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Modelling the dynamics of Liquidity risk and bank profitability. A case of U.S. commercial banks

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DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.

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ABSTRACT

This study examines the effects of liquidity risk on bank profitability in different time horizons in the United States of America's commercial banking sector over the years 2011 to 2020. The effects are studied using data obtained from 10 commercial banks in the United States of America. Both the two-step system GMM and the generalized least squares methods are applied. The results from two-step system GMM show that liquidity risk negatively impacts bank profitability across all horizons. The random effects estimator on the other hand does not show any robust impacts of liquidity risk on bank profitability.

Keywords: *Liquidity risk, bank profitability, two-step system GMM.*

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

In the recent literature, there has been a surge on the study of liquidity risk and its management. These studies, however, became prevalent following the global financial crisis that saw the financial sector in the verge of collapse. The financial sector performs a vital role in the economy of any country and its major role is to offer commercial and retail customers financial services. After the financial crisis, academic research heightened, and risk came on the spotlight. Studies on the types of risk and its effects on financial stability were done. An example of such a study was done by Tan (2014) which focused on the influence of risk and competition on the profitability of banks in China. Some of the risks that came on the spotlight after the financial crisis were liquidity risk, credit risk and operational risk.

With the study of these risks, major concerns on liquidity management, risk and crisis management in banks rose and many governments started strengthening their financial stability. Commercial banking in virtually all countries have been subjected to regulations (Hull, 2012). Bodies have been formed to regulate the financial sector and capacities of crisis management increased. In Kenya for example, the mandate to regulate the commercial banks in Kenya was assigned to the Central Bank of Kenya. The Microfinance Act 2006 which regulates the establishment, business and how deposit taking microfinance institutions operate through licensing and supervision in Kenya became effective on May 2, 2008.

In the United States, banks have minimum capital requirement which is a key supervisory issue conducted by the Basel Committee. The Basel Committee aims to improve the quality of bank supervision. A series of regulations known as the Basel Accord was developed by The Basel Committee on Banking Supervision (BCBS). From these regulations, one of the major takeaways was the Liquidity Coverage Ratio and the Net Stable Funding Ratio (NSFR). The BCBS aims at discouraging banks from lending high levels of short-term debt by encouraging them to hold specific highly liquid assets and maintain fiscal solvency at a certain level. Companies are currently reporting high liquidity. An example is Barclays which declared a 144% LCR in the third quarter in 2019 in their consolidated financial statement. According to the Federal Reserve, banks are currently profitable as compared to the period 2007-2008.

Further studies have been done to determine whether liquidity risk has significant impacts on bank operations and its returns. An issue that has come up in the recent studies on liquidity is the lack of consensus on the relationship between liquidity risk and profitability. Researchers also lack consensus on the definition of liquidity and liquidity risk. Nikolaou (2009), therefore, classifies liquidity into three. The first type of liquidity is funding liquidity. Funding liquidity according to the Basel Committee of Banking supervision is the capacity of a bank to meet its obligations as they come due and therefore settle their positions. The unprecedented fluctuations of the bank's capacity to meet its obligations over time leads to funding liquidity risk. The second type of liquidity is the central bank liquidity. Nikolaou (2009) states that when the central is able to inject liquidity into the financial system when needed by the economy, the centra bank is said to be liquid. When the Central bank is unable to inject liquidity in the economy's needs, the Central bank is said to be illiquid and faces liquidity risk. The other type of liquidity is market liquidity. Many studies have defined market liquidity as being able to trade an asset on low cost in short notice and the price of the asset is not affected or the impact on the price is low.

Risk is the probability of an unlikely or unexpected event to occur and have dire effects on the operations of a company. In our case, the probability of being illiquid poses a likelihood of liquidity risk. Many topics on liquidity and liquidity risk have been explored. According to a study done by Acharya (2006), liquidity risk is caused by idiosyncratic risk and cash outflows in the case of liquidity shocks. He documents that funding liquidity can also be caused by market illiquidity. He gives an example of an instance when an instrument is unable to be sold in the market. This inability of an instrument to be traded in a market can cause the firm to face funding liquidity risk. To hedge against liquidity shocks, banks opt for deposit insurance and also the use of derivatives to hedge against risk.

