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The effect of the interest rate on the profitability of banks

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Abstract

The aim of this research is to study the effect of the interest rate on the profitability of banks. In order to study this effect, a panel data set has been constructed after which panel data analysis has been performed. Multiple hypotheses are tested while keeping into account the size of a bank and multiple macroeconomic factors. The results show that there is a significant positive effect of the interest rate on the net interest margins of banks. A positive significant effect of the net interest margins on the net interest income is also found. No significant effect of the interest rate on the non-interest income was found however. Finally, a significant positive effect of the interest rate on the profitability of banks is found. Combining these findings, I conclude that the interest rate has a significant positive effect on the profitability of banks.

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1.0 - Introduction

It has been almost three years since the Covid-19 pandemic shut down most economies. In an attempt to weaken the devastating impact this has on one's economy, the US Federal Reserve had lowered the federal funds rate to zero. This in combination with the expansionary fiscal policy has led to trillions of US dollars being poured into the economy according to the Committee for a Responsible Federal Budget. The result? An economy that managed to stay afloat but is now being crippled by high inflation rates. To fight this inflation, the Federal Reserve announced multiple federal funds rate increases. An announcement that is immediately felt within the whole financial world, with the banking sector in particular. With the recent failure of two large US banks, one starts to wonder how this affects banks' profitability, keeping their ever ongoing search for yield in mind.

According to the Federal Reserve Economic Data (FRED), US commercial and savings banks saw their net interest margin decrease during the low interest rate environment of the past years. The net interest margin compares the earnings of banks' interest on loans to the costs of banks' interest on deposits. Following the Great Recession, Bikker and Vervliet (2017) have studied the effect of low interest rates on bank profitability and risk-taking. They found that banks were, in times of low interest rates, able to maintain their profits in return for a smaller buffer against credit losses. Their research did confirm that in a low interest rate environment, a banks' net interest margin is compressed. Claessens, Coleman and Donnelly (2017) found similar results. Their research shows that low interest rates have a significantly greater impact on the net interest margins of banks than high interest rates do. The found effects on profitability were less strong. According to Claessens et al. (2017) this indicates that banks may be able to hedge themselves against the impact from low interest rates on overall profitability. Borio, Gambacorta and Hofmann (2017) found that the impact of the expansionary monetary policy that followed the Great Recession on banks' profitability was positive in the first two years post-crisis. However, the impact turned negative in the following four-years. This finding indicates that for banks, a low interest rate for a prolonged period of time may be more difficult to hedge against. This finding is interesting to keep in mind when studying the effects of the current raises of interest rates on banks' profitability while including data from recent years.

Despite the previous literature, no study has yet looked at the effect of interest rates on US banks' profitability using data of recent years. This study adds to existing literature by studying a unique time period. The time period to be studied has seen the interest rates sit at levels close to zero percent twice in a relatively short amount of time. This unique low interest rate environment must have had some effect on how banks operate. Additionally, now that the FED has started increasing the interest rates, I suspect that banks have had to deal with both very low net interest margins as well as rapidly increasing net interest margins in a relatively short time frame. Due to this suspicion, I expect the findings of this research to differ from previous literature. For instance, as a result of the expansionary fiscal- and

monetary policy during the Covid-19 crisis, banks currently have an abundance of deposits. Despite increasing rates on loans and mortgages, customers have not experienced the same increases in interest rates on their deposits, meaning that banks have seen the spread between interest earned and interest paid widen. It is well known that net interest margins are an important component of bank profitability. I shall therefore study the effect of interest rates on US banks' net interest margins. Borio, Gambacorta and Hofmann (2017) find that an increase in the short-term interest rate leads to higher net interest income due to the net interest margins increasing. However, higher net interest income does not automatically lead to higher profitability. Previous literature, such as the study by Altavilla, Boucinha and Peydró (2018), suggests that despite increasing net interest margins (with higher net interest income as a result) may not increase profits as much as one may expect. The relation between the net interest margins and net interest income shall therefore be studied, in order to examine the magnitude and significance of the effect between the net interest margin and net interest income.

The findings of Altavilla, Boucinha and Peydró (2018) additionally suggest that the effect of increasing net interest margins on profitability may be attenuated by non-interest income and loan loss provisions. Nguyen (2012) even finds that in one of the two observed periods, the non-interest income has a negative effect on the net interest margins. However, in a subsequent observation period, the non-interest income did not increase at the detriment of the net interest margins. This may indicate that in some periods, banks see their net interest margins decrease and decide to focus more of their efforts on non-interest earning activities to make up for the decreasing net interest margins. Additionally, in better times, where net interest margins are either stable or increasing, banks may see their non-interest income increase due to increasing demand for financial services (which increase fee- and other non-interest income earnings). To consider the effect of non-interest income on profitability, the effect of interest rate changes on the non-interest income of banks will be studied.

The observation period has seen multiple interest rate hikes and cuts in a relatively short time span. This is therefore an interesting observation period as banks may find it difficult to adapt to this volatile interest rate environment. Additionally, in the past few years the United States have seen periods of economic growth, as well as economic decline (due to the Covid-19 crisis). The effect of interest rates on US banks' profitability will be studied while taking into account some of the macroeconomic factors such as GDP growth and inflation.

This effect will be studied by performing a longitudinal regression analysis with profitability as the dependent variable. A panel data set will be constructed using secondary data. The sample period will include data from the first quarter of 2015 till and including the first quarter of 2023. This observation period has been chosen in order to catch the effects of multiple interest rate changes in a relatively small time frame. Data on all publicly listed commercial banks in the U.S. will be obtained from the Compustat

Bank Fundamentals Quarterly provided by the S&P Global Market Intelligence. This database is a sub database within the Wharton Research Data Services (WRDS) database.

The main objective of this study is to explain banks' profitability. The return on assets (ROA) and return on equity (ROE) will be used as proxies for banking profitability. The main variables of interest are therefore the interest rate, the ROA and the ROE. For the rest of this paper, when the interest rate is mentioned, I will be referring to the Effective Federal Funds Rate (EFFR). Data on the EFFR will be obtained from the Federal Reserve Economic Data (FRED) database. This rate is calculated on a volume-weighted median of overnight federal funds transactions according to the Federal Reserve. The effect of GDP growth and the inflation rate will also be considered. Data on these macroeconomic factors will also be obtained from the FRED database.

Based on previous literature I expect to find that an increase in interest rates leads to an increase in profitability of banks. A probable cause of an increase in profitability will be the decompression of the net interest margin which influences the overall profitability of banks. This means that I expect the net interest margin to increase when interest rates increase. Additionally, because I expect the net interest margins to increase when interest rates increase, I also expect the net interest income of banks to increase. At last, I expect the non-interest income of banks to increase when the interest rate is decreased due to an increase in demand for financial services.

This research adds to existing literature by including data from recent years, allowing us to study the effects of a volatile interest rate environment. Additionally, the Covid-19 crisis adds to the volatility of both the interest rate environment as well as the macroeconomic factors that are taken into account. The findings of this research may therefore help banks deal with a volatile interest rate, further adding to their repertoire in dealing with difficult situations. Additionally, governments may take note of this research when determining their monetary policies, both in good times and in bad times.

