium banks (bottom 90%). The dataset includes quarterly data from FDIC Call Reports for banks listed on NYSE or NASDAQ from 1980q1 to 2023q4.

Panel A. Bank Z-Score for All Times (1980q1–2023q4)

Z-Score	**All Banks**		**Largest Banks**		**Small to Medium Banks**	
	Coefficients	P-Values	Coefficients	P-Values	Coefficients	P-Values
Return on Equity	0.0000522***	0.0010	0.0000469***	0.0010	2.81e-05	0.1880
Federal Funds Rate	3.10e-07***	0.0000	4.10e-07***	0.0000	7.73e-08	0.1200
Cash Ratio	5.34e-06	0.2720	8.53e-06	0.1370	-1.03e-06	0.5990
Net Current Op. Earnings	6.11e-10***	0.0060	6.47e-10***	0.0050	8.77e-08***	0.0000
Total Non-Interest Income	-2.60e-10	0.1090	-2.33e-10	0.1380	-9.02e-09*	0.0500
Net Interest Income	-9.85e-11	0.5660	-1.78e-10	0.2880	-4.20e-09	0.5220
Debt Ratio	-0.001302***	0.0000	-0.001303***	0.0000	-0.001301***	0.0000
Size	4.35e-07	0.1580	7.23e-07	0.1440	-1.94e-06***	0.0010
Constant	0.0012971***	0.0000	0.0012933***	0.0000	0.0013195***	0.0000
Prob > Wald Chi-squared	0.0000		0.0000		0.0000	
Adjusted R-squared	0.9886		0.9866		0.9975	

Panel B. Bank Z-Score for the Pre-Dodd-Frank Period (1980q1–2009q4)

Z-Score	**All Banks**		**Largest Banks**		**Small to Medium Banks**	
	Coefficients	P-Values	Coefficients	P-Values	Coefficients	P-Values
Return on Equity	8.05e-05***	0.0000	8.65e-05***	0.0000	6.30e-06	0.7290
Federal Funds Rate	1.79e-07**	0.0230	1.56e-07*	0.0510	6.28e-08	0.3310
Cash Ratio	-8.51e-06***	0.0090	-9.87e-06**	0.0180	1.10e-07	0.9700
Net Current Op. Earnings	8.28e-10	0.1360	6.38e-10	0.2220	9.57e-08***	0.0000
Total Non-Interest Income	-2.44e-10	0.2630	-2.06e-10	0.3600	-2.78e-09	0.7170
Net Interest Income	2.78e-10	0.2060	3.16e-10	0.2440	-4.78e-09	0.5490
Debt Ratio	-0.001291***	0.0000	-0.001282***	0.0000	-0.001291***	0.0000
Size	-1.32e-06**	0.0240	-1.45e-06	0.1670	-2.52e-06**	0.0230
Constant	0.0013052***	0.0000	0.0012984***	0.0000	0.0013153***	0.0000
Prob > Wald Chi-squared	0.0000		0.0000		0.0000	
Adjusted R-squared	0.9863		0.9830		0.9971	

Panel C. Bank Z-Score for Post-Dodd-Frank Period (2010q1–2023q4)

Z-Score	**All Banks**		**Largest Banks**		**Small to Medium Banks**	
	Coefficients	P-Values	Coefficients	P-Values	Coefficients	P-Values
Return on Equity	4.12e-05***	0.0000	3.65e-05***	0.0000	6.38e-05***	0.0070
Federal Funds Rate	5.03e-07***	0.0000	5.97e-07***	0.0000	1.40e-09	0.9850
Cash Ratio	8.53e-06*	0.0970	9.81e-06*	0.0830	1.32e-06	0.5380
Net Current Op. Earnings	3.63e-10***	0.0030	3.93e-10***	0.0010	6.93e-08***	0.0000
Total Non-Interest Income	-1.92e-10*	0.0520	-1.48e-10	0.1160	-1.42e-08***	0.0010
Net Interest Income	-7.90e-11	0.6190	-1.79e-10	0.2880	-4.49e-09	0.3690
Debt Ratio	-0.001309***	0.0000	-0.001309***	0.0000	-0.001305***	0.0000
Size	5.96e-07	0.2130	8.28e-07	0.3400	-1.27e-06**	0.0430
Constant	0.0013015***	0.0000	0.0012976***	0.0000	0.0013163***	0.0000
Prob > Wald Chi-squared	0.0000		0.0000		0.0000	
Adjusted R-squared	0.9895		0.9892		0.9991	