Other researchers have further looked at the determinants of liquidity in banks. Munteanu (2012) concludes from a study he did on causes of liquidity in banks that capital adequacy, impaired loans, interbank funding, loan loss provisions, z-score, cost to income ratio and credit risk determine liquidity. Further to this study, Imbierowicz and Rauch (2014) did a study to determine the influence of liquidity risk on credit risk and vice versa. From his study, he concluded that the two risks did not have an economically meaningful time-lagged relationship. Studies on the effect of liquidity risk and profitability have also come on the spotlight. With liquidity and liquidity risk

being a major concern by researchers, studies on the effects of liquidity and liquidity risk on profitability have gained momentum and many studies have been done to establish this relationship. However, many researchers have different views on this relationship.

1.2 Prior relationship between liquidity and profitability

To establish whether liquidity has an effect on profitability of banks, Sufian and Kamarudin (2012) did a study on the determinants of profitability and this study was done on Bangladesh's Commercial Banks. In their study, they determined that profitability is determined by bank-specific factors and macroeconomic factors. To determine this relationship, they ran a regression analysis. From this regression they found out that the bank-specific determinants of profitability are liquidity, management quality, size of bank, non-traditional activities, and capitalization. The macroeconomic factors that had an influence on profitability from their study are growth in GDP, concentration, and inflation. Further on their research, they noted that liquidity has mixed impacts on profitability. In some instances, the relationship between liquidity and profitability is negative while in some instances the relationship is positive. To justify their findings, they state that in a weak economy, loans are unlikely to be defaulted and hence, less profitable. This shows that liquidity and profitability are negatively correlated. Using a different measure of profitability, they find that banks with higher loan to asset ratios tend to have higher profitability.

With the prior determination of a relationship between liquidity and profitability, Al-Qadi and Khanji (2018) further did a study to investigate whether the relationship between liquidity and profitability is negative or positive. However, they did their research on a trade service sector. They used liquidity indicators such as current ratio and quick ratio to investigate this relationship. To proxy profitability, they used return on assets (ROA) and return on equity (ROE). They found that profitability is greatly and significantly influenced by liquidity in the Jordanian trade companies. The study, however, does not justify whether the relationship between these two variables is positive or negative but justifies that there is an actual relationship between liquidity and profitability.

Empirical results from a study done by Staikouras and Wood (2004) in the European banking sector from 1994 to 1998 states that there is a negative effect of risk on bank profitability. The estimator used in the study is the fixed effect estimator.

1.3 Problem statement

According to economic theory, the ideal relationship between liquidity risk and profitability is a positive relationship. Holding liquid assets is an opportunity cost for returns hence some researchers suggest that liquidity risk is positively related with profitability. Risky investments are associated with higher returns and hence higher profitability and vice versa (Vieira, 2010).

However, there have been mixed results on the past literature about the relationship between liquidity risk and profitability. Studies on the relationship between liquidity and profitability have yielded different conclusions regarding this relationship. Staikouras and Wood (2004), in their study to determine the impacts of risk on bank profitability in the European banking sectors, find a negative relationship between liquidity risk and bank profitability. The estimator used for the study is the fixed effects estimator. The period of study is between 1994-1998. Sufian and Chong (2008) did a study on the Philippine banking sectors for the period 1990-2005 using the fixed effects estimator and found a negative relationship between liquidity risk and bank profitability. Tan (2016) did a study on the impacts of risk and competition on bank profitability in China. The estimator used is the one-step GMM estimator. The results, however, do not show any robust impacts of risk and competition on profitability. Sufian (2011) did a study on the effects of risk on bank profitability on the Korean banking sector in the period 1986-1995 using the fixed effects estimator and finds that banks with low liquidity level have higher profits which implies a positive relationship between bank profitability and liquidity risk.

These mixed results could be due to different estimators used. Some studies have used estimators that do not control for endogenous explanatory variables. Bwacha and Xi (2018) have observed that the mixed results could also be due to the use of short periods to investigate the relationship. They suggest that liquidity risk might not have an effect on profitability in the short term but might have an effect on profitability in the long term. These studies show that no exact final conclusion could be drawn till now and thus make this worth studying.