2.0 - Theoretical Framework

The following section will discuss various important topics as well as the relationships between them. This section starts off by discussing the interest rate. Next, banking profitability, components of banking income and the relationships with the interest rate are discussed. Finally, macro-economic factors and various other relationships are assessed.

2.1 – Interest rate

The short-term interest rate is set by the Federal Reserve (FED) with the purpose of pursuing three goals which combined are the FED's statutory mandate. The goals are to obtain maximum employment, keep price levels stable and to moderate long-term interest rates. Due to sky-rocketing inflation rates following the Covid-19 pandemic and the ongoing war in Ukraine, the FED has decided to raise interest

rates in an attempt to cool down the economy. Adjusting the interest rate is, however, an all-encompassing method.

This interest rate is therefore closely watched by many. It influences longer term interest rates for consumers who take out loans, mortgages and deposit their money at banks. The bond- and stock markets are affected as the interest rate can influence the amount of money going in or out of the economy. The interest rate has an effect on the general consensus about the future of the economy. With an endless list of people, markets and activities being affected by the interest rate, it is no wonder that the effects of adjustments to the short-term interest rate have been studied extensively.

The goal of this paper, however, is to study the effects of the interest rates on banking profitability. Increasing interest rates are generally believed to be good for banks. Increasing interest rates make borrowing more expensive for banks. However, lending to customers becomes more profitable as higher rates can be asked. A widening of the spread between the interest rates banks charge their customers and the rates they have to pay themselves, a net interest margin expansion, leads to higher net interest income according to the literature. Higher net interest income in turn can lead to higher profits. The interest rate also affects the values of banks' investments and securities. The main channel through which the interest rate influences bank profitability is, however, through the mentioned increase of the net interest margins. Additionally, the interest rate may also influence the demand for financial services, further affecting the channels through which a bank generates its profits. Net interest income (and the net interest margins which are at the basis of this sort of income) and non-interest income shall be discussed in the following section.

The interest rate is, therefore, of significant importance for banks. Banks have to pay close attention to the interest rate as the profitability of their maturity transformation activities and other investment activities heavily rely on the interest rate. This subject is, therefore, both interesting and important as banks play an important role in financial stability. An important role that cannot be fulfilled if the banking sector is not 'sound' due to profitability issues that may or may not arise from monetary policy.

2.2 – Banking profitability

Banking profitability can be defined in multiple ways. In this paper, the return on assets (ROA) and return on equity (ROE) will be used as proxies for banking profitability. Both the ROA and ROE are financial ratios that are widely used to assess the performance of companies and financial institutions. The main determinants of banking profitability are net interest income (NII), non-interest income (NNII) and loan-loss provisioning (LLP). In this section, the main determinants of banking profitability shall be further discussed.

2.2.1 - Net Interest Income

The net interest income is the difference between revenues on interest-bearing assets minus the costs from interest-bearing liabilities. The revenues originate from interest earned on loans, mortgages and other lending activities. The incurred costs arise from interest being paid to depositors and the interest banks have to pay in order to borrow funds. The net interest income is a significant part of a banks' income. A measurement often discussed in the relevant literature is the net interest margin (NIM). The NIM is calculated by dividing the net interest income by the average earning assets.

Following the Global Financial Crisis, the FED lowered the interest rates to stimulate the economy. For banks this meant an enhancement of their balance sheet, a reduction of non-performing loans, capital gains and increasing asset prices. However, recent literature has shown that lowering the interest rates has a negative effect on a banks' NIMs. Claessens, Coleman and Donnelly (2017) find that lowering the interest rate has a negative effect on banks' NIMs because the interest income diminishes more rapidly than the interest expenses. This effect may be caused by banks' reluctance to decrease interest rates for depositors as this may have the depositors start looking for higher yield alternatives. Banks are additionally limited by the zero lower bound.

Despite these limitations, interest rates on deposits have been close to zero for an extended period of time. According to the FED, the average savings account pays an interest rate on deposits that is close to zero percent while the rate has consistently gone up since the Covid-19 crisis. A reason for this can be the abundance of deposits banks currently have, meaning that there is little incentive to increase interest rates on deposits in order to attract more deposits. Examining U.S. commercial banks deposits data obtained from the Federal Reserve Economic Data database, shows that the value of deposits was at an all-time high in 2022. Although the low interest rates on deposits may be a special case due to the expansionary fiscal- and monetary policy of recent years, they do tell us something about the interest rate spread. If the short-term interest rate increases at a quicker rate than the interest rate on deposits, the interest rate spread widens which in turn leads to higher NIMs. Borio, Gambacorta and Hofmann (2017) find that an increase in the short-term interest rates leads to higher net interest income for banks due to the NIMs increasing. Cruz-García, Fernández de Guevara and Maudos (2017) find similar results. In their research a quadratic effect between the interest rates and NIMs was found, meaning that the lower the interest rates get, the more severe their effect on the NIMs.

Increasing NIMs due to higher interest rates lead us to believe that banks will see their profits increase as well. However, Altavilla, Boucinha and Peydró (2018) find that while increasing interest rates do increase NIMs, the overall profitability boost may not be as significant as other research may suggest. In their research they study the effects of monetary policy on banking profitability while controlling for future economic conditions. They find that while low interest rates do lower the NIMs, the effect on banking profitability is largely offset by decreasing loan-loss provisioning and increasing non-interest

income. Only if the rates stay low for an extended period of time may banking profitability be affected. However, they suggest that increasing real economic activity due to the expansionary monetary policy once again offsets this negative effect.

2.2.2 - Non-interest Income

Any income that is not coming from a bank's maturity transformation business or investing activities is considered as non-interest income. Non-interest income for banks mainly comes from the fees banks charge their customers. Think of transaction fees and account service fees. The composition of the non-interest income will differ per bank however. Fee-based income derived from aiding in mergers and acquisitions is also included in the non-interest income of banks. But, not all banks participate in facilitating mergers and acquisitions. Additionally, the size of a bank will also affect the total non-interest income. A large bank will most likely handle more transactions than a small bank meaning that more non-interest income is earned from transaction fees. On the other hand, large banks may experience economies of scale which allows the larger banks to lower their transaction fees in order to enhance their competitive position. The variance in non-interest income may therefore be explained by bank size, but also by the non-interest income earning activities a bank engages in.

According to the Minneapolis FED, both large- and small banks have seen their non-interest income as a percentage of total income double since 1980. This can mean that banks have started shifting more of their business activities towards fee-oriented activities. The ongoing rise of digital banking may be causing this increasing non-interest income trend. If non-interest income starts becoming a larger source of income for banks, this may reduce their exposure to the risk that comes with interest income-earning activities.

Smith, Staikouras and Wood (2003) show that non-interest income has indeed become increasingly important relative to interest income. They find that for European banks, non-interest income is more volatile than interest income, but seems to play a stabilising role when looking at the total operating income. Banks might be looking at non-interest generating activities to compensate for lower interest income during periods of low interest rates. Lee, Yang and Chang (2013) find that for Asian banks, non-interest income is of significant importance in reducing exposure to risk. However, their results also show that non-interest income does not play a significant role in increasing profits.

