# THE RELATIONSHIP BETWEEN DERIVATIVES USE AND BANK PROFITABILITY OF THE FIVE LARGEST U.S. BANKS

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## ABSTRACT

*The aim of this study is to examine the relationship between the use of derivatives and profitability of the five largest U.S. banks for the period Q3:2010 – Q2:2017 over which new rules governing bank behavior in the OTC derivatives market were in effect. Bank profitability is measured by the return on assets, ROA, and return on equity, ROE as functions of both bank internal and external determinants.*

*Using quarterly data (total of 140 observations on 5 banks and 28 quarterly periods) and a fixed effects model, our empirical results found evidence that internal factors have a stronger influence on profitability. The internal determinant net interest income has a positive and significant effect on profitability, while liquidity also has a positive but insignificant effect. Both size and leverage have negative effects on profitability but only leverage is significant. The external determinants forwards, swaps, and options traded by banks in over-the counter markets show that they are all negatively related to profitability. However, the only variable that is significant is forwards while both swaps and options are insignificant. For both ROA and ROE, GDP and inflation are negatively related to profitability, but the effect is insignificant. These results suggest that although the new regulations governing OTC trades had a negative impact on bank profitability, the overall effect was insignificant.*

## INTRODUCTION

The purpose of this study is to examine the impact on bank profitability of the new wave of bank regulations that were imposed on them to mitigate risk stemming from their trading activities in the OTC derivatives market. Specifically, we seek to determine whether these new rules had a significant positive or negative impact on bank profitability measured by ROA and ROE. Banks are increasingly using derivatives in innovative ways to achieve profits instead of traditional methods. Perhaps no business in finance is as profitable today as derivatives. The precise amount of money that banks make from trading derivatives isn't known, but there is anecdotal evidence of their profitability. The secrecy surrounding derivatives trading is a key factor enabling banks to make such large profits. Banks make money in at least five ways: (i) volume - the immense growth of OTC flow trading means that banks as dealers make large sums of money if they can professionally intermediate these massive order flows measuring in the trillions; (ii) economies of scale - as industry consolidates and market share increases, banks as dealers see more of the order flows which enables them to effectively "front run" the flow for their own trading book; (iii) proprietary trading - banks as dealers speculate on numerous risks associated with managing their OTC derivatives books utilizing the advantage of their market making role; (iv) complexity - Wall Street always seeks to add complexity to the derivatives business to allow tailoring of sophisticated risk profiles often purported to meet client needs. However, complexity often comes at the expense of high margins as structured and negotiated instruments are done via an opaque and non-competitive process; and (v) cheating - Wall Street opportunists seize opportunities to cheat either by direct lying, or by misleading clients into trade positions they don't know how to price fairly. Unwinding such trades when the client realizes the disaster is often a second opportunity to gouge.

The motivation for the study is the set of new rules that were imposed on banks to control and limit their risk-taking behavior in their trading activities in the OTC derivatives market. These rules include Basel II, Basel III, Dodd Frank Act, etc. Under Basel rules, banks were required to hold more equity capital with the definition of equity being tightened and were also required to satisfy liquidity ratios. The Dodd-Frank Act put restrictions on bank risk taking behavior stemming from OTC derivatives use by requiring that trades clear through Central Counterparties (CCPs) and Swap Execution Facility (SEFs). Dodd-Frank Act also restricted proprietary trading whereby banks invest for direct market gain rather than earning commission dollars by trading on behalf of their clients.

Following the provision of nearly $350 billion in capital or guarantees, under the Troubled Asset Relief Program (TARP) to help banks and financial institutions remain viable and to stabilize the global financial system, government leaders wanted some answers and changes. Congressional committees held hearings where bankers were asked to explain their business practices and policies. The problem at hand was that the financial crisis of 2008 had exposed significant weaknesses in the OTC derivatives market, including the build-up of large counterparty exposures between market participants which were not appropriately risk-managed, limited transparency concerning levels of activity in the market and overall size of counterparty credit exposures, and remaining operational weaknesses which demonstrated the need for further standardization and automation. Prior to the financial crisis, many financial institutions accumulated sizeable unrealized losses from highly speculative positions in OTC derivatives. However, since the trades were not regulated, the amount of market participant's exposures throughout the financial system could not be quantified. Congress therefore viewed the lack of regulation in the OTC derivatives transactions as a major contributing factor to the 2008 financial crisis with the government bailout of AIG loss position on its credit derivatives exposure most cited as the prime example. On July 21, 2010, President Obama signed into law the Dodd-Frank Wall Street Reform and Consumer Protection Act which called for changes in how banks clear derivatives in the US financial regulatory system to mitigate future systemic risk in financial markets and to abate poor practices performed by large banks that were deemed too big to fail. Title VII, known as Wall Street Transparency and Accountability is concerned with regulations of over-the-counter swaps markets which included credit default swaps and credit derivatives which were at the heart of bank failures. Broadly speaking, the act requires that various derivatives known as swaps which were traded over the counter (OTC) be cleared through exchanges or clearinghouses. Specifically, Title VII has three main goals: (i) reduce risk to the U.S. financial system and American taxpayers by increasing transparency in OTC derivatives markets; (ii) reduce systemic risk through mandating central clearing of previously unregulated derivatives instruments; and (iii) require more capital and liquid collateral to back derivative trades.

In this study, our research question is, "what impact did the new rules have on profitability defined by ROA and ROE of the five largest banks?" Since the aim of Title VII is not only to give regulators transparency into market participant's trading activities and exposures by mandating comprehensive reporting of OTC derivatives trades but also to require financial market participants to execute trades on regulated exchanges or trading platforms that require the public dissemination of the prices at which the majority of derivatives are executed, our paper makes a significant contribution to the literature by examining the impact of the new rules on how OTC trades are cleared.

The remainder of the article is organized as follows: Section 2 reviews the literature on bank derivatives. Section 3 presents the methodology, testable hypothesis, and summary of the variables used. Section 4 presents data analysis and results. Section 5 examines statistical diagnostics while section 6 presents conclusions for the article.

## LITERATURE REVIEW

**N**umerous studies that have examined the relationship between derivatives use and bank profitability show that banks use derivatives for two, sometimes conflicting objectives. In this section, we review some of the literature that provides a background and basis for our study. First, banks use derivatives to hedge against risk. Second, banks use derivatives to earn revenue from their own trading activity and fees from origination in transactions where they act as mediators. Diamond (1984) shows that banks use financial derivatives to hedge against uncontrollable risks so that they can focus on their core business such as monitoring borrowers. Hunter and Timme (1986) argue that because of their size and technical efficiencies, large banks are in a better position to take a lead in the innovation of financial derivatives. Thus, trading activity in financial derivatives is limited to large banks since smaller banks have little chance of providing a full range of risk management services and products to their clients. Tufano (1989) analyzes financial innovations and the first-mover advantage in investment banking in light of substantial costs associated with the development of new product. Smith (1993) argues that banks should recognize the benefit of providing financial derivatives products and the related services and make good use of it. Revenues come from generated fee income and stronger customer relationships. If used for hedging purposes, financial derivatives can prevent financial distress for bank customers (e.g., small banks, nonfinancial firms), increasing the stability of bank revenues. The bank involvement in dealing and trading in financial derivatives markets requires a substantial investment in capital, skilled employees, and good reputation, which all act as entry barriers for small banks. Gorton and Rosen (1995) find that banks, especially large dealer banks, use interest rate derivatives mainly to hedge against interest rate risk. Géczy, Minton and Schrand (1997) show that corporations use exchange rate derivatives to mitigate cash flow variations, such that they can exploit profitable growth opportunities.

