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The impact of macroeconomic factors and bank-specific factors on the profitability of U.S. commercial banks

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1. Abstract

The paper examines 506 US commercial banks from 2000 to 2023 to analyze their profitability structure. The determinants of profitability are split into two groups: the macroeconomic group and the bank-specific group. U.S. commercial banks are included in the sample if they were publicly listed during the period between 2000 and 2022; banks that declared bankruptcy during this period are also considered within the sample but only for the period of their operation. A Generalized Least Square (GLS) Fixed Effects model is utilized. The empirical finding of the paper suggests that the non-performing loan ratio, risk-adjusted Tier 1 capital ratio, and cost-to-income ratio from the bank-specific variables have a statistically significant impact on the profitability of U.S. commercial banks. Hence, the paper concludes that the profitability of the banks is positively associated with the Tier 1 capital ratio and the Cash ratio but negatively associated with the non-performing ratio and cost-to-income ratio. Furthermore, in addition to the main research, the paper investigates the statistical influence of the low-interest rate environment and historical crises: the 2008 financial crisis and Covid-19, on the profitability of the U.S commercial banks. The impact of the low-interest rate remains insignificant, while the financial crisis and Covid-19 are negatively correlated to the profitability.

1. Introduction

On the 11th of March, 2020, the WHO (World health organization) announced the Covid-19 pandemic. In response, most of the world's nations came up with pandemic restriction policies to prevent further spreading of the disease within their nations. As a spillover effect, global economic activity was hindered, resulting in industries and markets around the world operating at reduced capacity. Consequently, the global merchandise trade volume decreased by 12.9% in April 2020 (Statista Research Department, 2023). Specifically, according to a U.N. report, metals and minerals, energy, road vehicles, and other manufacturing industry experienced a 12%, 29%, 29%, and 11% decrease in trade volume, respectively, in 2020 and 2021 compared to 2019, while the textile industry recorded a 26% increase in the same period. During 2020, the world's collective GDP fell by 3.4%, which in absolute terms, means that the world lost output worth two trillion U.S. dollars (Statista Research Department, 2023). Moreover, from the 1st of January to the 18th of March 2020, U.S. major stock market indices, Nasdaq and S&P 500, fell by 12.4% and 14.9%, respectively. During

the same time period, Asian stock markets suffered too, with the CSI 300 (China), KOSPI (Korea), Hang Seng (Hong Kong), and Nikkei 225 (Japan) dropped by 12.1%, 22%, 14.7%, and 19.4%, respectively (Statista Research Department, 2023). Moreover, the airline industry was one of the industries that suffered the most from the Covid-19 pandemic due to the entry restriction. Within the period from the 6th of January 2020 to the 4th of January 2021, the number of scheduled flights was down by 43.5% globally (Statista Research Department, 2023). Due to the sudden drop in demand, oil prices even recorded a negative price between April 20 and 22, 2020 (Statista Research Department, 2023). In order to stimulate global economic activities and to mitigate the impact of the pandemic on corporations, on March 3rd and 16th, 2020, the Federal reserve bank (Fed) lowered the interest rate by 50 basis points (bp) and 100 bp, respectively, which brought the interest rate level to near zero. This was the most aggressive reduction in the interest rate by the Fed since the 2008 financial crisis. Furthermore, the Fed, via fiscal and monetary policy such as cutting interest rates, purchasing treasury securities and MBS as well as REPO operations, provided a total facility of almost \$ 5.8 trillion from December 2020 to March 2021, which is about 28% of the US GDP (Clarida et al).

The motivation for the paper comes from the curiosity to investigate how macroeconomic factors and bank-specific factors impact bank profitability which leads to our main research question: which bank-specific factors and macroeconomic factors have a significant impact on the profitability of the U.S commercial banks. The paper further examines the impact of the low-interest rate and the crises on the profitability. The Fed fund rate is chosen as one of the macroeconomic variables since it is directly related to the cost of funding. To provide a background of the recent changes in the interest rate, Alan Greenspan, former chair of the Fed, increased the interest rate by 25bp seventeen times in a row between 2004 to 2006, thus increasing it from 1% to 5.25%. This historical hike is still known to be one of the most aggressive tightening in recent history. However, as a response to the most aggressive tightening, the crisis shortly came after the hike, the financial crisis, which is known as "the Great Recession" in 2007-2009. By that time in the United States, multiple banks and other financial institutions provided not only numerous Asset-back securities mortgages for real estate but also related derivative products which involved substantial risks. The market started to doubt the solvency of banks and financial institutions, which triggered the crisis. Only after the market started to face a severe recession the Fed started to lower the Fed fund

rate to stabilize the economy and mitigate the economic panic. In response to the financial crisis, the Fed kept the rate at a near-zero level until December 2015. The transition from 2008 to the covid crisis is too abrupt, Yellen, former Chair of the Fed, increased the interest rate nine times by 25 bp over a two-year period, which brought the level from near-zero to the range of 2.25% to 2.5% in December 2018. In 2019, Covid-19 hit the world, and central banks, including the Fed, dropped the interest rate to support the depressed economy. Powell, the current Chair of the Fed, dropped the rate on the 3rd and 16th of March by 50 bp and 100 bp respectively, putting the level of the rate to near-zero again. However, since then, as a response to excessive liquidity in the market, the inflation rate has started to gain the Fed's attention. From the 17th of March 2022, the Fed started to hike the rate nine times which brought the level from near-zero to 4.75 bp by the 2nd of March 2023 over a little less than a two-year period. Since then, the Fed funds rate has been one of the crucial factors influencing the margin of banks. Having observed changes in the interest rate and its impact on the economy, I became curious about how changes in macroeconomic factors and bank-specific factors would impact the profitability of U.S. commercial banks which is the main research question of the paper. Thus, the null hypotheses are as follows:

Set1: Null hypothesis for Macroeconomic Factors

H₀: Macroeconomic factors have a significant impact on the profitability of the U.S commercial banks.

H_a: Macroeconomic factors do not have a significant impact on the profitability of the U.S commercial banks.

Set2: Null hypothesis for Bank-specific Factors

H₀: Macroeconomic factors have a significant impact on the profitability of the U.S commercial banks.

H_a: Macroeconomic factors do not have a significant impact on the profitability of the U.S commercial banks.