There seems to be no consensus regarding the effects of non-interest income on profitability and risk yet. The study by Delpachitra and Lester (2013) suggests that Australian banks have actually taken the diversifying of their revenue streams too far. Their results indicate that if the banks would try to diversify even more by trying to increase the non-interest income share, their profits would stagnate and their risk of defaulting would increase. Maudos (2017) has studied the income structure of European banks during and after the 2007-2011 financial crisis. Maudos shows that banks with more diversified streams of income are at higher risk than banks with more traditional sources of income. Additionally, the volatility

of profitability of banks with mostly traditional income-earning activities was found to increase when those banks diversified their sources of income. Non-interest income may not be so stabilising after all.

Although non-interest income earning activities may become more interesting when interest rates are low, there is no consensus regarding their effects on profitability and risk yet. Non-interest income will therefore be included in this research, as previous data and literature has shown that it is at least becoming increasingly important relative to interest income.

2.2.3 - Loan loss provisions

The third main determinant of profitability is loan loss provisioning. Loan loss provisions are accounting entries on a bank's financial statements. These entries account for possible loss on uncollectable loans or loans that decline in value. The value of the loan loss provision presented on the financial statement is usually deducted from the total value of a bank's loan portfolio.

Loan loss provisions are subject to accounting- and other regulatory standards due to the fact that their goal is to improve the accuracy of a financial institution its financial health assessment. Additionally, loan loss provisions should ensure that banks keep sufficient reserves in order to absorb potential losses.

Loan loss provisions, among other things, have been used by banks for income smoothing. Income smoothing allows for banks to report more stable earnings, signalling that the bank is stable and financially healthy. Previous studies such as the one by Ma (1988) have indeed confirmed that US commercial banks often used loan loss provisions to smooth their earnings. This was achieved by increasing loan loss provisions in good times and decreasing loan loss provisions in bad times. This led to a 'smoothing' of the earnings trend by dampening the high earnings in good times and the low earnings in bad times.

Following the great financial crisis, accounting standards have been revamped and changes have been implemented in order to improve the transparency, accuracy and comparability of the financial statements. Loan loss provisions can therefore not be used for income smoothing (and possible financial health manipulation) as easily before.

The aim of this research is to study the effect of the interest rate on the profitability of banks, without taking into account the credit risk management done by banks. Since I deem loan loss provisioning to be more related to credit risk management than to income and profitability, loan loss provisioning shall not be further discussed.

2.3 Macro-economic factors

2.3.1 Inflation

Inflation has always been an extensively studied topic. The International Monetary Fund defines inflation as "*the rate of increase in prices over a given period of time. Inflation is typically a broad*

measure, such as the overall increase in prices or the increase in the cost of living in a country" (Oner, 2019). The inflation rate has an impact on numerous economic factors, as well as on the overall economic stability. Following the Covid-19 crisis and the ongoing war in Ukraine, prices have skyrocketed with huge implications as a result. Due to the value erosion of fixed-income securities, increasing costs and numerous other affected aspects, banks are also wary of high inflation rates.

An important implication of the inflation rate is the negative relationship between rates of inflation and real economic activity. Barro (1995) finds evidence that for all rates of inflation, a negative relationship between the inflation rate and real economic activity exists. However, there is no clear consensus yet, as other studies, such as the study by Bruno and Easterly (1998), suggest that this relationship only exists when a certain inflation rate threshold is exceeded. Nonetheless, there does seem to be a negative relationship between the inflation rate and real economic activity. Decreasing or stagnating real economic activity can influence the demand for- and quality of loans. Huybens and Smith (1999) find a positive relationship between bank lending activities and real economic activity while at the same time finding a negative relationship between the inflation rate and real economic activity. This suggests that decreasing real economic activity due to high inflation rates will also negatively affect bank lending activities. This is in line with the findings of Boyd, Levine and Smith (2001), who find a strong negative correlation between bank lending activities and the inflation rate inflation for countries with low-to-moderate rates of inflation. Inflation therefore seems to hinder lending activities, which is the primary source of income for most banks.

Inflation can also erode the net interest income of banks due to asset maturity mismatches and rising interest expenses. Additionally, inflation erodes purchasing power of borrowers, increasing default risk and forcing banks to increase their loan loss provisions. Boyd and Champ (2006) find that even for modest inflation rates, the real net interest margins (the net interest margins adjusted for inflation) of banks decrease.

Despite the numerous ways in which inflation can have a negative effect on the activities and profitability of banks, there are also channels through which banks can profit from increasing rates of inflation. High rates of inflation may increase the demand for loans. Borrowers may decide to invest before prices increase even further. This can in turn counter the previously mentioned effect of the inflation rate on lending activities. Additionally, banks' asset portfolios may experience an increase in value due to rising asset prices.

2.3.2 - GDP Growth

The GDP growth rate is yet another extensively studied topic. The GDP growth rate serves as an important indicator of an economy's growth, performance and overall health. This indicator gives insights into the levels of investment, levels of consumption and the overall business cycle. The World

Bank defines the (annual) GDP growth rate as the "*(annual) percentage growth rate of the gross domestic product at market prices based on constant local currency".*

Banks can benefit from a growing economy in numerous ways. Growing economies typically see an increase in economic activity and investments. The money needed for these investments can come in the form of loans, which means that loan demand increases during periods of economic prosperity. Due to the increasing amount of outstanding loans, the interest income of banks may increase. Banks may also see their non-interest income increase due to an increasing demand for financial services. Petria, Capraru and Ihnatov (2015) find evidence that GDP growth has a significant positive effect on the profitability of European banks. These findings are in line with the notion that banks benefit from a growing economy due to an increase in the demand for their lending- and financial services. However, the literature seems to be somewhat inconclusive about the sign of the effect, as Staikouras and Wood (2004) found GDP growth to have a negative effect on the profitability of European banks. The effect of a growing economy on the profitability of banks may also differ depending on other aspects. Tan and Floros (2012) find that for Chinese banks, a higher GDP growth actually leads to lower bank profitability. This may be explained by differences in the system of government and/or market structure, although this finding does add to the inconclusiveness relating to the effect between GDP growth and banking profitability.

3.0 - Research question and hypotheses

The aim of this paper is to study the effect of the interest rate on the profitability of banks. This is an important topic to be studied since a healthy banking system is crucial for a well-functioning financial system. Studying the effects of the interest rate on banking profitability can help banks in preparing themselves for future interest rate changes. Due to the fact that setting the fed funds rate is the primary policy instrument of the FED, results of this study may also help policy makers in determining the optimal monetary policy. The research question of this paper will therefore be as follows:

What is the effect of interest rate hikes and cuts on the profitability of commercial banks in the United States?