Brewer, Minton and Moser (2000) find that banks that use interest rate derivatives increase commercial and industrial lending faster than banks that do not use interest rate derivatives. Duffee and Zhou (2001) argue that credit derivatives hedge a bank against financial distress and this additional flexibility allows a bank to avoid the lemon problem due to bank information superiority. Bauer and Ryser (2004) formally model how banks use financial derivatives to mitigate the occurrence of bank runs. Morisson (2005) stresses that hedging by financial derivatives has a dark side. He argues that the informational value of a bank loan ceases to exist if banks can trade in the credit derivatives market. More specifically, when the bank incorporates credit default protection, it is no longer exposed to the borrower's potential default. Consequently, the bank can no longer commit to monitoring and screening its borrowers. In addition, the adverse selection problem may be present as well. Purnanandam (2007) shows empirically that banks closer to financial distress hedge against interest rate risk more aggressively. Minton, Stulz and Williamson (2009) argue that the use of credit derivatives by banks is limited thus questioning the size of the benefits realized from the use of credit derivatives for hedging purposes. To avoid the cost of financial distress, banks may use financial derivatives to lower the probability of default. Norden, Buston, and Wagner (2011) also find that banks use credit derivatives to improve their management of credit risks. The notion that banks use financial derivatives to hedge and that banks are risk-averse, however, is not universally accepted: Hirtle (1997), Sinkey and Carter (2000), Gunther and Siems (2002) and Yong, et al. (2009) find that increases in the bank's use of interest-rate derivatives corresponds to greater interest rate risk exposure.

Minton, Stulz and Williamson (2009) argue that there are economies of scale in using derivatives and it is expected that larger banks tend to participate more in this market and use several types of derivatives for hedging. Ryu, Back, Yang and Chae (2011) document that an increase in the volume of OTC traded options is positively related to abnormal returns. However, an increase in futures and credit derivatives is negatively related to abnormal returns. Kwon, Park, and Chang (2011) show that derivatives trading volumes are positively related to abnormal returns. Brunzel, Hansson and Liljeblom (2011) find that although most firms listed in Nordic economies trade derivatives for the purpose hedging, the majority of firms use derivatives in search of higher returns. Dewally and Shao (2012) find that the use of financial derivatives by BHCs increases their opacity. Well-operating corporate governance can mitigate this effect. Besides hedging purposes, banks also use financial derivatives for trading purposes. Revenues generated by trading activities drive banks to provide financial derivative products to the small banks and nonfinancial firms. Yang (2013) finds that the volume of OTC traded derivatives before the financial crisis was positively related to return on assets while the volume of exchange traded derivatives was positively related to return on assets after the financial crisis.

Shen & Hartarska (2013) examined the performance of agricultural banks that utilized derivatives for risk management and found that the profitability of the banks improved in a discernable fashion over a number of years. In addition, Ghosh (2017) showed that aggregate derivatives increase banks' risk-adjusted return on assets that are driven by exchange-rate derivatives. Chaudron (2018), after examining the effect of interest rate risk on profitability, found that banks could lower their interest rate risk significantly when the yield curve flattens.

To our knowledge, there is no related literature that has examined issues related to Title VII in the Dodd-Frank Act. Since the aim of Title VII is not only to give regulators transparency into market participant's trading activities and exposures by mandating comprehensive reporting of OTC derivatives trades but also to require financial market participants to execute trades on regulated exchanges or trading platforms that require the public dissemination of the prices at which the majority of derivatives are executed, our study makes a significant contribution to the literature by examining the impact of Dodd-Frank on volume of derivatives use by banks and bank profitability stemming from restrictions on where bank could trade derivatives which to date has received little attention.

## Data & Methodology

We use quarterly aggregate panel data from Capital IQ covering the period Q3:2010 through Q2:2017 to examine the relationship between the use of derivatives and profitability of the five largest U.S. banks. The five banks are JP Morgan, Bank of America, Citigroup, Goldman Sachs, and Morgan Stanley. We chose these banks because they comprise approximately 90% of all U.S. derivatives hedging/trading activities in futures & forward contracts, swaps, options and credit derivatives. The period 2010 through 2017 was chosen because it enables us to assess the impact of the Dodd-Frank Act on bank profitability since it put restrictions on bank risk taking behavior stemming from derivatives use by requiring all trades to clear through exchanges or clearing houses. There are 28 quarterly observations per bank for a total sample size of 140 observations.

## Empirical Model

To examine bank profitability, we apply a panel data technique which is a combination of cross section and time series approaches to data analysis. The technique enables us to provide more informative parameter estimates as it is better at detecting and measuring effects of variables that cannot be observed in cross section and time series data or variables that change over time but not across entities or banks in our case.

## Model

We apply the panel data techniques used by Chowdhury et al (2017), Trad et al (2017), and Alshatti (2015) to analyze bank profitability. The basic model of the panel regression is given below as:

$$Yit = \alpha + \beta Xit + \varepsilon it \quad (1)$$

where $Y_{it}$ is profitability measured by ROA or ROE, α is the intercept, β is explanatory variable or parameter coefficient estimate, $X_{it}$ is the observed independent variable that is 1 x k, i = 1,…, N; t = 1,…,T, and $\varepsilon_{it}$ is the error term

The panel regression model can also be written as:

Profitability = f (Bank internal variables + Bank external variables) (2)

where the bank internal variables are asset size, net interest income, leverage and liquidity while bank external variables are volume of OTC traded forward contracts, volume of OTC traded swaps, volume of OTC traded options, GDP, and inflation.

By extending equation (2), we can also rewrite the panel regression as

$$Prof_{it} = \beta 0 + \beta_1 Size_{it} + \beta_2 NII_{it} + \beta_3 Lev_{it} + \beta_4 Liq_{it} + \beta_5 FOTC_{it} + \beta_6 SOTC_{it} + \beta_7 OOTC_{it} + \beta_8 GPD_{it} + \beta_9 Infl_{it} + \varepsilon \quad (3)$$

Equation (3) is estimated through a fixed effects regression analysis, taking each measure of bank profitability as the dependent variable. The decision to use a fixed effects model rather than random effects has been verified with Wald test and the Breusch-Pagan test by checking for residual heteroscedasticity.

## DETERMINANT VARIABLES & TESTABLE HYPOTHESES

### Dependent Variables

We use ROA and ROE as dependent variables to measure bank profitability. ROA, defined as the ratio of net income to total assets, is a measure of a bank's ability to generate profits from assets or overall profitability which compares a bank's performance relative to others. However, since ROA can disguise credit issues that may be hidden within a bank's portfolio, best performing banks combine ROA and ROE to obtain a more precise estimate of profitability. ROE, a ratio of net income to total equity reflects the ability of a bank to generate profits from equity. While ROA gives executives a view from above, ROE helps banks understand the value, and risk associated with each deal.

### Independent Variables

We formulate the following testable hypothesis on each variable.

### Size

Bank total assets is used to represent size. Consistent with previous bank studies such as Ashraf et al. (2005), we use the natural logarithm to scale (normalize) total assets. In general, size is positively related to bank performance as larger banks tend to be more profitable because of advantages they have such as greater market power, lower funding costs because of economies of scale and scope, and ability to set more favorable interest rate spreads in their banking models. Therefore, bank size is expected to have a positive impact on bank profitability.

*Hyp 1: There is a positive and significant relationship between bank size and profitability*

### Net Interest Income

We define NII as the ratio of noninterest income to total assets. Noninterest income is revenue derived mostly from fees and other activities outside the core activity of bank lending. Noninterest income accounts for over 40% of operating income in the U.S. commercial banking industry. In tandem with fees, it is an important driver of bank profitability. Lapavitsas & Muñoz (2019) find that well-managed banks expand more slowly into noninterest activities, and that marginal increases in noninterest income are associated with poorer risk-return tradeoffs on average. These findings suggest that although noninterest income coexists with interest income for banks, interest income from intermediation activities remains the banks' core financial services function. We expect the ratio of net interest income to be positively related to profitability.