Most of the research on this relationship was done immediately after the global financial crisis and therefore most of them do not incorporate data for the years after 2008. The time horizons for most studies have also been relatively short. Additionally, this study incorporates panel data lag selection to investigate whether there is a lag relationship between liquidity risk and bank profitability. I will use panel data to study the relationship between liquidity risk and profitability

in this study. In order to control for endogeneity, the study uses two-step system GMM estimation to find parameters.

1.4 Research objectives

1. To determine the relationship between liquidity risk and profitability

1.5 Research questions

1. What is the relationship between liquidity risk and bank profitability?

2. Does the relationship change depending on the time horizon?

1.6 Justification of the study

Liquidity ensures proper operation of financial markets and determines the progress and advancement. Low liquidity levels cause adverse effect on the bank performance and market values of asset. Due to poor liquidity risk management, banks around the world face financial crisis and hence the study of liquidity risk and its implications on bank performance becomes an important topic to study on. This paper analyzes the profitability of the banks especially because the profitability of a bank reflects the banks management and because a bank's competitiveness is increased by high profits from the bank. Therefore, studying and understanding liquidity risk has very important practical implications.

CHAPTER 2: LITERATURE REVIEW

2.1 Theoretical review

According to economic theory, liquidity risk and profitability have a positive relationship. This is because it is expected that a company that uses its current assets to invest in risky investments is expected to realize returns in the future hence with more returns the company realizes more profits (Vieira, 2010). Elsharif (2016) explains some of the theories used in explaining liquidity management. These theories are anticipated income theory, shiftability theory, liquidity management theory and commercial loan theory.

2.1.1 Anticipated income theory

According to this theory, loan portfolios are considered as a source of liquidity to the firm in the long term. Loans for example mortgage loans are expected to be paid in installments over a certain period of time and hence the banks anticipates this loan payments as future income. In this way, these loan payments are important to the bank as they give constant flow of income and hence adds liquidity to the bank. However, if the bank needs liquidity in the short-term, the bank can sell the loan in secondary markets in order to obtain liquidity (Alshatti, 2014). This theory supports that a company can use its liquid cash now in order to get future returns and hence a positive relationship between liquidity risk and returns. The more a bank gives out loans, the more the returns in the future.

2.1.2 Shiftability theory

The shiftability theory is a theory that advocates for the shift of assets to a more liquid bank when a bank needs liquidity. The bank can decide to sell off its assets in exchange of liquid money in order to satisfy its liquidity needs. This enables the bank to run more efficiently as there is less money as reserves. To avoid a liquidity crisis, this shiftability theory enables a bank to sell off their assets at a low price (Elsharif, 2016). This theory, however, does not show any relationship between returns and current liquidity.

2.1.3 Liquidity management theory

The liquidity management theory does not advocate for the traditional ways of maintaining liquidity in a bank such as holding liquid investments. Instead, the liquidity management theory advocates for banks to borrow from money markets and capital markets when in need of liquidity (Emmanuel, 1997). This theory does not show the relationship between liquidity risk and bank

profitability. The theory does not advocate for liquidity in banks and only advocates in it only when there is need for liquidity in the bank. This theory does not show whether there is correlation between future returns and liquidity risk.

2.1.4 Commercial loan theory

The commercial loan theory states that loans are given to customers with short-term needs and will be able to pay the loan in the short-term. According to this theory, the bank does not lend money for the purpose of real estate investment which is expected to pay back in the long term. Therefore, the bank constantly receives money in cycles since loan customers take them in cycles and hence the bank does not lack liquidity. This theory shows that the bank does not face liquidity risk due to the constant flow of returns from loans given to customers. This theory shows that there is a positive correlation between liquidity risk and profitability.

2.2 Empirical review

2.2.1 Empirical literature on profitability

According to a study done by (Sufian and Chong 2008), profitability is determined by internal and external factors. Internal factors are bank-specific factors and are mainly influenced by the bank's management decision and policy objectives while external factors do not relate to bank's management decisions and operations. The external factors are influenced by the legal environment in which the bank is in and the economic environment of the bank among other factors. These internal factors include size of the bank, liquidity, asset quality, management quality, bank's non-traditional activities, and capitalization. External determinants include inflation, economic growth, and financial crisis.