The organization of the paper is as follows: First, we introduce the research question in the introduction; In Section 2, related works of literature are comprehensively discussed and reviewed to provide the theoretical and empirical backgrounds on the research question; then

Section 3 introduces the data and methodology and discusses the result of the analysis; In Section 4, in the implication part, further investigations are conducted regards to the impact of the lower interest rate and the crises: the financial crisis and the Covid-19 on the profitability of the U.S. commercial; In Section 5, the conclusion is drawn.

2. Literature Review

To answer the research question, it is crucial to understand U.S. banks' primary income sources. First of all, a financial institution so-called "Bank" is a financial intermediary that earns its profit from three major sources: Firstly, the primary source of profit is from the Spread, which is the difference between the interest rate which banks pay their clients for their deposits and the interest rates that they offer to clients on loans. Secondly, they earn interest on securities (debt, equity, derivatives, and hybrid securities). Lastly, they gain fees and commissions from providing financial services such as checking accounts, financial counseling, loan servicing, and the sales of financial products (the State of Connecticut, 2023). Hence, people tend to think that banks favor high-interest rates over low-interest rates as the increase in interest rates on loans is higher in high-interest rate periods. However, this is a one-dimensional understanding of the banking system. Banks' profitability only increases if their net margin, margin without base rate, increases. Ironically, increasing interest rates can hurt banks' profitability because an increase in the interest rate leaves little room for banks' margins. During the high-interest rate period, there is less demand for investment which implies fewer loans for banks to give out because if banks keep their margins on loans, then there will be no demand for loans, and if banks cut their margin to secure their customers, they will keep customers at cost. In either scenario, banks' revenue decreases substantially, especially during the high-interest rate period. Fortunately, there are many financial tools that can mitigate the impact of high-interest rates without losing customers, which lies outside of the scope of this research.

Secondly, having background knowledge of what determines banks' profitability is essential. The research paper takes an approach to answer the research question by having two explanatory groups: a bank-specific determinant group and a macroeconomic determinant group. Firstly, the discussion on which bank-specific variables determine the profitability of banks is started by Modigliani and Miller (1958). They argue that under a perfect capital market where there is value-maximization behavior, no bankruptcy costs, no

tax, and no entry barriers to the market, the value of corporations must be identical because the cost of debt and equity are the same. Thus, Modigliani and Miller assume a negative correlation between corporates' profitability and the capital ratio (independent variable for banks' profitability) because an increase in equity and a decrease in debt by the same portion would lower the market risk, which leads to a decrease in the market's rate of return. On the other hand, Bourke's (1989) finding stands against the finding of Modigliani and Miller's finding; he states that the perfect capital market doesn't exist in reality, so larger banks which tend to have stronger financial stability often can access to the capital with lower funding costs. Hence, larger banks have incentives to increase their capital ratio. The conclusion on whether the capital ratio determines the banks' profitability is yet to be discussed, but some literature, including Paolo (2011), supports the findings of Modigliani and Miller, although their research does not assume a perfect capital market. Several other studies are also done on that matter but not only on the capital ratio of banks but also on other determinants, namely bank-specific, industry-specific, and macroeconomic factors (Petria et al, 2015).

Further discussion on the importance of bank-specific is continued by Bernanke and Gertler (1995). They argue that the Fed observes the current and expected market conditions, including both the economic and financial systems, and then provides monetary policies accordingly. This argument by Bernake and Gertler is supported by several existing literature; Praet (2016) suggests the financial vulnerability of banks during the crisis plays a major role in implementing monetary policies by Fed. Thus, a bank-specific factor that measures the financial condition of financial institutions can explain the correlation between macroeconomic factors and banks' profitability, such as the Tier 1 capital ratio.

Hence, it is important to include both bank-specific and macroeconomic variables in the regression model to investigate their impact on banks' profitability. The question is which bank-specific and macroeconomic indicators should be included in the regression model. Altavilla and others claimed to be the very first paper to use the expected macroeconomic variables and (forward-looking) credit risk as control variables examining the correlation between bank profitability and macroeconomic and bank-specific factors (2018). This paper takes the return on asset (ROA) as the dependent variable to measure bank profitability. ROA is not only taken as a variable to measure and quantify bank profitability by this paper but also by numerous other existing papers: 'The influence of monetary policy on bank profitability' (Borio & Claudio 2017), 'The dynamics of U.S. bank profitability';

(Chronopoulos & Dimitris K 2013), 'Determinants of banks' profitability: evidence from E.U. 27 banking system' (Petria & Nicolae 2015) and others.

The research paper takes the following six macroeconomic factor variables and four bank-specific factor variables. Under Macroeconomic factors, the Fed funds rate (FFR), yield Spread between 10-year and 2-year U.S. treasury bonds (the Spread), VIX index to measure market volatility (VIX), GDP growth (GDP), inflation (Inf), and expected inflation (exp Inf) are chosen. Firstly, FFR is determined based on how the Federal reserves observe the economic condition which is directly linked to the rate which decides the interbank rate on an uncollateralized basis. This is crucially important to banks' net margin as the lower the FFR, the more room for net margin to increase. On the other hand, the higher the FFR, there is less room for net margin to improve banks' profitability in theory. The Spread is chosen as it provides how the market views the economy. In a stable economic scenario, the Spread is positive as the cost of long-term financing is higher than the cost of short-term financing, which provides a favorable margin to banks since banks' primary source of revenue is coming from the difference between the deposit interest rate which banks pay and the long-term interest rate which banks receive from clients on loans. VIX measures the volatility in the market, which reflects the investors' sentiment. A higher VIX rate represents greater uncertainty in the market and rigid investment sentiment, where banks face limited opportunities to offer loans or circulate deposits. GDP growth measures the economic performance of nations which offers information on the demand of banks' financial products. Higher GDP growth implies a more active economy, increasing the demand for loans and investments through financial products. Last, the inflation and the exp inflation are chosen, which are linked to the FFR. The Federal Reserve has two major targets to achieve and maintain depending on the stage that the national economy is in, namely price stability and maximum employment rate. As the inflation rate and the expected inflation rate are the indicators to determine the level of price stability, they are chosen. Banks-specific variables: non-performing ratio (NPL), Tier 1 capital ratio, cost-to-income (CTI), and cash-to-asset ratio are chosen. The NPL ratio is a major key performance indicator to analyze banks since a higher NPL ratio implies banks receive fewer payments from their clients than they should, meaning losses for the bank. Having a high NPL doesn't only imply how much portions from total outstanding loans are in either default status or delayed in repayments but also limited deposit circulation to invest in financially strong clients, as they need higher provisions to

cover potential losses. Tier 1 capital ratio measures banks' financial health and capital adequacy. The higher Tier capital ratio implies banks have a strong capital buffer to absorb potential losses or to endure financial distress during a recession. CTI ratio is a measurement of the net margin of a bank which shows how efficiently a bank operates, which is one of the crucial factors to the profitability of banks. Lastly, the Cash-to-asset ratio indicates a bank's ability to liquidate its assets to meet its short-term obligations, which plays a crucial explanatory role in the recession scenario.