*Hyp 2: There is a positive and significant relationship between net interest income and profitability.*

### Leverage

We use debt to equity ratio to measure leverage. Debt to equity ratio is the ratio of total liabilities of a bank to its shareholders' equity. The leverage ratio measures the degree to which the assets of the bank are financed by the debts and the shareholders' equity of a bank. Leverage is one component of the capital structure of a company. This is because the choice between debt and equity suggests somehow a trade-off between business and financial risk. Therefore, companies using large borrowings face higher risks while those using more equity tend to operate more conservatively by relying on internal funds. According to the trade-off theory of capital structure, the optimal debt level balances the benefits of debt against the costs of debt. The tax benefits of debt dominate up to a certain debt level, resulting in higher ROE, but the benefit would be less than the cost after a certain level of debt. The more a company uses debt, the less income tax it pays, but the greater its financial risks (Myers, 1984). Charumathi (2012) examined the determinants of profitability for the Indian life insurance companies and found that leverage has a negative and significant impact on profitability. Eriotis *et al.* (2011) investigated the relationship between debt to equity ratio and profitability and concluded that financing investments using retained profits are more profitable than using borrowed funds.

Generally, the influence of capital structure on performance is not clearly stated in the literature. Some studies have argued that companies have higher returns when they operate with a larger amount of borrowed funds, but there is a negative influence on long-term debt (Abor, 2005). Other studies have not found any relationship between financing decisions and profitability (Ebaid, 2009). Because of the trade-off theory, we expect a negative relationship between leverage and profitability.

*Hyp 3: There is a negative and significant relationship leverage and profitability.*

**Liquidity**

We use the ratio of cash and equivalents to total assets to measure a bank's liquidity. Cash equivalents are investment securities that are short-term, have high credit quality and are highly liquid. Liquidity and profitability are inversely related. The higher the liquidity, the lower will be profitability. The reason is that holding cash is a non-profit generating activity. Therefore, we expect a negative relationship between liquidity and profitability since the more cash and equivalents you hold, the more you give up the opportunity to acquire assets that produce profit.

*Hyp 4: There is a negative and significant relationship between liquidity and profitability.*

Yang(2013) finds that the volume of OTC derivatives before the financial crisis were positively related to ROA while the volume of exchange traded derivatives was positively related to ROA after the financial crisis. Because the rule changes affected the OTC derivatives more than exchange traded derivatives, we hypothesize that FOTC, SOTC and OOTC will be negatively related to both ROA and ROE.

**FOTC**

FOTC is the ratio of the volume of notional value of OTC forwards to total notional value of derivatives. We hypothesize that when the volume of notional value of OTC traded forwards is low, there is a negative relationship between profitability and FOTC.

*Hyp 5: There is a negative and significant relationship between profitability and FOTC.*

**SOTC**

SOTC is the ratio of the volume of notional value of OTC swaps to total notional value of derivatives. We hypothesize that when the volume of notional value of OTC swaps is low, there is a negative relationship between ROA and SOTC & between ROE and SOTC.

*Hyp 6: There is a negative and significant relationship between profitability and SOTC.*

**OOTC**

OOTC is the ratio of the volume of notional value of OTC options to total notional value of derivatives. We hypothesize that when the volume of notional value of OTC options is low, there is a negative relationship between ROA and OOTC & between ROE and OOTC.

*Hyp 7: There is a negative and significant relationship between profitability and OOTC.*

### GDP

We use seasonally adjusted data for GDP as an independent variable. GDP is used to gauge the health of a country's economy. It is the monetary value of all the finished goods and services produced within a country's borders in a specific time period and includes anything produced by the country's citizens and foreigners within its borders. The growth rate in GDP is a barometer used to set the lower bound for the growth rate in profitability of banks. In general, the growth rate in GDP is expected to be positively related to ROA and ROE because a favorable economic environment promotes investment and lending which contributes to a bank's bottom line.

*Hyp 8: There is a positive and significant relationship between profitability and GDP.*

### Inflation

We use seasonally adjusted data for inflation as an independent variable. Inflation measures the change in the consumer price index and in the general price level of goods and services in an economy over a period of time. Inflation is important for banks because they typically deal in nominal instruments, that is, instruments denominated in fixed dollars. Nominal instruments make up the bulk of a bank's assets and liabilities. An increase in anticipated inflation rate raises the nominal interest rate. This increases the number of nominal dollars that lenders or borrowers who are transacting in nominal instruments expect to receive/from or pay/to the bank. Therefore, we expect inflation to be positively related to profitability.

*Hypo 9: There is a positive and significant relationship between profitability and inflation.*

Table 1 below provides a summary of each variable and its expected sign

**Table 1**
**Variable Description**

| **Variable** | **Notation** | **Measure** | **Expected Sign** |
|---|---|---|---|
| Return on assets | ROA | NI/TA | |
| Return on equity | ROE | NI/TE | |
| Asset Size | Size | Ln(TA) | + |
| Net Interest Income | NII | NII/TA | + |
| Liquidity | Liq. | Cash & Equivalents/TA | - |
| Leverage | Lev. | Total debt/TE | - |
| OTC Forwards | FOTC | FOTC/Total derivatives | - |
| OTC Swaps | SOTC | SOTC/Total derivatives | - |
| OTC Options | OOTC | OOTC/Total derivatives | - |
| Gross Domestic Product | GDP | GDP growth rate | + |
| Inflation | Infl. | Change in consumer price index | + |

## RESULTS

### Descriptive Statistics

Table 2a provides basic descriptive statistics of mean, min, max and std. deviation for all the variables.

**Table 2a**
**Descriptive Statistics (Variables)**

| Variable | Mean | Minimum | Maximum | Std. Deviation |
|---|---|---|---|---|
| ROA | 0.2890% | -0.39% | 1.04% | 0.269% |
| ROE | 3.0157% | -3.97% | 10.68% | 2.849% |
| Size | 14.2099% | 13.52% | 14.76% | 0.459% |
| NII | 1.1399% | 0.09% | 4.27% | 0.986% |
| Liquidity | 39.9858% | 3.77% | 93.22% | 25.376% |
| Leverage | 9.4470 | 6.76 | 12.53 | 1.462 |
| FOTC | 39.2571% | 1.15% | 63.73% | 10.19% |
| SOTC | 9.3371% | 0.01% | 14.89% | 2.627% |
| OOTC | 3.9894% | 0.03% | 8.38% | 1.922% |
| GDP | 3.8214% | 2.30% | 5.17% | 0.761% |
| Inflation | 1.6313% | -0.07% | 3.57% | 0.942% |

The table shows that ROA has a mean return of 0.2890% and a standard deviation of 0.269% while ROE has a mean return of 3.0157% and a standard deviation of 2.849%.

Table 2b provides mean returns and standard deviations for the five banks.

**Table 2b**
**Descriptive Statistics of Within Group (Banks)**

| Bank | ROA | Std. deviation | ROE | Std, deviation |
|---|---|---|---|---|
| BOA | 0.1565% | 0.2496% | 1.3123% | 2.2094% |
| Citigroup | 0.2939% | 0.2365% | 2.6966% | 2.08914% |
| Goldman Sachs | 0.3447% | 0.2899% | 3.8659% | 3.2157% |
| JP Morgan | 0.3921% | 0.2972% | 4.4244% | 3.2443% |
| Morgan Stanley | 0.2578% | 0.2229% | 2.8791% | 2.4533% |

Table 2b shows that JP Morgan had the highest ROA and ROE mean returns while Bank of America had the lowest.