A substantial amount of studies have tried to examine and estimate the effect of the interest rate on banking profitability. However, not all research is inconclusive about the effect of the interest rate on banking profitability. Bikker and Vervliet (2017) found that banks were able to maintain their overall profits despite times of low interest rates. However, their research did confirm that in a low interest rate environment, a bank's net interest margin is compressed. According to Claessens, Coleman and Donnelly (2017), this effect is due to the interest income diminishing more rapidly than the interest expenses. Despite the result that banks were able to maintain profits, I expect the profitability of banks to decrease due to the compressed net interest margin. However, before I can say that a decrease in

profitability is due to compressed net interest margins (and vice versa) the effect of interest rate hikes and cuts on the net interest margins should be assessed first:

H1: An interest rate hike increases the net interest margin of US commercial banks

Increasing net interest margins leads to higher net interest income for banks according to the literature. Previous research, such as the study by Borio, Gambacorta and Hofmann (2017), finds that an increase in short-term interest rates (set by the FED) leads to higher net interest income for banks due to the net interest margins increasing. This may be explained by the increasing spread between rates paid on deposits versus the rates banks charge their customers. The expansionary fiscal- and monetary policy during the Covid-19 crisis lead to an abundance of deposits meaning that banks are not looking to lower their rates on deposits in order to attract more deposits (see Section 2.2.1). Increasing rates on loans and mortgages combined with low rates on deposits is therefore bound to increase net interest margins and as a result, the net interest income of banks. Since the net interest income plays a significant role in the total income of a bank, it may sound reasonable to assume that increasing net interest income leads to higher profitability. However, the relationship may not be that simple. A study done by Altavilla, Boucinha and Peydró (2018) finds that increasing net interest margins (with, according to related literature, higher net interest income as a result) may not increase profits as much as one may expect. They find that the increase in profits due to net interest margins increasing is largely offset by increasing loan-loss provisions and a decrease in non-interest income. Assessing the impact the net interest margins have on the net interest income of banks can help us further understand the relationship between the interest rates and the profitability of banks. The significance and magnitude of the relationship between the net interest margins and the net interest income will therefore be studied:

H2: An increase of the net interest margins leads to higher net interest income for banks

Non-interest income has been found to play an increasingly important role for both banking profitability as well as risk reduction. According to Altavilla, Boucinha and Peydró (2018), non-interest income attenuates (together with loan loss provisions) the effect of net interest margins (NIMs) on profitability. Nguyen (2012) even finds that non-interest income has a negative impact on the NIM in a first subperiod, suggesting that banks may see increasing non-interest income at the expense of their NIMs. However, the results for a subsequent subperiod suggest that the non-interest income does not increase at the detriment of the NIM. There does seem to be an interesting relationship between the net interest margin and non-interest income.

However, the share of non-interest income is relatively small compared to that of the interest income. But, there does seem to be an increasing trend in the importance of non-interest income. According to the Minneapolis FED, banks have seen their non-interest income as a percentage of total income double since 1980. Banks may decide to allocate more of their efforts towards non-interest income earning activities, especially in times of low interest rates. Considering the growing importance of non-interest

income and the increasing scholarly interest, I find it important to study the effect of the interest rate on non-interest income. In doing so, the magnitude and significance of the interest rate on the profitability of banks can be explained more thoroughly.

H3: Interest rate cuts have a positive effect on the non-interest income of banks

Utilizing the findings of the aforementioned hypotheses combined with the results of the panel data analysis, I expect to be able to formulate a clear and comprehensive answer to the research question. The methodology and data sections, by means of which I am studying the effects of interest rate hikes and cuts on the profitability of US commercial banks, shall be discussed next.

4.0 – Data

This paper aims to study the effects of the interest rate set by the FED on banking profitability. I therefore require quarterly data on the effective federal funds rate and a variable that indicates banking profitability. In this paper I will be using the return on assets (ROA) and return on equity (ROE) of banks as proxies for banking profitability. Since bank assets for a large part consist of loans, I expect this variable to be a good proxy for banking profitability. Additionally, the return on equity (ROE) shall also be used as a proxy for banking profitability as this will improve the robustness of the results of this research. Both ROA and ROE are financial ratios that are widely used to examine the performance of companies and financial institutions. These proxies for banking profitability shall be further discussed in Section 5.2.

Furthermore, I will control for some macroeconomic factors such as GDP growth and inflation. Due to the findings of previous research, I consider it important to include GDP growth and inflation as control variables in my analysis. In this paper I will be using quarterly data on the annual inflation rate. To include GDP growth in my research I will be using quarterly data on the annual GDP growth.

The quarterly data on the effective federal funds rate will be obtained from the Federal Reserve Economic Data (FRED). The FRED is a comprehensive database maintained by the Federal Reserve Bank of St. Louis which contains a wide range of economic data over an extensive period. Data on the GDP growth rate and inflation rate will also be obtained from the FRED.

To capture banking profitability, data on the return on assets (ROA) and the return on equity (ROE) will be obtained using data from Wharton Research Data Services (WRDS). WRDS is a comprehensive database which combines financial, economic, and marketing data from multiple sources. To obtain the necessary data, I will be using the sub database called Compustat Bank Fundamentals Quarterly provided by the S&P Global Market Intelligence.

Additionally, WRDS will be used to obtain quarterly data on the net interest income, non-interest income, and net interest margins of banks. The Compustat Bank Fundamentals Quarterly database

allows me to obtain this data for 752 banks. Due to only data being available for publicly listed banks, the sample will contain 752 banks instead of all insured US commercial banks. After getting rid of banks with missing data, 362 banks remained in the data set. Quarterly data on the ROA and ROE is not directly available from this database. However, the ROA and ROE can be calculated using the to be discussed formulas and the available data on net income, total assets and total equity.

In addition to the mentioned variables, I will also control for bank size using a categorical variable. The banks will be sorted into three different categories based on the value of their total assets. Banks that have a hundred billion or more in total assets will be labelled 'Large' banks. Banks with total asset values between a hundred billion and ten billion will be labelled 'Medium' banks while banks with less than ten billion in total assets will be labelled as 'Small' banks.

The size of a bank can have a significant impact on the financial and operational aspects of a bank. Larger banks have more assets to potentially generate earnings with. Larger banks may also experience increasing returns to scale. This is in line with the research of Wheelock and Wilson (2012) who find that since 2006, most US banks experienced increasing returns to scale. Previous literature suggests that larger banks may take less risk than smaller banks. Khan, Scheule and Wu (2016) for instance, find that larger banks, with more deposits, take less risk than smaller banks due to decreasing funding liquidity risk. These impacts on aspects of banks, among others, convince me that size should be included as a control variable in my analysis.

Table 4.0 Description of variables

Concept	Variable	Operationalization	Database	Description
Monetary policy	Short term interest rate (InterestRate)	Volume-weighted median of overnight federal funds transactions	Federal Reserve Economic Data (FRED)	The weighted average for all overnight transactions between depository institutions
Financial performance	Return on assets (ROA)	Net income / Total assets	WRDS Compustat Bank Fundamentals Quarterly	A financial performance ratio that indicates how effective the assets are used to generate earnings
	Return on equity (ROE)	Net income / Total stockholders' equity	WRDS Compustat Bank Fundamentals Quarterly	A financial performance ratio that indicates how effective the equity is used to generate earnings
	Net interest margin (NIM)	(Interest revenue – Interest expense) / average earning assets	WRDS Compustat Bank Fundamentals Quarterly	A performance measurement for investment activities
Income	Net interest income (NII)	Interest revenue – Interest expense	WRDS Compustat Bank Fundamentals Quarterly	The difference between interest earnings and the interest expenses
	Non-interest income (NNII)	Total revenue – Interest revenue	WRDS Compustat Bank Fundamentals Quarterly	All income that is not interest income
Macro-economic variables	Inflation rate (Inflation)	(Old CPI / Present CPI) x100%	Federal Reserve Economic Data (FRED)	Percentage change in the cost of the CPI basket of goods and services
	GDP growth rate (GDPGrowth)	(Old GDP growth rate / Present GDP growth rate) x100%	Federal Reserve Economic Data (FRED)	The growth rate of the market value of goods and services produced
Categorical variables	Bank size (Size)	Based on total assets Large if assets > 100B Medium if 10B < assets < 100B Small if assets < 10B	WRDS Compustat Bank Fundamentals Quarterly	Based on total assets. Bank sizes are generally categorized into three categories: large, medium and small banks.