Those macroeconomic and bank-specific variables are also chosen by multiple existing literature. Among many, Altavilla's paper (2018) chose the Short-term rate, the Spread, VIX, GDP growth, exp GDP, and expected inflation under the macroeconomic variables and expected default frequency, NPL ratio, Regulatory Tier1 capital ratio, and CTI ratio under the banks-specific variables to investigate the profitability of commercial banks in different countries within the Euro area. The paper found that the following explanatory variables, expected real GDP growth at time t , expected inflation at time t , expected default frequency at time t , NPL ratio at time t , and CTI ratio at time t , have a statistical significance on ROA while other variables remain insignificant. Expected default frequency at time t , NPL ratio at time t , and CTI ratio at time t are found to be negatively correlated to the profitability of U.S. banks, while expected real GDP growth at time t , and expected inflation at time t are positively correlated to the profitability of U.S. banks.

On the other hand, similar research was conducted by Borio, Gambacorta, and Hofman (2017). The paper investigated how monetary policy affected the profitability of 109 large international banks in 14 major economies for the period 1995 – 2012. The empirical findings of the paper suggest that among various explanatory variables, they choose: short-term interest rate, the slope of the yield curve, solvency ratio, liquidity ratio, and housing price, which have a statistically significant on the banks' profitability (ROA).

Taking into account the result of the abovementioned literature, the research paper builds an extensive regression model which adds value by utilizing a combination of selected regression variables across existing literature. This research paper also extends the research periods, which provides insight into how those explanatory variables' impacts on the profitability of bank changes over time compared to the results of existing literature.

3. Research Methodology

3.1 Data

The data of 506 U.S. commercial banks with 33,668 total observations are collected from the beginning of 2000 and the end of 2022, as the availability of the data is limited to 2022. The data consists of two groups: a bank-specific group data and a macroeconomic group data. Firstly, the bank-specific data consists of the quarterly balance sheet and the quarterly income statement data for U.S. commercial banks: return-on-asset ratio (ROA), non-performing ratio (NPL), risk-adjusted Tier 1 capital ratio, cost-to-income ratio (CTI) and cash-to-asset ratio (Cash), are retrieved from Wharton Research Database System (WRDS). Secondly, the following variables are chosen for the macroeconomic data: inflation rate (Inf), Fed funds rate (FFR), spread between 10yr and 2yr U.S. treasury bonds (Slope), the stock market volatility index (VIX), and expected inflation (ExpInf). The macroeconomic variables are taken from The Federal Reserve Economic Data (FRED). These two data resources are specifically chosen for the sake of the credibility and accuracy of the data. The time range is chosen such that the data maintains its informative representativeness; for instance, data in 1900 can have much less explanatory power over U.S. commercial banks' ROA in 2022 than the data in 2000. Furthermore, gathering more than 1,800 sample sizes for each year secured the accuracy of the coefficient of the regression analysis.

As the paper analyzes the impact of the macroeconomic variable data and the bank-specific data across U.S. commercial banks over time, the research paper utilizes panel data regression which involves both cross-sectional data and time-series data. By using panel data, our regression model determines and quantifies the statistical significance of each independent variable in changes in the U.S commercial banks' profitability. Furthermore, when it comes to analyzing panel data, there are two major models, which are REM (random-effects model) and FEM (fixed-effects model). The methodology will be discussed in the next chapter. Our regression model is in the form of the following for each chosen year:

$$ROA_{i,t} = \alpha_i + \beta_1 * FFR_t + \beta_3 * Slope_{i,t} + \beta_4 * VIX_t + \beta_5 * GDP_t + \beta_6 * Inf_t + \beta_7 * ExpInf_{i,t} + \beta_8 * NPL_{i,t} + \beta_9 * RegCap_t + \beta_{10} * CTI_{i,t} + \beta_{11} * Cash_{i,t} + \varepsilon_{i,t}$$

Table 1. Description of variables in the regression model

Variables description	Notation	Definition
<i>Macroeconomic variables:</i>		

Short-term interest rate	FFR_t	<i>Fed Fund rate</i>
10yr and 2yr U.S. treasury bonds Spread	$Slope_t$	<i>10yr US treasury bond yield – 2yr Us treasury bond yield</i>
The stock market volatility	VIX_t	<i>CBOE Volatility Index *</i>
Real GDP growth	GDP_t	$\frac{Real\ GDP_t - Real\ GDP_{t-1}}{Real\ GDP_{t-1}}$
Inflation rate	Inf_t	<i>Consumer Price Index(CPI)</i>
Expected Inflation rate	$ExpInf_t$	<i>1 year expected inflation rate</i>
<i>Bank-specific variables:</i>		
Return on Assets	ROA_t	$\frac{Net\ Income_t}{Total\ Assets_t}$
Non-performing Loan ratio	NPL_t	$\frac{Nonperforming\ Loans_t}{Total\ Loans_t}$
Regulatory Tier 1 capital ratio	$RegCap_t$	$\frac{Tier\ 1\ Capital_t}{Total\ Risk\ Weighted\ Asset_t}$
Cost-to-income ratio	CTI_t	$\frac{Total\ operating\ Expense_t}{Total\ operating\ Income_t}$
Cash-to-asset ratio	$Cash_t$	$\frac{Cash\ and\ Cash\ equivalents_t}{Total\ Assets_t}$

*Chicago Board Options Exchange Volatility Index

**Source: FRED and WRDS

Table 2. Descriptive summary of the regression variables

	Obs	Mean	Std.Dev	Min	Max
ROA	31,905	5.52%	0.64%	-17.2%	10.6%
FFR	33,214	1.41%	1.70%	0.05%	6.5%
Slope	33,214	1.19%	0.89%	-0.45%	2.84%
VIX	33,214	2.73%	25.1%	-38.5%	75.2%
GDP	33,214	0.5%	15.2%	-8.48%	7.85%
Inf	33,214	2.77%	1.35%	0.13%	7.6%
ExpInf	33,214	1.92%	0.6%	-0.05%	3.39%
NPL	31,907	0.88%	1.52%	0	48.1%
RegCap	33,671	10.17%	6.00%	-6.9%	57.4%
CTI	31,238	77.6%	21.9%	-1878%	691.4%

Cash	31,905	5.57%	5.54%	0%	55.84%
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Source: The profitability analysis of U.S. commercial banks.dta

Table 2 is the overall descriptive summary from the beginning of 2000 to the end of 2022. ROA, the dependent variable, is the measurement of the profitability of a bank "i" at the time "t"; net income is chosen as a numerator instead of revenue to put a stricter measure on the data. During the research period, the average ROA is 5.52% with a standard deviation of 0.64% which implies that ROA is fairly distributed within samples. The summary suggests that the skewness lies within the distribution expected. The mean of the interest rate is 1.41% with a 1.7% standard deviation which indicates there are substantial deviations among selected periods.