**Table 3**
**Pearson Correlation for ROA**

| | ROA | Size | NII | Liq. | Lev. | FOTC | SOTC | OOTC | GDP | Infl |
|---|---|---|---|---|---|---|---|---|---|---|
| ROA | 1 | | | | | | | | | |
| Size | -.034 | 1 | | | | | | | | |
| NII | .698** | -.359** | 1 | | | | | | | |
| Liq. | -.112 | -.266** | .173* | 1 | | | | | | |
| Lev. | -.009 | -.434** | .177* | .029 | 1 | | | | | |
| FOTC | -.134 | .462** | -.108 | -.241** | .084 | 1 | | | | |
| SOTC | .093 | .111 | -.150 | -.552** | .233** | .385** | 1 | | | |
| OOTC | -.065 | .219** | -.008 | -.075 | .514** | .683** | .319** | 1 | | |
| GDP | -.098 | .004 | .002 | -.009 | .175* | .222** | .110 | .186* | 1 | |
| Infl. | -.186* | .010 | -.068 | -.005 | .374** | .309** | .128 | .373** | .071 | 1 |

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

**Table 4**
**Pearson Correlation for ROE**

| | ROE | Size | NII | Liq. | Lev. | FOTC | SOTC | OOTC | GDP | Infl |
|---|---|---|---|---|---|---|---|---|---|---|
| ROE | 1 | | | | | | | | | |
| Size | -.084 | 1 | | | | | | | | |
| NII | .733** | -.359** | 1 | | | | | | | |
| Liq. | -.113 | -.266** | .173* | 1 | | | | | | |
| Lev. | .141 | -.434** | .177* | .028 | 1 | | | | | |
| FOTC | -.093 | .462** | -.108 | -.241** | .084 | 1 | | | | |
| SOTC | .131 | .111 | -.150 | -.552** | .233** | .385** | 1 | | | |
| OOTC | .028 | .219** | -.008 | -.075 | .51488 | .683** | .319** | 1 | | |
| GDP | -.055 | .004 | .002 | -.009 | .175* | .222** | .110 | .186* | 1 | |
| Infl. | -.122 | .010 | -.068 | -.005 | .374** | .309** | .128 | .373** | .071 | 1 |

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Most of the correlation coefficients in Tables 3 and 4 show values whose magnitudes are less than 0.5 which indicates that the variables have either low or moderate correlation. Only NII and profitability have correlation coefficients that may be considered moderately high with magnitudes of 0.698 and 0.733, respectively.

### Tests of unit root for stationarity of time series

Before running our panel model for parameter estimates, we use R-extensions in SPSS to check for stationarity of the data series using Dickey-Fuller test (ADF stationary)/K:4/n), and Phillips-Perron test (PP (no intercept)/Lag: Short / N).

For ADF, our testable hypothesis is:

*$H_0$: There is a unit root for the series*

*$H_a$: There is no unit root for the series. The series is stationary.*

We reject $H_0$ if the computed value is lower than the significance level of alpha = 0.05 and accept the alternate hypothesis $H_a$.

For Phillips-Perron test (PP (no intercept)/Lag: Short / N), our testable hypothesis is:

*$H_0$: There is a unit root for the series*
*$H_a$: There is no unit root for the series. The series is stationary.*

We reject $H_0$ if the computed value is lower than the significance level of alpha = 0.05 and accept the alternate hypothesis $H_a$.

Table 5 shows that at alpha = 0.05, we reject the null hypothesis of a unit root in the time series for ROA, ROE, FOTC, GDP, and inflation and accept the alternate hypothesis of stationarity in the series for ADF and Phillips-Perron test. Furthermore, we reject $H_0$ for NII, SOTC and OOTC under Phillips-Perron test.

**Table 5**
**Unit Root Test Results**

| Variable | ADF | Phillips-Perron |
|---|---|---|
| ROA | 0.0115 | 0.01 |
| ROE | 0.02465 | 0.01 |
| Size | 0.43039 | 0.4956 |
| NII | 0.33904 | 0.01 |
| Liq | 0.5303 | 0.6783 |
| Lev | 0.07403 | 0.2295 |
| FOTC | 0.02524 | 0.01 |
| SOTC | 0.43189 | 0.01 |
| OOTC | 0.26937 | 0.01 |
| GDP | 0.01 | 0.01 |
| Infl. | 0.01237 | 0.01 |

The results above show that our time series data is stationary and so we can now run the panel regression model with the confidence that our series will provide reliable parameter estimates.

### Parameter Estimates

To obtain parameter estimates for our fixed effects model where bank is the fixed variable, we use the univariate generalized linear model in SPSS version 28. Tables 6a and 6b present the parameter estimates for ROA and ROE.

| Table 6a<br>Parameter estimates with ROA as dependent variable | | | | |
|---|---|---|---|---|
| **Parameter** | **B coefficient** | **Std. Error** | **t** | **Sig** |
| Intercept | 14.453 | 5.716 | 2.528 | .013 |
| Size | -1.064 | .424 | -2.510 | .013 |
| NII | .216 | .014 | 15.641 | <.001 |
| Liq | .003 | .004 | .805 | .422 |
| Lev | -.005 | .018 | -264 | .792 |
| FOTC | -.008 | .003 | -3.064 | .003 |
| SOTC | -.004 | .010 | -.375 | .709 |
| OOTC | -.010 | .012 | -.817 | .416 |
| GDP | -.002 | .017 | -.104 | .918 |
| Infl | .005 | .016 | .338 | .736 |
| Bank = BOA | 1.322 | .486 | 2.720 | .007 |
| Bank = Citigroup | 1.384 | .421 | 3.286 | .001 |
| Bank = Goldman Sachs | .560 | .302 | 1.850 | .067 |
| Bank = JP Morgan | 1.772 | .514 | 3.445 | <.001 |
| Bank = Morgan Stanley | | | | |

The value of the intercept belongs to Morgan Stanley

| Table 6b<br>Parameter estimates with ROE as dependent variable | | | | |
|---|---|---|---|---|
| **Parameter** | **B coefficient** | **Std. Error** | **t** | **Sig** |
| Intercept | 130.516 | 58.689 | 2.224 | .028 |
| Size | -9.821 | 4.353 | -2.256 | .026 |
| NII | 2.335 | .142 | 16.438 | <.001 |
| Liq | .027 | .039 | .695 | .488 |
| Lev | .226 | .189 | 1.195 | .234 |
| FOTC | -.072 | .026 | -2.788 | .006 |
| SOTC | -.026 | .102 | -.257 | .798 |
| OOTC | -.108 | .128 | -.841 | .402 |
| GDP | .103 | .175 | .076 | .940 |
| Infl | .049 | .163 | .300 | .765 |
| Bank = BOA | 12.431 | 4.992 | 2.490 | .014 |
| Bank = Citigroup | 13.057 | 4.325 | 3.019 | .003 |
| Bank = Goldman Sachs | 5.303 | 3.105 | 1.708 | .090 |
| Bank = JP Morgan | 16.822 | 5.280 | 3.186 | .002 |
| Bank = Morgan Stanley | | | | |

The value of the intercept belongs to Morgan Stanley

From the parameter estimates, we can rewrite the panel regression equations as

ROA = 14.453 – 1.064Size + .216NII + .003Liq - .005Lev - .008FOTC - .004SOTC - .010OOTC -.002GDP + .005Infl.

and

ROE = 130.516 – 9.821Size + 2.335NII + .027Liq + .226Lev - .072FOTC - .026SOTC - .108OOTC +.103GDP + .049Infl.

We use the parameter estimates to check and verify whether the predicted signs in our testable hypothesis for each independent variable are consistent with our observable signs in the regression models at .05 alpha level.

In both regressions, contrary to our hypothesis, size is negatively related to profitability, and this relationship is significant at the .05 level. Consistent with our hypothesis, NII is positively and significantly related profitability. Contrary to our hypothesis, liquidity is positively related to profitability, but the relationship is not significant. Consistent with our hypothesis, leverage is negatively related to ROA but positively related to ROE. In both cases, the relationship is not significant. Consistent with our hypothesis, FOTC is negatively related to profitability in both regression models and this relationship is significant. Consistent with our hypothesis, SOTC and OOTC are both negatively related to profitability in both regression models and the relationship is not significant. Contrary to our hypothesis, GDP is negatively related to ROA but positively related to ROE. However, in either case, the relationship is not significant. Consistent with our hypothesis, inflation is positively related to profitability in both regression models, but this relationship is not significant.

### Statistical Diagnostics

To validate our parameter estimates in the fixed effects generalized linear model, we run linear regression models on ROA and ROE and their predictor variables and perform statistical tests on the model and diagnostics on the residuals to ensure that linear regression assumptions are met.