5.0 – Methodology

The main objective of this paper is to study the effects of the interest rate set by the FED on the profitability of commercial banks in the United States of America. In order to study these effects, a panel data set has been obtained from Wharton Research Data Services. The following section will start off with descriptive statistics. Then the panel data models will be presented after which I will describe the intended method to analyse this panel data.

5.1 – Descriptive statistics

In this section, the descriptive statistics as well as the size distribution of the banks in my sample are presented. The descriptive statistics can be found in Table 5.1, while the distribution of bank size can be found in Table 5.2.

Table 5.1 Descriptive statistics

Variable	**Obs.**	**Mean**	**Std.Dev.**	**Min**	**Max**
NI	11871	93.65	635.19	-3846	14300
NII	11812	200.67	1148.31	-449.202	20711
NIM	10951	3.47%	.63%	.67%	8.22%
NNII	11802	161.02	1116.31	-58	19377
Total assets	11731	36900	237435.4	88.84	3954687
Total equity	11678	3812.81	23044.55	2.55	303082
ROA	11731	.25%	.19%	-6.72%	4.43%
ROE	11678	2.46%	2.03%	-73.85%	49.53%
Interest rate	11946	1.06%	1.11%	.06%	4.52%

Note: NI = net income, NII = net interest income, NIM = net interest margin, NNII = non-interest income, ROA = return on assets, ROE = return on equity.

NIM, ROA, ROE and the interest rate are expressed as percentages. Values for remaining variables are in millions.

Table 5.2 Size distribution of banks

Size	**Obs.**
Large	23
Medium	58
Small	274

Note: Large = total assets > 100B, Medium = 10B < total assets < 100B, Small = total assets < 10B

5.2 – Proxies for banking profitability

5.2.1 - Return on Assets

The return on assets (ROA) of a bank is a financial performance measure. It measures the profitability of a bank (or any other company or financial institution) in relation to the total assets of the bank. The return on assets can be calculated with the following formula:

$$ROA = (Net\ Income / Total\ Assets) * 100\%$$

The ROA is used to measure a bank's ability to generate profits with its assets and is expressed as a percentage. A high ROA indicates that a bank is using its assets efficiently to generate earnings. This means that its profitability is likely better than a bank with a low ROA. It also suggests better management of assets.

5.2.2 - Return on Average Equity

The return on equity (ROE) of a bank is another financial performance measure. The ROE measures the profitability of a bank (or any other company or financial institution) in relation to the total shareholders' equity. The ROE is expressed as a percentage and tells us the return earned by shareholders on their investment in the bank. The ROE can be calculated using the following formula:

$$ROE = (Net\ Income / Shareholders' Equity) * 100\%$$

The ROE is used to measure the return shareholders earn by investing in the bank. It is therefore often used by investors to assess whether the bank is performing well. This measure will be used as a second proxy for profitability within my research.

5.2.3 Relative importance and differences

The main difference between the return on assets and the return on equity is the denominator in their respective formulas. The return on assets is a profitability measure that indicates how well a business or financial institution utilizes its total assets to generate profits. This means that the return on assets takes into account both the funds invested by shareholders as well as the funds invested by debt holders. The return on equity is a similar profitability measure, however, it only takes into account the funds invested by equity holders. This means that the return on assets takes into account the degree of leverage while the return on equity does not. Being aware of this difference is especially important when looking at banks, since banks are generally highly leveraged. Table 5.1 shows the differences in mean and extreme

values between these two ratios. Examining only one of the two ratios could lead to a biased perception. Therefore, since both ratios are deemed to be important indicators of financial health and performance, both the return on assets and the return on equity will be included in this research.

5.3 - Models

I expect a fixed-effects model to be the best option for my research as I believe there to be significant heterogeneity among the banks in my sample. Think of differences in characteristics as well as other unobservable differences affecting the profitability. A fixed-effects model controls for time-invariant unobserved heterogeneity. However, time-variant heterogeneity is not controlled for, meaning that by using a fixed-effects model, I assume that all time-variant variables are included in the model. This may lead to omitted variable bias. Later in this section, multiple tests will be conducted to examine whether the use of a fixed-effects model is appropriate. If this is not the case, the use of a random-effects model could be more appropriate instead.

In this model I will try to explain banking profitability using the interest rate. This means that banking profitability (for which return on assets (ROA) and return on equity (ROE) will be used as proxies) is the response variable and that the interest rate is the explanatory variable.

The model will take the following form:

Model 1.0: $Y_{it} = \alpha + \beta X_t + \gamma D_i + \varepsilon_{it}$

In this model, the variables will be as follows; Y_{it} represents the ROA(/ROE) of bank (i) at time period (t), X_t represents the interest rate at time period (t), α represents the constant term, D_i represents the individual-specific fixed effect for bank (i) and ε_{it} represents the error term.

Additionally, I will try to explain banking profitability using the interest rate while also including other relevant explanatory variables. In my research I will be including data on the inflation rate, GDP growth and the size of the bank and expand my models:

Model 1.1: $ROA_{it} = \alpha + \beta InterestRate_t + \gamma D_i + \varepsilon_{it}$

Model 1.2: $ROA_{it} = \alpha + \beta 1 InterestRate_t + \beta 2 Inflation_t + \beta 3 GDPGrowth_t + \beta 4 Size_{it} + \gamma D_i + \varepsilon_{it}$

Model 1.3: $ROE_{it} = \alpha + \beta InterestRate_t + \gamma D_i + \varepsilon_{it}$

Model 1.4: $ROE_{it} = \alpha + \beta 1 InterestRate_t + \beta 2 Inflation_t + \beta 3 GDPGrowth_t + \beta 4 Size_{it} + \gamma D_i + \varepsilon_{it}$

To determine whether an interest rate hike decompresses the net interest margins of US commercial banks, two more models are established. In the model, inflation, GDP growth and the size of a bank will serve as control variables.

Model 2.1: $NIM_{it} = \alpha + \beta 1 InterestRate_t + \gamma D_i + \varepsilon_{it}$

Model 2.2: $NIM_{it} = \alpha + \beta 1 InterestRate_t + \beta 2 Inflation_t + \beta 3 GDPGrowth_t + \beta 4 Size_{it} + \gamma D_i + \varepsilon_{it}$

Similar models are established to determine the effect of the net interest margin on the net interest income of US commercial banks. Keeping the research of Nguyen (2012) in mind, non-interest income will be added to the model and will serve as control variable. If non-interest income has an effect on the net interest margins of banks, it will most likely influence the net interest income as well (through the NIM). The models will take the following forms:

Model 3.1: $NII_{it} = \alpha + \beta 1 NIM_{it} + \gamma D_i + \varepsilon_{it}$

Model 3.2: $NII_{it} = \alpha + \beta 1 NIM_{it} + \beta 2 NNII_{it} + \beta 3 Inflation_t + \beta 4 GDPGrowth_t + \beta 5 Size_{it} + \gamma D_i + \varepsilon_{it}$

The final random-effects models are established to determine the effect the interest rate has on non-interest income. The models are similar to the other random-effects models in this research:

Model 4.1: $NNII_{it} = \alpha + \beta 1 InterestRate_t + \gamma D_i + \varepsilon_{it}$

Model 4.2: $NNII_{it} = \alpha + \beta 1 InterestRate_t + \beta 2 Inflation_t + \beta 3 GDPGrowth_t + \beta 4 Size_{it} + \gamma D_i + \varepsilon_{it}$

5.4 - Robustness tests

In this section, multiple robustness tests will be conducted. First, the use of either a fixed-effects model or a random-effects model will be discussed along with endogeneity. Second, the normality assumption will be tested. Then, the assumption of independence and multicollinearity will be tested. Finally, I shall test for heteroscedasticity.