Staikouras and Wood (2004) did a study on the impacts of risk on bank profitability in the European banking sector. The period of study was between 1994-1998. The estimator used in the study was the fixed effects estimator. The empirical results from the study state that the risk has a negative effect on bank profitability in the European banking sector. Sufian and Chong (2008) in their study on the Philippine banking sector in the period 1990-2005 found that risk is negatively related to bank profitability. The estimator used was the fixed effects estimator.

Sufian (2011) studied the effects of risk and concentration on bank profitability. The study was done on the Korean banking sector. The period of study is between 1986-1995. Sufian (2011) used the fixed effects estimator to find estimates of the model. The empirical results from the study show that credit risk is negatively related to bank profitability. He also finds that the Korean banks with low liquidity levels which exhibit liquidity risk tend to have higher profitability. This implies a positive relationship between liquidity risk and bank profitability. It is argued that the institutions that are more profitable could easily offer new products and services to their customers and hence acquire more profits from the new products and services. For profitability to be realized, the profits from the new products and services should be more than the losses of liquidity risk.

In a study done to identify the bank-specific and macroeconomic determinants of bank profitability in a sample of 31 commercial banks in Bangladesh, (Sufian and Kamarudin, 2012) used multiple regression analysis to identify the determinants of bank profitability. The Generalized Least Squares method is applied and followed by fixed effects model instead of the random effects model and tested using the Hausman test. The study highlights that non-traditional activities and liquidity have a mixed impact on bank profitability. The study also suggests that GDP and market concentration have a negative impact on profitability.

Kosmidou (2008) did a study to determine what impacts performance in Greek banks between the years 1990 and 2002. To proxy performance, he used return on average assets. In the study, high return on average assets (ROAA) meant that the bank was performing well. He found out that banks that had higher returns on average assets were well capitalized and ratio of cost to income was low. He also determines that as GDP increases, the return on average assets also increases. This impact was significant which implies that an increase in GDP leads to an increase in return on average assets. In his study, he also observed that the negative impact of inflation on ROAA is significant. An increase in inflation would negatively impact the return on average assets. He also determined that the size of the bank had an impact on the return on average assets and was only significant when the macroeconomic factors were included in the model.

Mayne (1969) in a study to determine whether membership in the Federal Reserve System determined liquidity and earnings in banks, compares the cash ratios of non-member banks and member banks. Member banks are required to maintain a certain level of cash reserve which increases the liquidity burden of the bank as opposed to non-member banks. This implies that

member banks hold significantly large cash ratios as compared to non-member banks hence a member bank would be more liquid than a non-member bank. Member banks are also required to hold a higher proportion of non-earning assets as compared to non-member banks. This would mean that, holding all other determinants of earnings constant, a member bank would be expected to have low earnings as compared to non-member banks. According to the author, the members would be forced to sacrifice profitability for liquidity. It is however, argued that the member banks reduce liquidity in loans and investments by holding risky earning assets to compensate for the large cash flows. These risky earning assets in turn earn higher rates of return which compensates for the non-earning assets. The study concludes that membership in the Federal Reserve System does not determine the profitability of the bank.

Deloof (2000) did a study to determine whether working capital management had an effect on profitability or whether profitability had an effect on working capital management. The study was, however, done on non-financial firms in Belgian. He notes that many firms invest heavily on working capital and hence, firms that manage their working capital well as compared to those firms that do not manage their working capital well should earn higher profits. To test this hypothesis, he used number of days accounts receivable, number of days payable, inventories and cash conversion cycle as a comprehensive measure of working capital management. From his findings, a non-profitable company would take more days to pay off their debt and hence, a negative relationship between number of days payable and profitability. He also concludes that days payable, days receivable have a negative relation with profitability.

Tan (2014) did a study on the impacts of risk and competition on bank profitability in China. The study focuses on state-owned, joint-stock and city commercial banks from the years over the years 2003-2011. The estimator used is the one-step GMM estimator. The results, however, do not show any robust impacts of risk and competition on profitability but findings show that there is an impact of taxation, overhead cost, labor productivity and inflation on profitability. According to Tan (2014), the central government in China has so much influence on the operations of banks especially the state-owned commercial banks and hence influences the non-performing loans negatively. The increase in non-performing loans causes a decrease in the profits of a bank and hence lack of improvement in profitability.