We start our statistical diagnostics by examining the properties of the models. First, we test for the goodness of fit of the regression models by using the F-Test with the null hypothesis $H_0$: $\beta_1 = \beta_2 = \cdot\cdot\cdot = \beta_N = 0$ and the alternate H1: $\beta_i \neq 0$ for at least one i, i = 1, . . ., N. From the ANOVA Tables 7a and 7b, obtained F values are 29.309 for ROA and 33.125 for ROE with 139 degrees of freedom for both. The statistics are significant for both models since the p-value of <.001 is less than the significance level of .05. Since we reject $H_0$, we conclude that the data provides sufficient evidence to show that at least one of the independent variables in each regression contributes significantly to the model making it a better fit than a model with no independent variables.

**Table 7a**
**ROA ANOVA**

| Model | | Sum of Squares | Df | Mean Square | F | Sig |
|---|---|---|---|---|---|---|
| 1 | Regression | 6.763 | 9 | .751 | 29.309 | <.001 |
| | Residual | 3.333 | 130 | .026 | | |
| | Total | 10.095 | 139 | | | |

Predictors: (Constant), Inflation, Liquidity, GDP, NII, OOTC, Size, SOTC, FOTC, Leverage.

| Table 7b<br>ROE ANOVA | | | | | | |
|---|---|---|---|---|---|---|
| **Model** | | **Sum of Squares** | **Df** | **Mean Square** | **F** | **Sig** |
| 1 | Regression | 785.727 | 9 | 87.393 | 33.125 | <.001 |
| | Residual | 342.621 | 130 | 2.636 | | |
| | Total | 1128.348 | 139 | | | |

Predictors: (Constant), Inflation, Liquidity, GDP, NII, OOTC, Size, SOTC, FOTC, Leverage.

Second, Tables 8a and 8b present the model summaries for ROA and ROE, respectively, with respect to $R^2$, Standard error of the estimate, and Durbin-Watson.

For ROA, $R^2$ is 0.670 which tells us that the independent variables explain 67% of the variation while the more conservative adjusted $R^2$ of 0.647 shows that the model explains 64.7% of the variation in the data. For ROE, $R^2$ is 0.696 with an adjusted $R^2$ of 0.675. This means that the independent variables in both models explain about two-thirds of the variation in the models.

| Table 8a<br>ROA Model Summary | | | | | |
|---|---|---|---|---|---|
| **Model** | **R** | **R square** | **Adjusted R square** | **Std. Error of the estimate** | **Durbin-Watson** |
| 1 | .818 | .670 | .647 | 0.16011% | 1.851 |

Predictors: (Constant), Inflation, Liquidity, GDP, NII, OOTC, Size, SOTC, FOTC, Leverage.

| Table 8b<br>ROE Model Summary | | | | | |
|---|---|---|---|---|---|
| **Model** | **R** | **R square** | **Adjusted R square** | **Std. Error of the estimate** | **Durbin-Watson** |
| 1 | .834 | .696 | .675 | 1.62344% | 1.819 |

Predictors: (Constant), Inflation, Liquidity, GDP, NII, OOTC, Size, SOTC, FOTC, Leverage.

The small values of the standard error of the estimate for both ROA 0.160% and ROE 1.623% models further confirm how well the data points are packed around the estimated regression lines. The results are a confirmation of the goodness of fit of our models since the smaller the standard error of estimate, the smaller the margin of error in the estimate.

We also use the Durbin-Watson statistic to check for autocorrelation of the independent variables. Since our Durbin-Watson statistics obtained are 1.851 and 1.819, respectively, and are between 1.5 and 2.5, we conclude that the variables in both models are not autocorrelated. That is, the predictor variables are independent.

Third, we check for multicollinearity of the predictor variables in the regression models by looking at the variance inflation factor (VIF) values for each variable. Large values of VIF greater than 10 indicate the presence of multicollinearity. The presence of multicollinearity can cause distrust of the p-values to identify independent variables that are statistically significant. Tables 9a and 9b below show that although there is some level of multicollinearity in the data, it is not severe enough to warrant concern because all VIF values for both ROA and ROE models are less than 5. We can therefore have confidence in the significance of our regression coefficient estimates because the variables in the model are not correlated. That is, the predictor variables are independent.

**Table 9a**
**ROA**

| | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** | **Sig** | **Collinearity statistics** | |
|---|---|---|---|---|---|---|---|
| **Model** | | | | | | **Tolerance** | **VIF** |
| 1 | Constant | -2.520 | | -3.567 | <.001 | | |
| | Size | .198 | .338 | 4.471 | <.001 | .445 | 2.245 |
| | NII | .230 | .842 | 15.227 | <.001 | .830 | 1.204 |
| | Liq | -.001 | -.099 | -1.551 | .123 | .625 | 1.600 |
| | Lev | -.005 | -.029 | -.341 | .734 | .345 | 2.900 |
| | FOTC | -.008 | -.316 | -3.681 | <.001 | .345 | 2.984 |
| | SOTC | .026 | .256 | 3.812 | <.001 | .563 | 1.778 |
| | OOTC | .006 | .046 | .490 | .625 | .285 | 3.512 |
| | GDP | -.021 | -.059 | -1.117 | .266 | .915 | 1.093 |
| | Infl | -.020 | -.070 | -1.219 | .255 | .759 | 1.317 |

**Table 9b**
**ROE**

| | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** | **Sig** | **Collinearity statistics** | |
|---|---|---|---|---|---|---|---|
| **Model** | | | | | | **Tolerance** | **VIF** |
| 1 | Constant | -30.547 | | -4.265 | <.001 | | |
| | Size | 2.138 | .345 | 4767 | <.001 | .445 | 2.245 |
| | NII | 2.468 | .855 | 16.113 | <.001 | .830 | 1.204 |
| | Liq | -.012 | -.103 | -1.682 | .095 | .625 | 1.600 |
| | Lev | .238 | .122 | 1.484 | .140 | .345 | 2.900 |
| | FOTC | -.080 | -.285 | -3.471 | <.001 | .346 | 2.894 |
| | SOTC | .267 | .246 | 3.819 | <.001 | .563 | 1.778 |
| | OOTC | .058 | .039 | .436 | .664 | .285 | 3.512 |
| | GDP | -.174 | -.046 | -.920 | .359 | .915 | 1.093 |
| | Infl | -.206 | -.068 | -1.227 | .222 | .759 | 1.317 |

In the following section, we examine the statistical properties of residuals and check whether they meet model assumptions for linear regression. To do so, we check for normality, homoscedasticity, and for outliers.

First, we check for normality of predicted residuals using histograms and the normal Q-Q plots of standardized residuals. Using SPSS Version 28, we standardize/normalize the predicted residuals so that the values have a mean of zero and a standard deviation of one and then use these values to graph the histograms.

Figures 1a and 1b show the graphs of histograms we obtained for ROA and ROE standardized residuals, respectively.