5.4.1 - Endogeneity

To decide whether to use fixed-effects models or random-effects models, I will test for significant differences in the estimated coefficients between fixed-effects and random-effects models. A fixed-effects model assumes that no endogenous variables are present. A random-effects model allows for endogenous variables to be present.

Following the estimation of both a fixed-effects model and a random-effects model, a Hausman test is performed. The obtained result (p-value > 0.05) indicates that I cannot reject the null hypothesis, meaning that there is no significant difference in the estimated coefficients between fixed-effects and random-effects models. This suggests the use of a random-effects model instead of a fixed-effects model.

To confirm whether a random-effects model should be used, a Breusch-Pagan Lagrange Multiplier test has been conducted. Using this test I am able to determine whether random effects are significant in my panel data. The null-hypothesis of the Breusch-Pagan Lagrange Multiplier test is that the random effects in the model are insignificant. The obtained result (p-value < 0.05) indicates that the null hypothesis

should be rejected. I conclude that the random effects are significant. The use of a random effects model instead of a fixed-effects model is therefore more appropriate.

5.4.1.1 – Omitted Variable Bias

A random effects model assumes that the unobserved individual specific effects are uncorrelated with the observed independent variables. Random effects may account for time-invariant omitted variables. However, if there are time-variant omitted variables, the random effects may not be able to adequately capture the effects of these omitted variables. This will lead to over- or underestimation of the coefficients of the independent variables, which causes the estimators to be biased and inconsistent.

5.4.1.2 – Reverse Causality and Simultaneity Bias

Reverse causality and simultaneity bias are two more possible causes of endogeneity. Reverse causality refers to a situation where the dependent variable explains an independent variable, instead of the other way around. Simultaneity bias refers to a situation where an independent variable does explain the dependent variable but is also explained by said dependent variable.

In this research, the effect of the interest rate on numerous variables is examined while controlling for the inflation rate. In this situation, simultaneity bias may be present. The interest rate has an effect on the inflation rate through the Federal Reserve, which aims to bring down the inflation rate by increasing the interest rate. On the other hand, lenders may be inclined to demand higher interest rates to compensate for the loss of purchasing power due to inflation, meaning that the inflation rate also has an effect on the interest rate. This is important to keep in mind since simultaneity bias will lead to biased and inconsistent estimators.

5.4.2 - Normality

First, I shall test for normality. This means that the residuals should be normally distributed. Whether this is the case shall be tested using the Jarque-Bera test for normality. Testing for normality using the Jarque-Bera test results in a chi-squared value of 0.0. The null hypothesis is therefore rejected, meaning that the residuals are not normally distributed. This result is confirmed by the plotted Q-Q plot which shows data points deviating from the diagonal line on both ends. Additionally, the Q-Q plot tells us that the distribution of the residuals is heavy-tailed. The Q-Q plot can be found in section 9.0, Graph A.

5.4.3 - Autocorrelation

Autocorrelation refers to the correlation between the same variables between two successive time periods. The presence of autocorrelation would mean that the assumption of independence is violated. This can lead to biased and inefficient estimators. In order to determine whether autocorrelation is present in the residuals of my panel data set, a Wooldridge test is performed. This test allows me to detect first-order autocorrelation in the panel data set.

The result of the Wooldridge test (p-value < 0.01) indicates that I should reject the null-hypothesis of no first-order autocorrelation. Autocorrelation is present in the panel data set. This violates the assumption that the observations are independent from each other.

5.4.4 – Multicollinearity

Multicollinearity refers to a situation where two or more independent variables are highly correlated with each other. The issue of multicollinearity can lead to unreliable and misleading results and should therefore be addressed. To test for multicollinearity, the variance inflation factor (VIF) for each independent variable will be calculated. VIF values of between 5 and 10 indicate moderate correlation, while VIF values larger than 10 indicate high correlation. Unless a VIF value is below 5, further action may be required.

Table 5.3.1 VIF-values independent variables

ROA/ROE	**VIF**
InterestRate	1.12
Inflation	2.29
GDPGrowth	2.11
Size	1.01

In Table 5.3.1, the VIF-values for the independent variables can be found. Table 5.3.1 only contains the VIF-values for the variables being used in Models 1.1-1.4. The VIF-values for the independent variables that are being used in the remaining models can be found in Section 9.0, Table A. Examining the results tells us that none of the VIF values are above 5. This indicates that there is low correlation among the independent variables. Therefore, no further action seems to be needed.

5.4.5 - Heteroscedasticity

Next, I will test for group wise heteroscedasticity within the residuals of my random-effects model using a modified Wald test. The null hypothesis is that there is no group wise heteroscedasticity in the residuals of the model. After estimating the random-effects model and performing the modified Wald test, the obtained result (p-value < 0.05) indicates that I should reject the null hypothesis. This means that group wise heteroscedasticity is present in the model. As a result, robust standard errors shall be used when estimating the random-effects models.

6.0 – Results

In this section I will present the findings of my research which has been conducted in order to assess the previously discussed hypotheses and research question. By examining the obtained data, constructing multiple models and studying the relationships between the variables of interest, I aim to provide clear and comprehensive answers to the questions at hand.

First, I shall present and discuss the findings of the first hypothesis. The aim of this hypothesis was to study the effects of the interest rate on the net interest margins (NIM) of commercial banks in the US. My expectation is that an increase in the interest rates decompresses the net interest margins. To test this hypothesis, I conducted a panel data analysis using a random-effects model.

Table 6.1 Effect of the interest rate on the net interest margins of banks

NIM	2.1	2.2
InterestRate	0.081***	0.117***
	(0.007)	(.007)
Inflation	-	-0.058***
		(.004)
GDPGrowth	-	.008***
		(.001)
Size	-	-.002***
		(.000)
Observations	10951	10951

Note: NIM = net interest margin, Size = Small/Medium/Large.

NIM, InterestRate, Inflation and GDPGrowth expressed as decimal percentage points.

Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Table 6.1 shows the results of the first two models that shall be discussed. The dependent variable, the NIM, and the interest rate are the main variables of interest. The inflation rate, GDP growth rate and size of the bank serve as control variables.

Examining the results tells us that the interest rate has a significant positive effect ($p<0.01$) on the net interest margin in both of the models. Keeping all else constant, a one percentage point increase in the interest rate is estimated to increase the NIM by 0.081 percentage point in Model 2.1 and 0.117 percentage point in Model 2.2. This increase can be explained by banks increasing the rates they charge their customers, while keeping the rates on deposits the same. The cause of stagnating rates on customer deposits has been explained in a previous section.