This paper analyzes the profitability of the banks especially because the profitability reflects the banks management and because a bank's competitiveness is increased by high profits from the bank. Their findings show that competition and risk have no impact on profitability. They further find out that state-owned commercial banks, as compared to joint-stock commercial banks and city commercial banks, have higher profitability in terms of Return on Asset (ROA), Net Interest Margin (NIT) and Profit Margin (PBT). Since 1978, several rounds of banking reforms in China have aimed to increase the competitive condition and lower risk-taking behavior which is supposed to have influence on bank profitability.

Tan (2014) also states the empirical results of studies done earlier on profitability in banks in the European countries, emerging markets banking sectors and the US banking sector. Most of the researchers have used GMM two step system while others have used OLS and fixed effect estimator in their methodologies. Empirical results from a study done by Staikouras and Wood (2004) in the European banking sector from 1994 to 1998 states that there is a negative effect of risk on bank profitability. The estimator used is the fixed effect estimator. Goddard et al. (2004a) did a study on bank profitability using a two-step GMM estimator in the European banking sector from 1992 to 1998 and found out that diversification has a positive effect on profitability in the UK.

2.2.2 Empirical literature on liquidity

Munteanu (2012) in a study to determine the causes of liquidity in banks, he conducted the research on banks in Romania. The research focuses on external and internal determinants of bank liquidity. The external determinants studied are macroeconomic factors and the internal determinants studied include bank-specific factors. The author determines the relationship between these factors and bank liquidity. He also compares the effects of these determinants on liquidity before and during the financial crisis of 2008. Munteanu (2012) suggests that many profitable companies with management systems do not consider liquidity when analyzing their funds and they face many difficulties due to this misunderstanding of liquidity risk. He gives an example of a profitable company, Lehman brothers, which defaulted during the financial crisis of 2008 due to mismanagement of liquidity. These factors studied help companies to manage their liquidity risks and therefore, protect against failure of a company/defaulting.

Munteanu (2012) uses two liquidity ratios to measure liquidity in a company. The first liquidity measure, L1 is a ratio of net loans to total assets. The second liquidity measure, L2 is a proportion of liquid assets to deposits to short-term funding. He uses data from Fitch's Bank Scope database for bank-specific factors and Eurostat database for macroeconomic factors. He uses data from 2002 to 2010 to capture the pre-crisis period and the crisis period. Linear multivariate regression model is used to find the relationship between the variables and liquidity.

Munteanu (2012) found that the independent variables capital adequacy, impaired loans, interbank funding, loan loss provisions, z-score, cost to income ratio and credit risk rate had either a positive or negative relationship on liquidity. In the pre-crisis period, however, there was a relationship between capital adequacy, impaired losses, Interbank funding and loan loss provision and liquidity. The loan loss provision had a positive effect on liquidity while capital adequacy, impaired losses, Interbank funding had a negative effect on liquidity. In the crisis period, the z-score and impaired losses influenced liquidity. The z-score had a positive effect on liquidity and the impaired losses had a negative effect on liquidity. For L2, loan loss provisions funding cost, ROBOR and unemployment had an influence on liquidity. In the pre-crisis period, capital adequacy had a positive effect on liquidity while credit risk rate and inflation rate had a negative effect on inflation. During the crisis period, the loan loss provisions, ROBOR and inflation rate had a positive effect on liquidity.

Taghavi and Diman (2013) did a study on the relationship between liquidity and credit risk in Islamic banking industry in Iran. They studied the effect of ownership type, bank size and financial crises on liquidity risk and credit risk. They came up with four hypotheses: the relationship between liquidity and credit risk components, the effect of ownership on the relationship between credit risk and liquidity risk, the third hypothesis is the effect of bank size on the relationship between credit risk and liquidity risk and the fourth hypothesis is the effect of the financial crisis on the relationship between credit risk and liquidity risk.