The yield spread between 10-year bonds and 2-yr bonds, known as the yield curve slope, implies the market expectation of future economics. The slope tends to be positive as the 10-year bonds yield usually higher than the 2-year bond due to uncertainty in the longer future. The slope's average is 1.19% which indicates on average 10-year treasury bonds yield 1.19% higher than 2-year treasury bonds. The deviation within samples is considered moderate (0.89%). VIX index level is 2.73% on average, with a substantial deviation level of 25.1%. The mean of inflation and expected inflation are 2.77% and 1.92% respectively, which is less than a 1% difference of what the market would have expected the inflation rate to be in the respective year on average.

Only 0.88% of the total loan is non-performing on average, although the highest NPL ratio with the samples during the research years is 48.1%. Tier Capital 1 ratio on average, is at 10.17%, which is very impressive since the required Tier 1 capital ratio is 6% under the Basel3 regulation (Schneider et al, 2017). CTI ratio is 77.6% on average, with substantial volatility within samples. Finally, the Cash ratio is at 5.57% on average, with a very skewed distribution.

Table 3. Descriptive summary of regression variables from 2016 to 2021

Mean	2016	2017	2018	2019	2020	2021	2022
Std.Dev							
ROA	0.0058	0.0056	0.0054	0.0054	0.0054	0.0054	0.0055
	0.0059	0.0057	0.0061	0.0065	0.0061	0.007	0.0059
FFR	0.0038	0.0098	0.0182	0.0222	0.0043	0.0009	0.013

	0.0007	0.0023	0.003	0.0035	0.0063	0.0003	0.0119
Slope	0.0101	0.0098	0.0039	0.0018	0.0047	0.0113	0.0004
	0.0015	0.0018	0.0013	0.0005	0.0023	0.0023	0.0039
VIX	0.0593	-0.0644	0.1328	-0.1157	0.0659	0.0764	0.1495
	0.1959	0.0958	0.3947	0.1752	0.3462	0.2799	0.3835
GDP	0.0049	0.0069	0.0057	0.005	-0.0006	0.0135	0.0023
	0.0012	0.0023	0.0023	0.0102	0.0576	0.0053	0.0051
Inf	0.0274	0.0241	0.0293	0.0262	0.0264	0.0397	0.0649
	0.0067	0.0071	0.0075	0.0037	0.0077	0.0231	0.0035
ExpInf	0.0165	0.0187	0.0202	0.0181	0.0119	0.0181	0.0296
	0.0012	0.0016	0.0015	0.0024	0.0071	0.0028	0.0046
NPL	0.0089	0.0086	0.0089	0.0049	0.0085	0.0088	0.0092
	0.0147	0.0129	0.0139	0.0000	0.0138	0.016	0.0252
RegCap	0.1026	0.1002	0.0986	0.0999	0.0999	0.1010	0.1005
	0.0614	0.0613	0.0582	0.0585	0.0585	0.0603	0.0612
CTI	0.7651	0.7749	0.7828	0.7813	0.7844	0.7751	0.7803
	0.1848	0.1671	0.2097	0.2237	0.1714	0.1882	0.1882
Cash	0.0562	0.0558	0.0562	0.0567	0.058	0.0595	0.0577
	0.0538	0.0556	0.0552	0.0533	0.0582	0.0028	0.0583
Obs	1,733	1,858	1,857	1,885	1,918	1,906	1,827

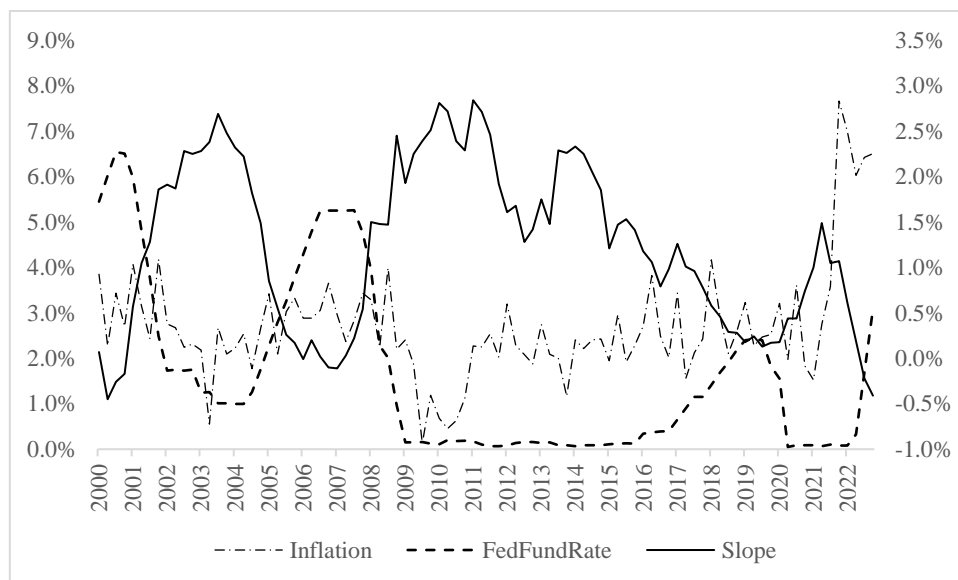
Source: The profitability analysis of U.S. commercial banks.dta

Table 3 provides a descriptive summary of each determinant and the dependent variable from 2016 to 2022 which allows us to observe the trend. The mean of ROA remains at the 5% level consistently, which is a surprise knowing there were drastic changes not only the U.S. economy but also in the global economy due to the pandemic.