Inflation is found to have a significant ($p<0.01$) negative effect on the net interest margin. A one percentage point increase of the inflation rate is estimated to decrease the NIM to by 0.058 percentage point, ceteris paribus. This effect is most likely due to the erosion of customer purchasing power.

Decreasing customer purchasing power leads to less demand for credit, preventing banks from increasing the rates they charge on loans. The significant ($p<0.01$) effect of GDP growth is relatively small in magnitude. A one percentage point increase of the GDP is, on average, estimated to increase the NIM by 0.008 percentage point, ceteris paribus. A growing economy presents more lending opportunities for banks, potentially increasing the NIM. Finally, the size of a bank shows a significant ($p<0.01$) negative effect on the NIM. The effect may be attributed to larger banks making use of economies of scale, negotiating lower borrowing costs, offering more competitive rates to customers and effectively working with lower NIMs.

The first hypothesis has been tested and has been found to be supported by the obtained results. The significant positive effect between the interest rate and net interest margin indicates that a bank's NIM gets decompressed when the interest rate increases. This is a valuable finding since increasing NIMs have been found to lead to higher net interest income and therefore potentially higher profitability.

The findings regarding the relationship between the net interest margin and the net interest income shall be discussed next. Previous literature has found that an increase of the net interest margin leads to higher net interest income for banks. By testing this hypothesis, I aim to confirm the existence of this positive relationship, as well as assessing the magnitude of this effect.

Table 6.2 Effect of the net interest margin on the net interest income of banks

NII	3.1	3.2
NIM	1414.898	4294.775**
	(1413.651)	(1879.562)
NNII	-	.556***
		(0.103)
Inflation	-	1149.576***
		(291.361)
GDPGrowth	-	-296.279***
		(85.348)
Size	-	103.285***
		(25.937)
Observations	10936	10936

Note: NII = net interest income, NIM = net interest margin, NNII = non- interest income, Size = Small/Medium/Large. NIM, Inflation and GDPGrowth expressed as decimal percentage points. Values for remaining variables are in millions. Robust standard errors in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 6.2 contains the results of the second pair of models. The main variables of interest are the net interest income (NII) and net interest margin (NIM). Non-interest income (NNII), the inflation rate, the GDP growth rate and the size of the bank serve as control variables.

In Model 2.1, the net interest margin does not exhibit a significant relationship on the net interest income. However, in Model 2.2 the NIM exhibits a significant ($p<0.05$) positive effect on the net interest income. This effect is in line with the previous literature. On average, a one percentage point increase in the NIM is estimated to increase the net interest income by 4294.775 million, ceteris paribus.

There is a significant ($p<0.01$) positive effect of the non-interest income on the net interest income. A one million increase in the non-interest income is, on average, estimated to increase the net interest income by 0.556 million, keeping all else constant. The inflation rate exhibits a significant ($p<0.01$) positive effect. On average, a one percentage point increase of the inflation rate is estimated to increase the net interest income by 1149.576 million, ceteris paribus. The GDP growth rate exhibits a significant ($p<0.01$) negative effect on the net interest income. If the GDP growth rate increases by one percentage point, then the net interest income of a bank is estimated to decrease by 296.279 million, all else being equal. Finally, the size of a bank exhibits a significant ($p<0.01$) positive effect on the net interest income.

The second hypothesis is also supported by the results. The NIM has a significant positive effect on the net interest income. Both the NIM and the inflation rate exhibit significant positive relationships with the net interest income. The estimated coefficients indicate that increases of both the NIM as well as the inflation rate significantly increase the net interest income of banks.

The aim of the final hypothesis is to assess whether changes in the interest rate have a significant effect on the non-interest income of banks. In times of low interest rates, banks may decide to allocate more of their efforts toward non-interest income earning activities. Furthermore, low interest rate environments may lead to more demand for loans, financial services and other activities that could lead to an increase of the non-interest income. Interest cuts are therefore expected to have a positive effect on a bank's non-interest income.

Table 6.3 Effect of the interest rate on the non-interest income of banks

NNII	4.1	4.2
InterestRate	68.295	-118.800
	(306.545)	(282.060)
Inflation	-	272.172
		(214.957)
GDPGrowth	-	-23.164
		(79.173)
Size	-	25.428*
		(14.534)
Observations	11802	11802

Note: NNII = non-interest income, Size = Small/Medium/Large.

InterestRate, Inflation and GDPGrowth expressed as decimal percentage points. Values for remaining variables are in millions.

Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

The results can be found in table 6.3. The main variables of interest are the non-interest income (NNII) and the interest rate. The inflation rate, GDP growth rate and bank size serve as control variables.

The interest rate was found to have no significant effect on the non-interest income of banks in either of the two models. The results shall not be further interpreted.

The inflation rate and GDP growth rate were also found to have no significant effect on the non-interest income of banks. The coefficients of these variables shall therefore also not be interpreted. The size of a bank, however, does exhibit a significant ($p<0.1$) positive effect on the non-interest income of banks.

The third hypothesis is not supported by the results. Non-interest income is, however, a significantly smaller fraction of a bank's total income compared to interest income. The inability to confirm this hypothesis does not have to preclude answering the research question, which shall be discussed next.

At last, the research question shall be discussed. In this final section, the effect of interest rate changes on the profitability of banks in the United States will be examined. By discussing the findings derived from the tested hypotheses and the results of the random-effects models, I aim to provide a clear and concise answer to the research question.

Tabel 6.4 Effect of the interest rate on the profitability of banks

ROA	1.1	1.2	ROE	1.3	1.4
InterestRate	.00937***	.00686***		.13234***	.05116**
	(.00205)	(.00201)		(.02518)	(.02462)
Inflation	-	.00011		-	.11780***
		(.00095)			(.01215)
GDPGrowth	-	.00355***		-	.01285*
		(.00067)			(.00694)
Size	-	.00014		-	-.00075
		(.00009)			(.00096)
Observations	11731	11731		11678	11678

Note: ROA = return on assets, ROE = return on equity, Size = Small/Medium/Large.

ROA, ROE, InterestRate, Inflation and GDPGrowth expressed as decimal percentage points.

Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

The results of the final random-effects models can be found in table 6.4. The main variables of interest are the return on assets (ROA), return on equity (ROE) and the interest rate. ROA and ROE serve as proxies for bank profitability. Inflation, GDP growth rate and the size of a bank serve as control variables.

Models 1.1 and 1.2 estimate the effect of the interest on the ROA. In both models, the interest rate has a significant ($p<0.01$) positive effect on the ROA. In the first model, which does not include the control variables, a one percentage point increase in the interest rate is, on average, estimated to increase the ROA by 0.00937 percentage point ceteris paribus. In the second model, which does control for the mentioned variables, on average, each percentage point increase of the interest rate is estimated to increase the ROA by 0.00686 percentage point ceteris paribus.

The random-effects regression results indicates that inflation and the size of a bank do not have a significant effect on the ROA. The coefficients of these variables shall not be further interpreted therefore. The GDP growth rate, however, does have a significant ($p<0.01$) positive effect on the ROA. On average, a one percentage point increase of the GDP growth rate is estimated to increase the ROA by 0.00355 percentage point, ceteris paribus. This result may be explained by increasing loan demand and lower default rates on loans due to a growing economy, both of which may lead to an increasing ROA.