According to Taghavi and Diman (2013), a positive liquidity risk would mean that the bank would not be able to guarantee incidents in case of an crisis and vice versa. The study uses dummy variables on variables that are not quantifiable. In the research, bank ownership and financial crises are treated as dummy variables. For financial crises, 0 represents a period of no crises while 1 represents a period with financial turbulence. For bank ownership, 0 represents ownership by

government and 1 represents ownership by private companies. In this study, log of total assets was used as a proxy to calculate the size of the bank. At a 5% level of significance, bank size is the only variable that is normally distributed. Results from the study of hypothesis 1 shows that there is a significant negative relationship between liquidity risk and credit risk. An explanation for this negative relationship, which is given by Taghavi and Diman (2013) is that an increase in credit is given by reduced risk. Results from the second hypothesis suggest that given a five percent significance level, ownership does not have any impact on the relationship between liquidity risk and credit risk. Results from the third hypothesis suggest that bank size has no impact on the relationship between credit risk and liquidity risk. Results from the fourth hypothesis suggest that the crisis did not have an impact on the relationship between credit risk and liquidity risk. Other results show that ownership and bank size influence liquidity risk while the financial crisis has no effect on liquidity risk.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter sets to highlight how I am carrying out my study, the population I am studying on, the basis of how I sampled my population, the sources I got my data from, the technique I will use to analyze my data and analysis of the data.

3.2 Research design

3.2.1 Measuring Liquidity risk

For the period of the financial crisis of 2007 and in the successive years, many banks were not able to measure their liquidity risk adequately and were also not able to monitor and control their liquidity risk. Following these failures, the Basel Committee on Banking Supervision (BCBS) created two liquidity benchmarks as part of the Basel III post-crisis improvements. The two standards that were introduced were Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). The LCR enhances the short-term flexibility of the liquidity risk contour of banks. The Net Stable Funding Ratio (NFSR) aims to promote flexibility over a longer time frame by establishing incentives for banks to fund their activities with more secure sources of funding on an enduring basis. However, in this study I am using quarterly data and hence a short-term measure would be required hence the use of Liquidity Coverage Ratio (LCR).

3.2.1.1 Liquidity Coverage Ratio (LCR)

Liquidity Coverage Ratio is a measure used by the Basel Committee to measure liquidity. The liquidity coverage ratio (LCR) is a ratio of highly liquid assets to total net cash flows held by financial institutions. The LCR ensures that a company is able to meet its short-term obligations without external funding. The LCR ensures that banks have enough and suitable capital reserves that ensure continuity of the bank in case of any disruptions on the short-term liquidity that may aggravate the market. This also helps banks in anticipating market-wide shocks.

$$Liquidity\ coverage\ ratio\ = \frac{High\ quality\ liquid\ asset\ amount}{Total\ net\ cash\ flow\ amount}$$

Highly liquid assets may include Treasury bonds, cash, or corporate debt. The measurement and implementation of the LCR was done in 2011 by the Basel Committee and its 100% minimum being enforced in 2015. All banking institutions are expected to maintain 100% liquidity coverage ratio or more. This means that the high-quality liquid asset amount should be equal to or more than

the company's total net cash flow amount over a 30-day stress period. According to the Basel committee, to measure liquidity risk, a threshold of 100% is set. If the liquidity coverage ratio is above 100%, then the company is said to be liquid enough and does not face liquidity risk. If the liquidity coverage ratio is below 100%, the company is said to be illiquid and faces liquidity risk.

$$LCR = \frac{High\ quality\ liquid\ assets}{Total\ net\ cash\ flows} \geq 100\%$$

3.2.2 Measuring profitability

Presently researchers have nagging doubts about the proxy variable for profitability study in banking sector. Proxies such as Return on Equity (ROE), Return on Assets (ROA) and Net Interest Margin (NIM) have been used to measure how profitable a bank is (Goudrean et al., 1989; Uchendu, 1995; Qin et al., 2012; Ayanda, 2013). However, Joo and Hussanie (2017) highlights that most researchers measure profitability of banks using the return on assets. ROA reflects the efficiency of a bank's management in generating profits from the assets the bank owns. However, it may be biased based on off-balance sheet activities (Athanasoglou et al., 2005). Researchers such as Hancock (1989), Hoffmann (2011) proxied profitability in banks using return on equity. In contrast, Kosmidou (2008); Flamini et al., 2009; Scott et al., (2011); Babalola, 2012, Gremi, 2013 used return on assets to express profitability. ROA assesses the efficiency of a company's ability to manage its expenses and revenues and generate profits from the available assets (Jahan, 2012). ROE on the other hand shows how much profit a company has managed to generate with the money invested in the company by the shareholders. ROA is however, considered a better measure for profitability as compared to ROE because ROE does not take into consideration the financial leverage and risks associated with its analysis (Flamini et al., 2009). ROE is prone to timing problem, a risk problem, and a value problem (Joo and Hussanie, 2017). In this study, therefore, I use ROA as a proxy for bank profitability.