In early 2000, the U.S. experienced the dotcom bubble and subsequent burst, which led to an economic downturn. The interest rate hike triggered the burst, and the Fed had to take a hawkish stance to calm the economy down from the excessive risky investment in the tech industry. In addition, the inflation rate was far above the Fed's target rate until Fed hiked the rate above 5% in 2004. As a result, the Fed slashed the interest rate to ease the economy until 2004. After the Dotcom bubble, the market moved its investment toward the housing market,

and the economy was expanding. In response to that, the Fed decided to increase the interest rate to restrain the excessive growth, which triggered another crisis, the financial crisis. Since then, the interest rate remained at zero level to support the damaged economy from the financial crisis until the Fed decided to increase it in December 2015 due to the aggressive growth in inflation, although the level was below the Fed's target. As of 17th of December 2015, the Fed started to increase the rate by 25bp nine times until 20th of December 2018. In 2019, due to the "trade war" between U.S. and China, the Fed decreased the rate by 25bps three times due to concerns that the economy might be harmed, which led to an increase in the unemployment rate. Then Covid-19 hit, the Fed slashed the interest rate to zero level once again to mitigate the damage.

Figure 1. U.S. inflation rate, the Fed Funds rate, and the yield spread from 2000 to 2023.



Source: FRED (Federal Reserve Economic Data.com)

The yield spread between 10-year bonds and 2-year bonds remained positive over the period, although the spread level got thinner, especially in 2019 and 2022, which implies the market has a less optimistic outlook on the future economy. The inverted yield curve, the 10-year U.S. treasury yield tops up the 2-year U.S. treasury bond, appeared in 2022. It has been an indicator of the recession for many years since seven times the yield curve appeared in the past 50 years, and every time, the recession hit the U.S. economy. On the 14th of August 2019, an inverted yield curve occurred which is the first time since the financial crisis. As Figure 1 shows, the yield curve has remained at a negative level currently since July 2022.

The VIX index is the most commonly used as a measurement of market volatility and market sentiment. The VIX index quantifies the volatility within ranges between 10 and 80, although it rarely goes over or below the range. The index, below 20, is considered as fairly low expected volatility in the current market, while any number above 30 is considered to expect substantial volatility. Table 3 indicates VIX index grows over time which implies the expected volatility is growing. In fact, on the 16th of March 2020, the VIX index reached 82.69% which is the highest since 2000 and even higher than the financial crisis time record.

The GDP growth level remained around 0.5% before Covid-19. In 2020, due to the combination of the pandemic and the tariff war against China, the GDP growth went below zero. Although, the economy made a swift recovery and managed to have an average of 1.3% of annual GDP growth rate in 2021.

The inflation trend shows a similar trend to the interest rate, which is logical since the Fed's dual mandates are price stability and maximum employment. Hence, the Fed targets to keep the inflation rate below 2%. From 2002 to 2003 and from 2008 to 2009, the U.S. experienced a very sharp drop in the inflation rate which is a result of the high level of the interest rate. The exponential increase in the rate in 2022 is caused by the pandemic. Meanwhile, the expected inflation rate was below the actual inflation rate over the period.

The bank-specific variables: Tier 1 capital ratio, Cost-to-income ratio, and Cash ratio, surprisingly show consistency in the level over the last decades. Not just the level of variables consistent over time, but also its standard deviation shows consistency which means despite all those crises: the financial crisis, the tariff war against China and the pandemic, etc., U.S. commercial banks managed to steadily maintain their regulatory variable and performance variables at a similar level.

3.2 Methodology

To ensure the stationarity of the data, the augmented Dickey fuller test is conducted on all variables to check the stationarity of the data set. Table 5 provides the p-value of the test, which implies that the data is stationary as the p-value is lower than 5%. This entails that it has constant mean and variance over time, which tells the reliability of the data.

For the panel data analysis, the GLS regression is utilized via Stata. By taking the GLS regression mode, the analysis is robust to heteroskedasticity, autocorrelation, and most

importantly, the GLS controls unobserved heterogeneities across the panel data. Fixed effects ("FE model") and Random effects ("RE model") models are two major panel data regression analysis models. The FE model controls for all time-invariant individual-specific effects, while the RE model assumes that the individual-specific effects are random and uncorrelated with the independent variables. The Wu-Hausman test is taken to determine which GLS regression model to be conducted for the regression analysis. The null hypothesis of the Hausman test assumes that the FE and RE estimators are both consistent and efficient and there is no correlation between the individual-specific effects and the independent variables. As Table 5 provides that as the p-value of the Hausman test is 0.023%, the null hypothesis is rejected due to the presence of a correlation between the individual-specific effects and the independent variables (Hausman,J.A.,1978). The GLS FE model is chosen to be the regression analysis model due to inconsistency of the RE model.

Table 4. Hausman test result

Variable	Coefficient		S.E
	F.E	S.E	
FFR	-0.000	-0.000	0.000
Slope	0.000	0.000	0.000
VIX	-0.000	-0.000	0.000
GDP	0.000	0.000	0.000
Inf	-0.002	-0.002	0.000
ExpInf	0.012	0.012	0.000
NPL	-0.112	-0.110	0.000
RegCap	0.024	0.024	0.000
CTI	-0.005	-0.005	0.000
Cash	0.008	0.008	0.000

Source: The profitability analysis of U.S. commercial banks.data

Moreover, the following tests are conducted to avoid autocorrelation and multicollinearity within the explanatory sample variables: the Durbin-Watson and Variance Inflation Factor ("VIF") tests.

Once the GLS model is determined, the Durbin-Watson test is conducted to detect autocorrelation between independent variables. As the result indicates in Table 5, no autocorrelation was found. Multicollinearity is assumed not to be present between the variables if VIF is less than one, while VIF of less than five is still considered acceptable but with the moderate presence of multicollinearity (Gujarati&Porter, 2009). Table 5 shows the level of VIF for each explanatory variable. Overall, the level of VIF remains at the acceptable range. Hence, the stability and robustness of the model are secured, which implies the credible estimated coefficient of the regression.