The results of Models 1.3 and 1.4 indicate that the interest rate has a significant positive effect on the ROE both in Model 1.3 ($p<0.01$) and Model 1.4 ($p<0.05$). On average, a one percentage point increase in the interest rate is estimated to increase the ROE by 0.132 percentage point, ceteris paribus. In model 1.4, each percentage point increase in the interest rate is, on average, estimated to increase the ROE by 0.051 percentage point, all else being equal.

The results of Model 1.4 indicate that the size of a bank does not have a significant effect on the ROE. The coefficient of this variable shall therefore not be further interpreted. However, in Model 1.4, both the inflation rate and the GDP growth rate have significant ($p<0.01$ & $p<0.1$ respectively) positive effects on the ROE. If the inflation rate increases by one percentage point, the ROE is estimated to, on average, increase by 0.118 percentage point, ceteris paribus. On average, a one percentage point increase of the GDP is estimated to increase the ROE by 0.013 percentage point, keeping all else constant.

The aim of this research was to study the effect of the interest rate on the profitability of U.S. banks. The results in table 6 indicate that the interest rate has a positive significant effect on the ROA and ROE, both of which served as proxies for banking profitability. The significant effect remained even after controlling for macro-economic factors and the size of a bank. To support these findings, three hypotheses have been tested. The first hypothesis was supported by the results, which indicated that the interest rate has a significant positive effect on the net interest margins of banks. With most banks earning a significant part of their total income using the spread between their borrowing and lending activities, one can assume that an increasing net interest margin has a positive effect on their income. The second hypothesis aimed to examine the effect of an increasing net interest margin on the net interest income of banks. This hypothesis was also supported by the results. An increasing net interest margin has a significant positive effect on the net interest income of banks. The third and final hypothesis was not supported by the results. The results indicate that there is no significant effect of the interest rate on the non-interest income of banks. As mentioned before, for most banks, the share of non-interest income compared to the net-interest income is small. Therefore, based on the obtained results and the supported hypotheses, I find the interest rate to have a significant positive effect on the profitability of U.S. banks.

7.0 - Conclusion and Discussion

This research was conducted in order to study the effects of the short-term interest rate, the federal funds rate, on the profitability of banks. A panel data set consisting of data from the first quarter of 2015 till and including the first quarter of 2023 was constructed. Using panel data analysis, I was able to provide answers to the hypotheses and research question.

First, the effect of the interest rate on the net interest margins of banks was examined. The results indicated that the interest rate has a positive effect of the net interest margins of banks, which is in line with the previous literature. Second, the effect of the net interest margins on the net interest income of banks was studied. According to the results, there is a positive relationship between the net interest margins and the net interest income. This finding is supported by previous literature. The third effect that has been examined is the effect of the interest rate on the non-interest income of banks. Here, no significant effect of the interest rate was found. Finally, to answer the research question, the effect of

the interest rate on the profitability of banks was studied. After analysing the regression results and evaluating the findings, I concluded that the interest rate has a positive effect on the profitability of U.S. banks.

However, not all of the assumptions for linear regression models have been fulfilled. First, the residuals are not normally distributed. Examining the plotted Q-Q plot shows us that the distribution of the residuals is heavy-tailed. This means that there are too many extreme positive and negative residuals. Second, the results of the Hausman test and the Breusch-Pagan Lagrane Multiplier test convince me that the use of random-effects instead of fixed-effects is more appropriate. Random-effects allows for endogenous variable to be present. Although I cannot test for endogeneity directly, I do suspect omitted variable bias and simultaneity bias to be present. This suggests that the estimated effects are likely biased, meaning that the estimated effects are either under- or over-estimated compared to the true effects. Third, the assumption of independence is violated as autocorrelation is present in the models. The presence of autocorrelation leads to biased and inefficient estimators. Inefficient estimators indicate that better estimators, which are more precise in estimating the true effect, exist. Since the estimators are likely both inefficient and biased, no robust conclusions can be drawn from the results. The results may still provide some evidence for the existence of relationships between the studied variables however.

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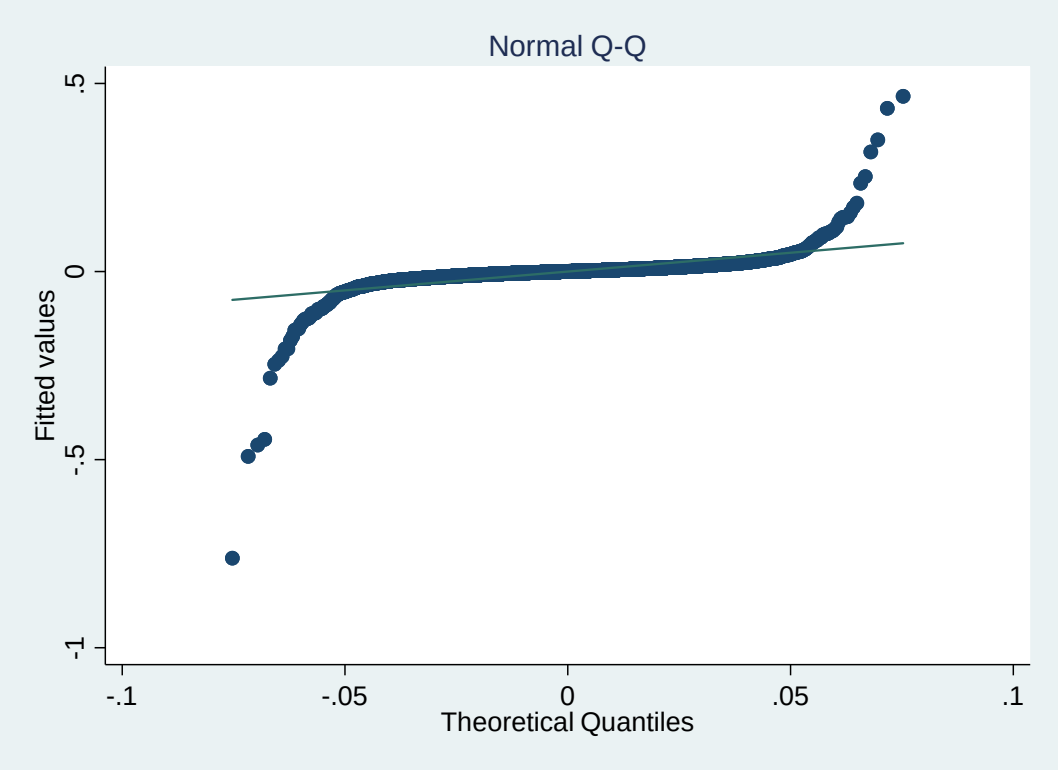
9.0 – Appendix

Table A. VIF-values independent variables

VIF	**2.1-2.2**	**3.1-3.2**	**4.1-4.2**
InterestRate	1.11	-	1.12
Inflation	2.29	2.11	2.28
GDPGrowth	2.12	2.08	2.11
Size	1.00	1.29	1.00
NIM	-	1.14	-
NNII	-	1.26	-



Graph A. Q-Q plot to test for Normality