**Figure 1a.**

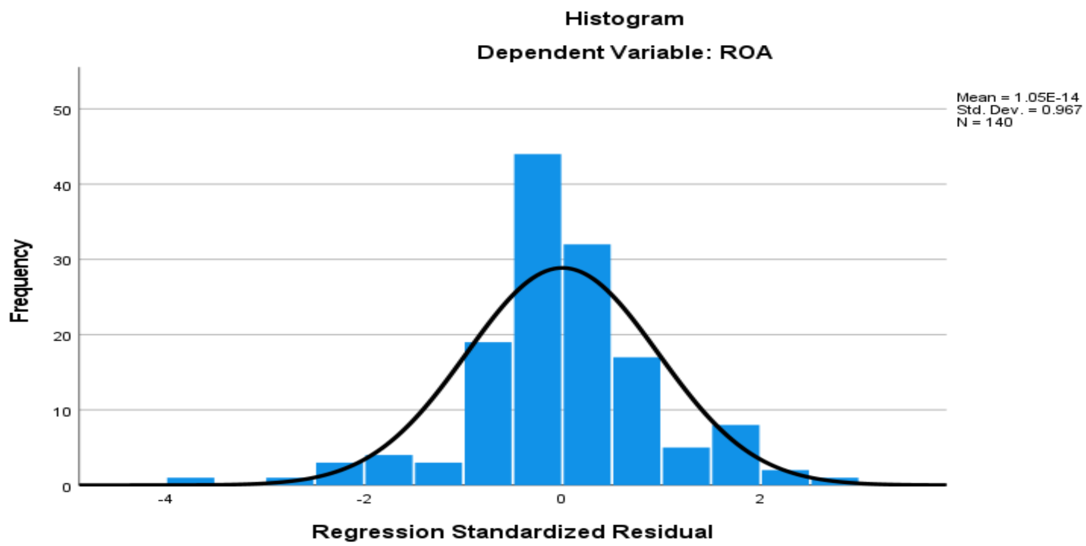
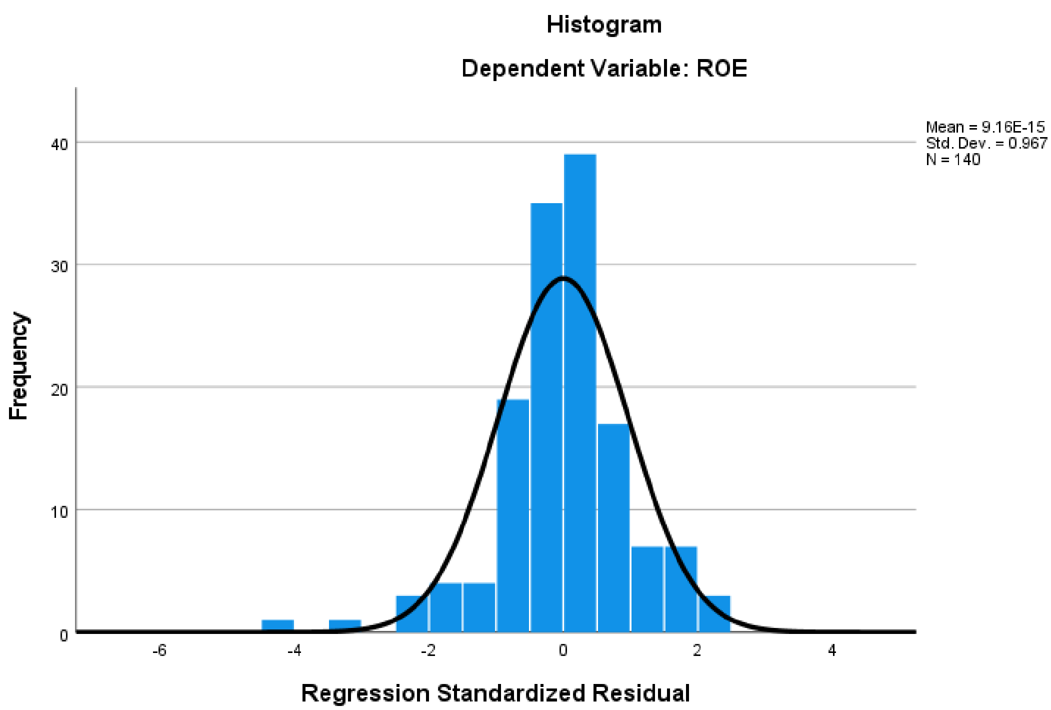



**Figure 1b.**



Figures 1a ROA and 1b ROE histograms show that standardized residuals closely follow a normal distribution. We therefore conclude that the standardized residuals are normally distributed.

**Figure 2a**

**ROA**

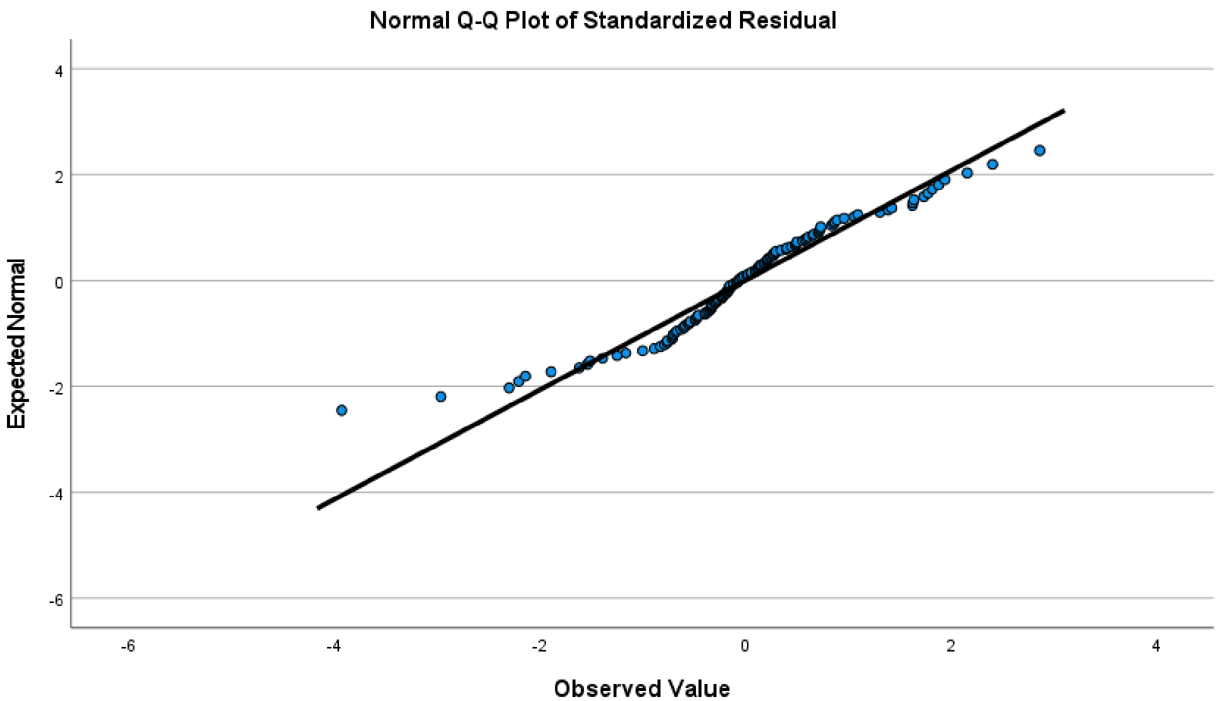
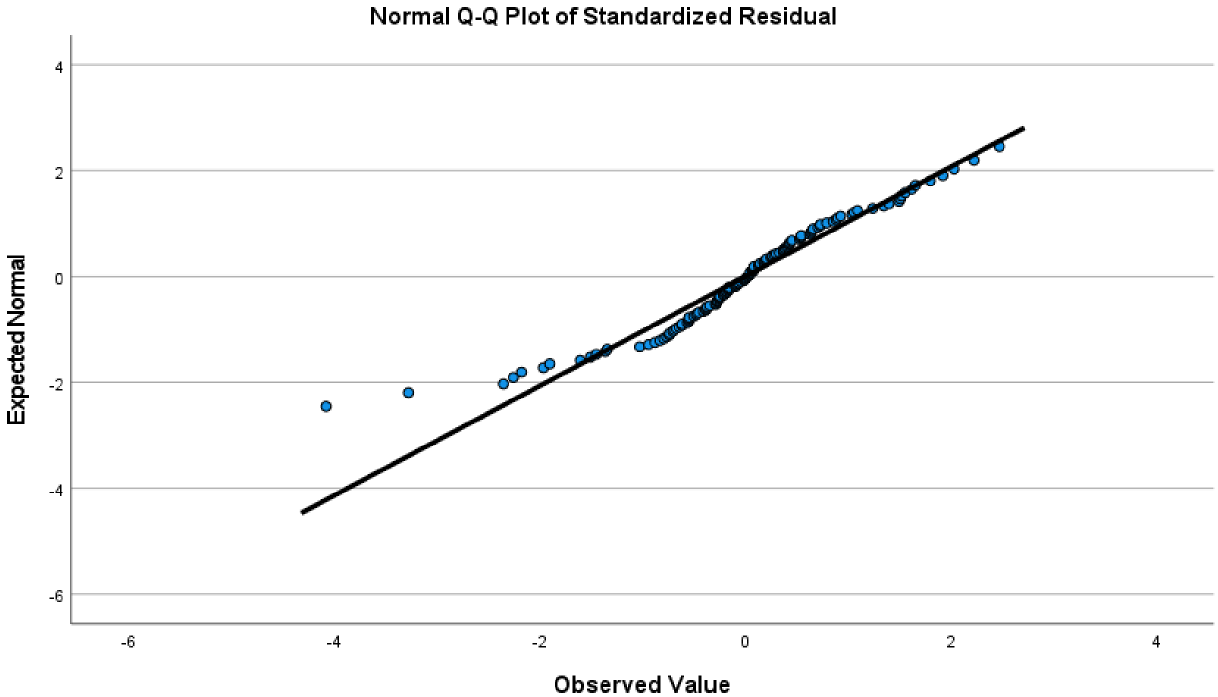


**Figure 2b**
**ROE**




Figures 2a ROA and 2b ROE normal Q-Q plots of standardized residuals show that although there are a few points that are away from the diagonal line, most of the data points closely follow the line and do not stray far away. Therefore, we can conclude that the standardized residual data points are normally distributed.