Table 5. Result of VIF and Augmented DF test for Multicollinearity and Autocorrelation

Independent Variable	VIF	ADF (P-value)
ROA		0.00
FFR	3.22	0.00
Slope	1.98	0.04
VIX	1.15	0.00
GDP	1.14	0.00
Inf	2.07	0.00
ExpInf	3.53	0.00
NPL	1.12	0.00
RegCap	1.07	0.00
CTI	1.17	0.00
Cash	1.02	0.00
AVG VIF	1.84	0.00

Source: The profitability analysis of the U.S. commercial banks.dta

3.3 Results & Implication

Table 6. GLS FE regression analysis model result

	Coefficient	Std. Err	95% Conf. Interval	
Constant	0.007***	0.001	0.005	0.009
FFR_t	-0.002	0.006	-0.013	0.009
$Slope_t$	-0.000	0.008	-0.015	0.015

VIX_t	-0.000	0.000	-0.0003	0.000
GDP_t	0.000	0.002	-0.003	0.004
Inf_t	-0.002	0.004	-0.009	0.005
$ExpInf_t$	0.012	0.011	-0.008	0.033
NPL_t	-0.11***	0.013	-0.137	-0.084
$RegCap_t$	0.024***	0.002	0.019	0.028
CTI_t	-0.005***	0.002	-0.009	-0.001
$Cash_t$	0.008***	0.002	0.004	0.013

Source: The profitability analysis of U.S. commercial banks.data

Standard errors are in parentheses. *, **, and *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

In Table 6, the GLS regression analysis suggests that there are no statistically significant macroeconomic variables on the dependent variable at any significance level while all bank-specific variables: NPL at time t, Tier 1 capital ratio at time t, and CTI ratio at time t, and Cash ratio at time t, are statistically significant at 1% level. Lastly, it is worth mentioning that the Tier 1 capital ratio and the Cash ratio are positively correlated to the profitability of banks. In contrast, the NPL ratio and the CTI ratio are negatively correlated.

Firstly, the NPL at time t has the -11% coefficient with a 1% significance level. This suggests that a 1% increase in the NPL ratio is correlated to a decrease in profitability by 11%, which is a very substantial impact. The NPL ratio implies how much of the loans are in default or overdue, suggesting that a higher NPL ratio is associated with a higher loss for banks. Furthermore, banks are required to set a provision for potential losses from their outstanding loans; the higher the NPL ratio implies that additional liquidity is set under the provision which could have been used for generating healthy profits. Thus, there are fewer loans to provide, which eventually leaves banks with less capital to make a profit from (Herring & Watcher, 1999). Moreover, if non-performing loans become unrecoverable, banks have to write off loans from their balance sheet, which indicates direct losses for banks.

Secondly, the CTI ratio measures the proportion of operation expenses to operating income. It shows how much banks cost to generate revenue. The paper finds that the CTI ratio at time t has a coefficient of -0.02% to the banks' profitability at time t. This result indicates that a 1% increase in the CTI ratio decreases the ROA at the current period by 0.05%. The result of the

regression aligns with our expectations of banks being less profitable when the cost of generating revenue is high (Koetter et al., 2009). Moreover, the indicator also indicates the cost control ability of banks, the higher ratio is, the bank is better at cost controlling which implies its efficiency. Hence, banks with the higher ratio compared to their peers, their financial stability and performance can only be better as they optimize usage of their deposits to generate revenue at less cost.

Moreover, the Tier 1 capital ratio has a 2.3% coefficient to the banks' profitability at time t , which implies a 1% increase in the Tier 1 capital ratio increases the banks' ROA by 2.4%. Tier 1 capital ratio represents the share of a bank's core equity capital, Tier 1 capital, to its risk-weighted assets. Under the Basel 3 establishments, banks are required to hold a Tier 1 capital ratio of at least 6% to its risk-weighted assets to provide puffer from external risks, so most of the time, the ratio represents banks' financial stability. On the other hand, holding excessive equity can imply that banks do not optimize their capital usage, which leads to a decrease in profitability (Lam, 2013). Furthermore, an excessively high Tier 1 capital ratio can signal to the market that the bank is very conservative or facing limited investment opportunities; either way, it doesn't offer a positive image to the market or external investors which could impact stock price negatively (Berge et al., 2000).

Lastly, the Cash ratio entails banks' ability to pay its short-term liability obligations and manage any potential liquidity risks (Ferouhi, 2014). Thus, this variable becomes one of the most important banks' financial health indicators during a crisis, as banks are most likely to face liquidity risks in a crisis. The ratio is positively correlated to the profitability at 1% statistically significant. A 1% increase in the ratio increases the profitability by 0.85%. This aligns with the explanation of the role of the Cash ratio in a crisis. Furthermore, the Cash ratio also provides flexibility to financing options to clients. This offers an opportunity to strengthen relationships with existing customers and the reputation of the bank which could build up a secure and stable image of the bank. This can be attractive to new customers, especially in time of crisis which directly leads to an increase in profitability.

With the finding of the regression model, our null hypothesis: *macroeconomic factors and bank-specific factors have a significant impact on the profitability of commercial banks* is rejected as only the bank-specific factors: NPL ratio, CTI ratio, Tier 1 capital ratio, and Cash ratio are found to be statistically significant to the U.S. commercial banks' profitability. During

times of crises, the importance of those bank-specific variables becomes more crucial as they are key indicator to judging banks' financial stability. The findings of the analysis are all connected to each other. Banks indeed have the higher Tier capital ratio and Cash ratio because they generate more revenue from having lower NPL ratio and more Cash on their hand from optimizing the cost. Moreover, if they control their costs efficiently, most likely that they are financial stable and set their provision ready for unexpected events which leads to increase in Tier 1 capital ratio.

In the following session, the paper conducts the impact of the independent variables on the profitability in different states of the market condition. The paper conducts the statistical significance of low-interest rates and historical crises on the profitability of the U.S. commercial banks by using the regression analysis model.