5. Summary and Conclusion

We investigate bank profitability and risk in response to interest rate fluctuations since 1980. We use a panel dataset of 2083 publicly listed banks with quarterly data between the first quarter of 1980 and last quarter of 2023, inclusive. Our data is an unbalanced panel of 93338 quarterly observations. We further study the impact of interest at fluctuations for small-to-medium banks and large banks where we define large banks in the 10th decile by total assets size. We use the Federal funds rate as the benchmark for interest rate levels, return on equity as the primary profitability measure, and Tier-1 capital ratio and Bank-Z-Score as risk measures. We use random effect panel regression with robust standard errors to account for possible shifts in variance due to business cycles and/or other dynamics during the study period. We also conduct our analysis in two sub-periods, before the Dodd-Frank Act (1980q1-2009q4) and after it became effective (2010q1-2023q4.) Our results indicate that bank profitability increases with interest rate increases for banks of all sizes, but the effects are amplified for larger banks. We also find that higher Tier-1 capital negatively affects bank profitability. The impact is more significant for small-to-medium banks than for large banks. This finding implies that higher capital ratio requirements impose higher costs for smaller banks than for large ones. The results are consistent in both the pre and post Dodd-Frank periods. Bank risk measured by Tier-1 capital ratio seems to not be affected significantly by interest rate fluctuations. This may be that banks consistently tend to hold the minimum Tier-1 capital ratio as required by law.

We also find that the Fed funds rate is positively and significantly correlated with the Bank Z-Score for large banks but insignificant for small-to-medium banks. It implies that interest rate fluctuation has a significant impact on risk for large banks but does not seem to affect risk for small-to-medium banks. These results are consistent during the entire study periods, as well as during the pre- and post-Dodd-Frank periods.

This paper has three distinct contributions to the banking research literature. First, it is an empirical study of how bank profitability is impacted by interest rate fluctuations since 1980. Second, it investigates how bank risk profile changes with interest rate fluctuations. Third, it explores whether bank profitability and risk behavior in response to interest rate fluctuations shifted from the pre-Dodd-Frank period to the post-Dodd-Frank period. Other contributions are the empirical evidence in bank profitability, capital, and risk for large versus small-to-medium banks.

Two methodology discussions may arise regarding this study. One is the use of dummy variables to account for the Dodd-Frank Act impact instead of conducting the analysis in two sub-periods or for the two categories of small-to-medium banks, and large banks. The other is the use of Impulse Response Functions (IRFs) for the impact of Dodd-Frank Act on variables. We conducted both approaches for robustness purposes. We found that the dummy variable approach, while yielding consistent results with our current methodology, only tells us whether a structural shift has happened pertaining to the dependent variable, e.g. profitability shift for large banks due to the Dodd-Frank Act. Whereas we wanted more detailed information on the percentage differences in all variables for the two groups of banks before and after the Dodd-Frank Act. Also, our current approach helps us juxtapose the results for depth and clarity.

We conducted Impulse Response Functions for all variables for the two groups of banks. While the IRFs graphs provide information on the effect of the Dodd-Frank Act, they are difficult for readers to see and/or measure the differences for the two groups of banks. To avoid clutter, we don't include the graphs in this paper but would gladly provide them to readers upon request. This paper has several limitations. For instance, the data is unbalanced panel data and a few of the banks merged or didn't survive long enough. This may have introduced survival bias. Another limitation is that banks often maintain the minimum Tier-1 capital ratio set by regulators. Or, during heightened market risk, banks may tend to reduce their risk by limiting loans which consequently results in higher capital ratio and risk, especially if

the Fed wants to bolster bank capital by providing funds at favorable rates like the term loans auctioned off during the 2007-2008 financial crisis. It is also not clear how much funds large banks have access to during financial downturn compared to smaller banks, which may result in different profitability and risk behavior than normal times. However, differentiating the effects of "too-big-to-fail" in terms of profitability and risk may fall outside the scope of this paper. We hope to see more research in this area.

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