Next, we test for linearity and homoscedasticity of standardized residuals using scatterplots in Figures 3a and 3b.

**Figure 3a**

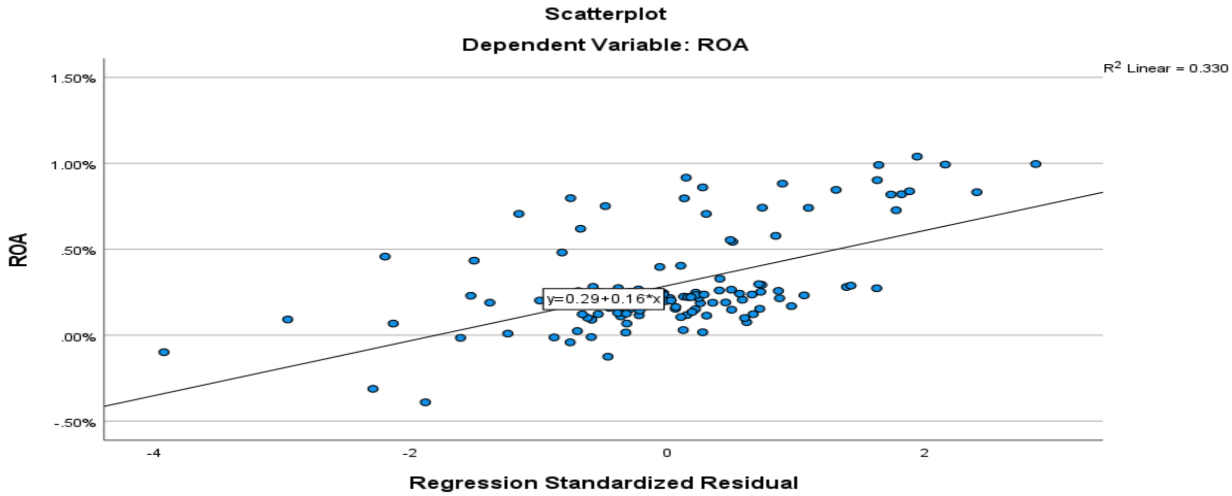
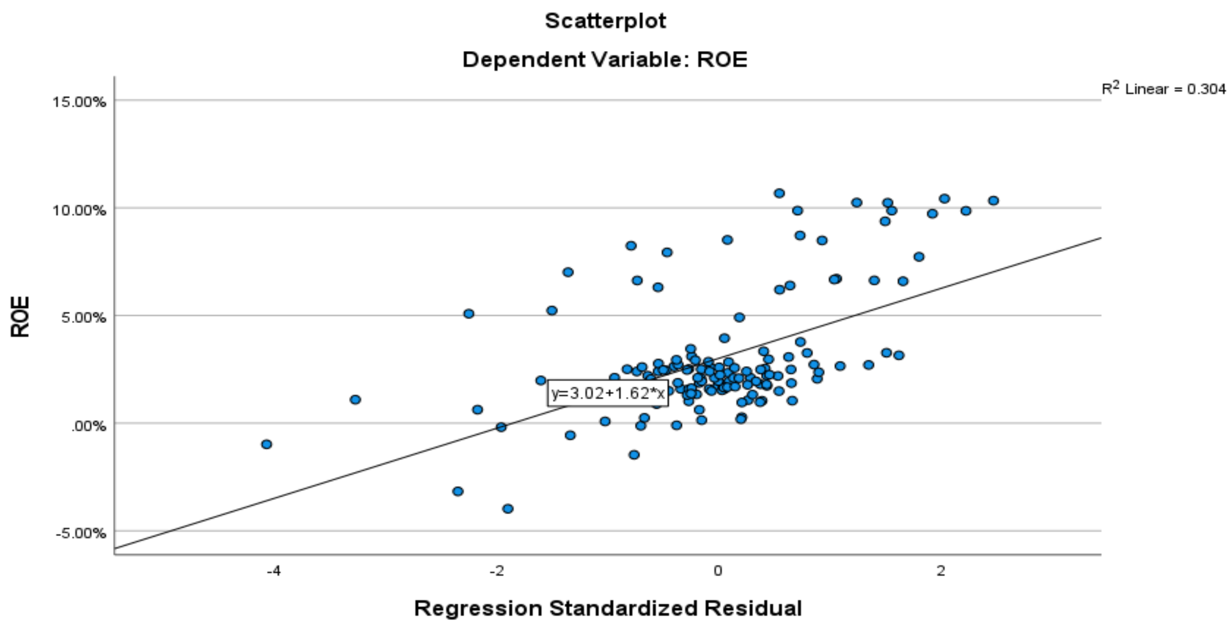



**Figure 3b**




Figures 3a and 3b show that the points in the scatterplots look like they fall on roughly a straight line, which indicates that there is a linear relationship between the standardized residuals and the dependent variable. Therefore, we conclude that the linearity assumption is met.

Figures 3a and 3b also show that the magnitude of the distance between the standardized residuals and the fitted lines for both ROA and ROE do not change to form a fan or a cone but stays consistent as you move from left to right. This happens because the variance is not increasing as you move from left to right. We can therefore conclude that the residuals are homoscedastic.

We also use the Breusch-Pagan test to determine whether heteroscedasticity is present in the regression model. The test uses the null hypothesis, $H_0$: homoscedasticity (residuals are distributed with equal variance) against the alternate, $H_a$: heteroscedasticity (residuals are distributed with unequal variance). Tables 10a and 10b present results of the Breusch-Pagan tests:

**Table 10a**
**ROA Breusch-Pagan Test**

| Chi-Square | df | Sig |
|---|---|---|
| .155 | 1 | .694 |

**Table 10b**
**ROE Breusch-Pagan Test**

| Chi-square | df | Sig |
|---|---|---|
| .154 | 1 | .695 |

Since the p-values for ROA and ROE are .6943 and .695, respectively and both values are greater than alpha of .05, we fail to reject the null hypothesis of homoscedasticity or equal variances.

We can further surmise that since the residuals are both normally distributed and homoscedastic in the results above, the linearity test assumption of the residuals is met.

Last, but not least, we use Cook's distance and Scatterplots of Centered Leverage Values and Standardized residuals to check for outliers. The cutoff for Cook's distance is 4/n where n is the sample/population size. Since n is 140, Cook's cutoff is 0.02857. With this cutoff, there are 15 outliers for ROA standardized residuals and 10 outliers for ROE standardized residuals. In percentages, these represent 10.7143% and 7.14% of standardized residuals, respectively.

We also check for outliers using a scatterplot of centered leverage values and standardized residuals (see figures 4a and 4b below) to investigate whether there are extreme values that will tend to pull the regression line towards them and thus having a significant impact on the regression coefficients. We are doing this because normal probability theory posts that approximately 5% of standardized residuals will be outside ±1.96 standard deviations and approximately 1% will be extreme outliers and lie outside ±3 standard deviations of the area under the curve in the normal distribution. In figure 4a, there is one residual outside of ±3 standard deviations while in figure 4b, there are 2 residuals outside ±3 standard deviations. We therefore conclude that we do not have a problem of extreme outliers.