4. Further investigation of the research question

4.1 the impact of the low-interest rate on the profitability of the U.S. commercial banks

The empirical finding suggests that the short-term interest rate doesn't have a significant impact on the U.S. commercial banks' profitability despite its role in the financial industry and the nation's economy. Therefore, the paper takes further steps to investigate whether the low-interest rate influences the profitability of the U.S. commercial banks as it provides a favorable investment environment to the market: corporates and financial institutions. A dummy variable, Low-FFR, is replaced with the FFR variable. The low-FFR variable counts the interest rate below 2%, it could be a topic for a heated discussion which level of the interest rate is considered as low. In this paper, the rate below the 2% level is taken as the Fed target 2% of the inflation rate. The regression model is the following:

$$ROA_{i,t} = \alpha_i + \beta_1 * Low\ FFR_t + \beta_3 * Slope_{i,t} + \beta_4 * VIX_t + \beta_5 * GDP_t + \beta_6 * Inf_t + \beta_7 * ExpInf_{i,t} + \beta_8 * NPL_{i,t} + \beta_9 * RegCap_t + \beta_{10} * CTI_{i,t} + \beta_{11} * Cash_{i,t} + \varepsilon_{i,t}$$

Table 7. Description of variables in the regression model

Variables description	Notation	Definition
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<i>Macroeconomic variables</i>		
Short-term interest rate	Low FFR	<i>Fed Fund rate below 2%</i>
10yr and 2yr U.S. treasury bonds Spread	Slope	<i>10yr US treasury bond yield – 2yr Us treasury bond yield</i>
The stock market volatility	VIX	<i>CBOE Volatility Index *</i>
Real GDP growth	GDP	$\frac{Real\ GDP_t - Real\ GDP_{t-1}}{Real\ GDP_{t-1}}$
Inflation rate	Inf	<i>Consumer Price Index(CPI)</i>
Expected Inflation rate	Exp Inf	<i>1 year expected inflation rate</i>
<i>Bank-specific variables:</i>		
Return on Assets	ROA	$\frac{Net\ Income_t}{Total\ Assets_t}$
Non-performing Loan ratio	NPL	$\frac{Nonperforming\ Loans_t}{Total\ Loans_t}$
Regulatory Tier 1 capital ratio	Reg Cap	$\frac{Tier\ 1\ Capital_t}{Total\ Risk\ Weighted\ Asset_t}$
Cost-to-income ratio	CTI	$\frac{Total\ operating\ Expense_t}{Total\ operating\ Income_t}$
Cash-to-asset ratio	Cash	$\frac{Cash\ and\ Cash\ equivalents_t}{Total\ Assets_t}$

Source: The profitability analysis of U.S. commercial banks.data

Since the panel data analysis is conducted, the same methodology is applied to the regression model. The VIF and the Durbin -Watson test are undertaken to detect any multicollinearity and autocorrelation between variables. The level of VIF and the Durbin-Watson indicates that there is no multicollinearity and autocorrelation between explanatory variables. The Hausman test indicates there is a significant difference between the random effects and fixed effects models. Hence, the GLS FE model is conducted to quantify the impact of the low-interest rate on the profitability of U.S. commercial banks.

Table 8. The GLS regression fixed effects model result

	Coefficient	Std. Err	95% Conf. Interval	
Constant	0.007***	0.000	0.02	0.02
<i>Low FFR_t</i>	0.012	0.000	-0.000	0.000
<i>Slope_t</i>	0.000	0.004	-0.0069	0.011

VIX_t	-0.000	0.000	-0.0003	0.0001
GDP_t	0.000	0.002	-0.004	0.0035
Inf_t	-0.002	0.003	-0.007	0.0049
$ExpInf_t$	0.012	0.006	0.02	0.014
NPL_t	-0.112***	0.002	-0.054	-0.045
$RegCap_t$	0.024***	0.001	-0.0078	-0.0052
CTI_t	-0.005***	0.000	-0.018	-0.018
$Cash_t$	0.008***	0.001	-0.002	-0.005

Source: The profitability analysis of U.S. commercial banks.data
Standard errors are in parentheses. *, **, and *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

The empirical finding of the analysis aligns with the earlier finding of the paper. All bank-specific variables have a statistical significance at 1% level. No autocorrelation was found between explanatory variables. The analysis indicates that low-interest rate doesn't have any significant impact on the U.S. commercial banks' profitability. Hence, it can be concluded that the level of the interest rate doesn't influence the net margin of the U.S. commercial banks. In addition to the findings of the paper, there is an on-going debate on the significance of the low-interest rate on banks' profitability. Saunders and Schumacher (2000) found that monetary policies with a lowered interest rate could negatively impact the net margin of banks (net interest margin), and Berger & Bouwman (2009) also argue banks' profitability is negatively correlated to the low-interest rate due to decrease in the base rate, the Spread between banks' lending rates and deposit rate become narrower. Hence, there is still room to discuss whether changes in the interest rate influence commercial banks' profitability significantly.

4.2 the impact of Covid-19 & the financial crises on the profitability of the U.S. commercial banks

Furthermore, the paper examines the impact of the major crises on the profitability of the U.S commercial banks. There are a few giant events that marked their presence in the U.S history, such as the financial crisis in 2008 and Covid-19. The Dotcom bubble is also a well-known U.S crisis, but it is excluded because the research data period only begins from 2000, which doesn't fully capture the impact of the Dotcom bubble period. Moreover, the same

methodology is applied to the analysis (Dickey-Fuller test, Durbin Watson/VIF test for autocorrelation and multicollinearity, and the GLS FE model). The paper includes both Covid-19 and the financial crisis variable in the regression model because their time period doesn't overlap; there is no potential multicollinearity, and it provides a comprehensive overview of how different crises affect the dependent variable at the same time. Hence, the regression analysis model is the following:

$$ROA_{i,t} = \alpha_i + \beta_1 * FFR_t + \beta_3 * Slope_{i,t} + \beta_4 * VIX_t + \beta_5 * GDP_t + \beta_6 * Inf_t + \beta_7 * ExpInf_{i,t} + \beta_8 * NPL_{i,t} + \beta_9 * RegCap_t + \beta_{10} * CTI_{i,t} + \beta_{11} * Cash_{i,t} + \beta_{13} * Covid_i + \beta_{14} * FinancialCrisis_i + \varepsilon_{i,t}$$

Table 9. Description of variables in the regression model

Variables description	Notation	Definition
<i>Macroeconomic variables:</i>		
Short-term interest rate	FFR	<i>Fed Fund rate</i>
10yr and 2yr U.S. treasury bonds Spread	Slope	<i>10yr US treasury bond yield – 2yr Us treasury bond yield</i>
The stock market volatility	VIX	<i>CBOE Volatility Index *</i>
Real GDP growth	GDP	$\frac{Real\ GDP_t - Real\ GDP_{t-1}}{Real\ GDP_{t-1}}$
Inflation rate	Inf	<i>Consumer Price Index(CPI)</i>
Expected Inflation rate	Exp Inf	<i>1year expected inflation rate</i>
<i>Bank-specific variables:</i>		
Return on Assets	ROA	$\frac{Net\ Income_t}{Total\ Assets_t}$
Non-performing Loan ratio	NPL	$\frac{Nonperforming\ Loans_t}{Total\ Loans_t}$
Regulatory Tier 1 capital ratio	Reg Cap	$\frac{Tier\ 1\ Capital_t}{Total\ Risk\ Weighted\ Asset_t}$
Cost-to-income ratio	CTI	$\frac{Total\ operating\ Expense_t}{Total\ operating\ Income_t}$
Cash-to-asset ratio	Cash	$\frac{Cash\ and\ Cash\ equivalents_t}{Total\ Assets_t}$
<i>Crises:</i>		
The financial crisis	FinancialCrisis	<i>A dummy variable from 2007 to 2008</i>

The Covid-19

Covid

A dummy variable
from 2020 to 2022

Source: The profitability analysis of U.S. commercial banks.data

The financial crisis in 2008, also known as the great recession, lasted from December 2007 to June 2009 which was the longest economic downfall since World War II (Rich, 2013). As the housing market was accessible to people with very weak credit ratings, the U.S housing market supplied mortgages to very unstable demand. With the combination of subprime mortgages, which is a financial derivative product of the U.S financial market and the down-grading of MBS and CDOs valuation, the bubble burst. To measure the impact of the financial crisis, a dummy variable is created for years from 2008 to 2009.

On the 11th of March 2020, WHO officially declared the pandemic which is a bit late, knowing the first case was reported in December 2019 from China. After everyone's hard work, especially civil servants and hospital officials, Joe Biden, the U.S. president, announced the end of Covid-19 on the 11th of May, 2023 (CNN, 2023). Hence, the presence of Covid-19 is calculated from 2020 to 2023 which is the latest of the research period.

To capture the statistical significance impact of each crisis on the U.S commercial banks' profitability independently, the GLS regression is run separately for each crisis. By doing so, the paper is able to quantify the impact of each crisis on the dependent variable in isolation.

Table 10. The GLS regression fixed effects model result

	Coefficient	Std. Err	95% Conf. Interval	
Constant	0.007***	0.000	0.02	0.02
FFR_t	-0.004	0.003	-0.009	0.006
$Slope_t$	-0.004	0.006	-0.0069	0.011
VIX_t	-0.000	0.000	-0.0003	0.0001
GDP_t	0.000	0.002	-0.004	0.0035
Inf_t	0.000	0.003	-0.007	0.0049
$ExpInf_t$	0.009	0.009	0.02	0.014
NPL_t	-0.112***	0.002	-0.054	-0.045
$RegCap_t$	0.024***	0.000	-0.0078	-0.0052
CTI_t	-0.005***	0.000	-0.018	-0.018
$Cash_t$	0.008***	0.000	-0.002	-0.005

<i>Crisis</i>				
FinancialCrisis	-0.000**	0.000	-0.000	0.000
Covid	-0.000*	0.000	-0.000	-0.000

Source: The profitability analysis of U.S. commercial banks.data
Standard errors are in parentheses. *, **, and *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

The paper finds both crises have a significant impact on the U.S commercial banks' profitability. Obviously, both are negatively correlated to the profitability. With the presence of the financial crisis, banks' profitability is decreased by 0.28% while Covid-19 decreases the profitability by 0.2%.

After the financial crisis, lack of transparency and weak regulations are named one of the major factors to cause the crisis; regulatory authorities implemented various regulations to enhance financial stability and enforce financial institutions to set their buffer: Basel III Framework by Basel Committee on Banking Supervision which increased capital buffers, stronger liquidity requirements, and measurements to address banks' financial stability, Dood-Frank Act (2010) was implemented by former U.S. president, Barack Obama, which is aimed to confront systemic risk, increase transparency in the financial industry, regulate OTC (over the counter) derivatives market and etc.

The finding on the impact of Covid-19 on the profitability of the U.S commercial banks aligns with the expectation, knowing that the crisis fastens the recession process in most nations in the world by business closures, reduced consumer spending, job losses and pressured demand for investments. This puts numerous loans to default risk which eventually damages banks' profitability. Furthermore, the Fed lowered interest rates to near-zero level in response to the pandemic to support the economy which squeezed banks' net interest margins. Hence, the pandemic provided challenging conditions to banks to maintain profitability (Federal Reserve, 2020). Other existing papers such as Classens and others (2020), they found that due to an economic downturn, it may have led to an increase in loan delinquencies and defaults, leading to higher loan loss provisions and negatively impacting banks' profitability.

5. Conclusion

In conclusion, this paper conducts a regression analysis to investigate the impact of the selected macroeconomic factors and bank-specific factors on the profitability of commercial

banks from early 2000 to 2022. It is worth noting that "Monetary Policy and bank profitability in a low-interest rate environment" by Altavilla, Carlo, and others (2017) provided the fundamental background of the regression analysis. Although Altavilla and others (2018) conducted research on European banks from early 2000 to 2015 while the research paper extended the period to 2022 and investigated U.S. commercial banks. Since the chosen research period is extensive, the paper is able to capture the statistical impact of each independent variable on the profitability of commercial banks during the crises, which provides extensive insights to understand the effects of macroeconomic and bank-specific factors on the U.S. banks.

Our empirical finding of the paper suggests all bank-specific variables: NPL ratio, CTI ratio, Tier 1 capital ratio, and Cash ratio, have a statistically significant influence on banks' profitability at 1%, which aligns with the expectation as they are key financial indicators for both banks' performance and regulatory obligation. NPL ratio and CTI ratio, performance variables, are negatively correlated to the profitability of the U.S. commercial banks, while the Tier 1 capital ratio and the Cash ratio are positively related to the profitability. In addition to our main findings, the paper finds that the low-interest rate is statistically insignificant to the profitability of the U.S. commercial banks. Meanwhile, the financial crisis and Covid-19 negatively impact the profitability of banks.

For future related research papers on this topic, there are a few limitations that this paper faces that can be improved. Firstly, since the regression analysis is based on the existing paper (Altavilla, Carlo, and others, 2017), which has taken European banks as their target sample, the selected independent variables might not fully reflect the characteristics of the U.S. commercial banks. Hence, it is recommended to include independent variables which reflect the difference between U.S. banks and European banks. Secondly, the sample of the research only covers the U.S. commercial banks. It is strongly recommended to expand its target samples to other nations to further deepen the knowledge of banks' profitability. Lastly, as the paper only covers the U.S. banks, the empirical findings of sub-topics are also limited to the U.S. Although, Covid-19 and the financial crisis of 2008 didn't only impact the U.S. economy but also globally. Hence, the paper advises expanding its target samples to compare the impact of the historical crises across nations.

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