The above tests validate our model parameter estimates as all linear regression assumptions are met.

**Figure 4a**
**ROA**

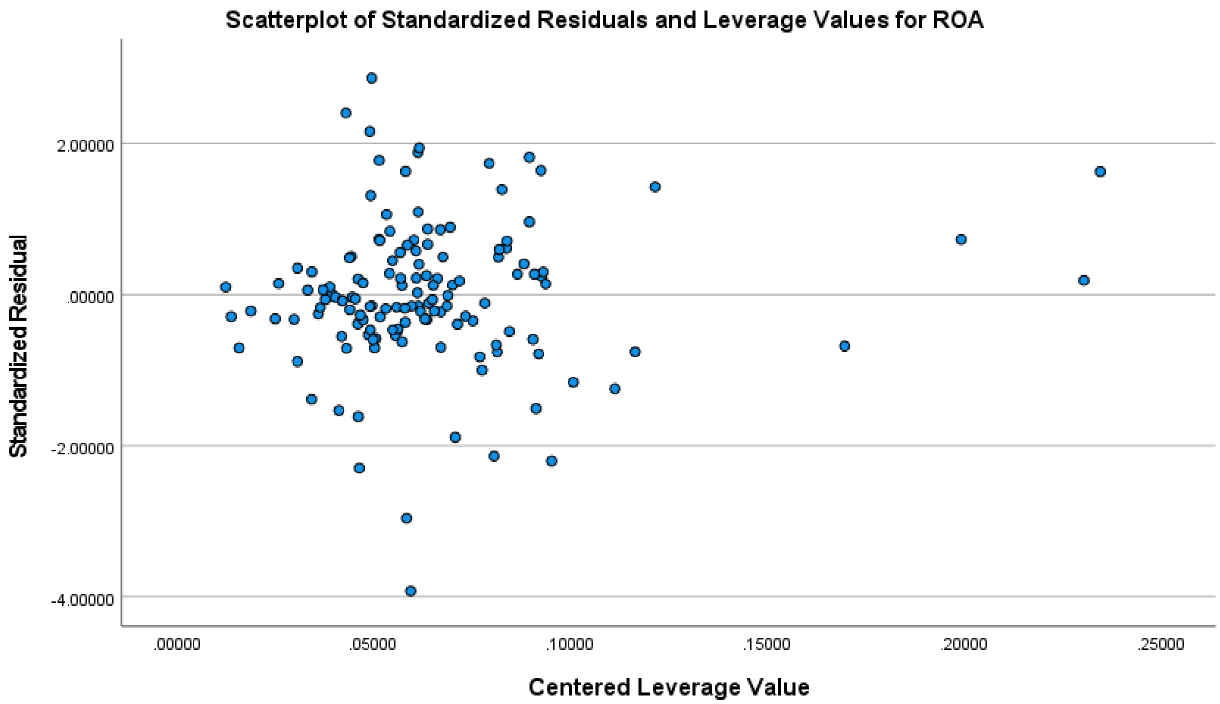
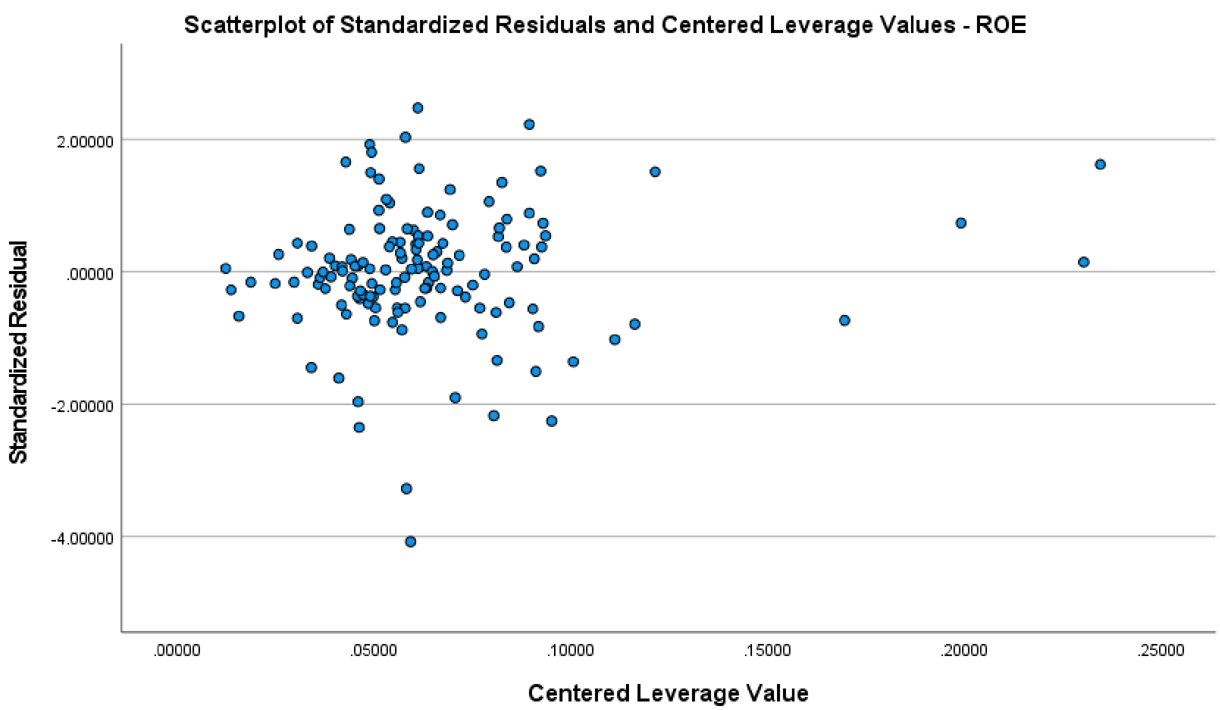



**Figure 4b**
**ROE**



## CONCLUSION

The finding of the study, consistent with our hypothesized predicted signs show that new rules imposed on banks following the financial crisis had a negative impact on bank profitability. The relationship between OTC forwards, swaps, & options and profitability are all negative, a finding that is not surprising given that the new rules put restrictions on bank risk taking behavior. Specifically, the following stipulations in the restrictions limited the amount of capital available to banks for their own trading. First, under the Volker rule, banks were prohibited from using customer deposits for their own trades and from using or owning hedge funds. Second, under Basel rules, banks were required to hold more equity capital to satisfy liquidity and reserve requirements. Third, since proprietary trading was restricted, banks could no longer make investments for themselves but could only do so on behalf of their clients as intermediaries. Fourth, under the new rules, banks that trade in OTC derivatives had to be prepared to pay higher margin commitments and more frequent margin calls. Prior to the financial crisis, banks were accustomed to trading both an underlying security and a hedging instrument with a single broker and took advantage of netting the margin for both transactions. Under the new rules, this advantage disappeared as the derivatives had to be cleared through a central counterparty using a swap execution facility, which is an electronic platform that matches counterparties in a swap transaction. These four factors provide a reasonable explanation why OTC forwards, swaps and options had a negative relationship with profitability. This finding also makes sense given that consistent with Yang (2013) study that found a positive relationship between the volume of OTC derivatives and ROA before the financial crisis, we would expect the opposite given the restrictive environment the new rules crested for OTC derivatives.

However, only the parameter estimate for OTC forwards is significant while the estimates for OTC swaps and options are insignificant.

## LIMITATIONS OF THE STUDY

The data used in assessing the relationship between the independent variables and dependent variables was aggregated data from Capital IQ. Aggregate data is focused on the relationship between derivatives use and profitability of banks as a group and fails to capture the impact of variable changes at the individual bank level.

## SUGGESTIONS FOR FURTHER RESEARCH

Further research focused on the relationship between derivatives use and profitability at the bank level is warranted. Such study would shade light on the manner in which profitability changed as independent variables changed from bank to bank due to their different individual bank characteristics.

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