$$ROA_t = \frac{Net\ income}{Average\ Assets}$$

3.2.3 Modelling the impact of liquidity risk on profitability

Dynamic econometric models' estimation mostly use panel data as compared to cross-section data by researchers because dynamic models cannot be estimated from observations at a given point in time, and therefore, it would be hard to investigate dynamic relationships using single cross-section

surveys to provide adequate evidence about earlier time periods (Bond, 2002). Panel data permits the use of relatively simple econometric techniques and also allows repeated observations in the micro data and further allows the use of variances in the micro data to be used in parameter estimates construction. The period of study is between 2011 and 2020 and the number of commercial banks in the study is 10. The data also contains single equation models with autoregressive dynamics and the explanatory variables are not strictly exogeneous hence the use of the Generalized Method of Moments estimators in the study.

$$ROA_{it} = \alpha + ROA_{i(t-1)} + \beta_1 LR_{it} + \beta_2 Asset\ quality + \beta_3 Size\ of\ bank + \mu_i + \varepsilon_{it}$$

..... equation 1

$i = 1,2, \ldots, N;$ $t = 1,2,\ldots, T$ where N>T

Where

$_t$ indexes time, LR is the liquidity risk at time t, and ε is a disturbance term. μ is the firm's unobserved effects which allows for heterogeneity. Individual effects, μ, are assumed to be stochastic. Positive correlation of the error term and explanatory variables rules out the use of Ordinary Least Squares estimator. We assume that liquidity risk is uncorrelated with the individual effects. To test this assumption, we use the difference Sargan test. To test for correlation, Hausman test can also be used. To investigate the relationship between liquidity risk and delayed profitability I used the two-step system GMM.

3.3 Data description

The population of interest is commercial banks in the United States of America. As of the first quarter of 2020, there were 4404 commercial banks in the United States which has significantly reduced from 14400 commercial banks which was recorded in 1984. My study focuses only on commercial banks that have been in operation till 2020. However, I am focusing on 10 commercial banks in the U.S. namely J.P Morgan Chase Bank, Bank of America, Wells Fargo, Citi Group, Goldman Sachs, Morgan Stanley, U.S. Bancorp, PNC Financial services, TD Bank and Truist Financial Corp. This sampling is due to the availability of data.

In this study, I am using quarterly data sources from Refinitiv. The period covered is between 2010 and 2020.

CHAPTER 4: ANALYSIS

4.1 Introduction

The income statements, balance sheets, ratios, cash flow statements are all obtained from Refinitiv database. Ratios and key metrics used are from the full spreadsheets and from raw data files. Refinitiv database provides data from 1960. The data provided is in US$. Since the availability of data required for the study is short between 1960 and 2010 for most commercial banks, I chose to work with a balanced panel of 10 commercial banks in the United States in the period 2011-2020. The objective of this is to utilize the latest data coverage and to get a balanced panel dataset to use in the study.

As reported in the literature review, bank profitability is determined by bank-specific factors and macroeconomic factors. In this study, I use Return on Assets as a proxy for profitability. The independent variables used in the study are asset quality, liquidity coverage ratio and size of the bank. Macroeconomic factors have not been used in the study because they are constant across all the cross-sections since all the cross-sections used are commercial banks from the United States.

Asset quality is calculated as the ratio of non-performing loans to total loans. The asset quality ratios, however, are already provided in the Refinitiv database under ratios-key metrics. Asset quality represents the potential level of credit risk due to loans. According to economic theory, the higher the non-performing loans, the lower the asset quality which translates to lower return on assets. The lower the non-performing loans, the higher the asset quality which translates to higher return on assets. Liquidity Coverage ratio has been calculated as the ratio of cash and cash equivalents to net cash flows. Net cash flows are reported in the cash flow statement while cash and cash equivalents are reported in the balance sheets. The size of bank is calculated as the log of the total assets. The total assets are reported in the balance sheets.

The commercial banks used in the study are JP Morgan Chase Bank, Bank of America, Wells Fargo, Citigroup, Goldman Sachs, Morgan Stanley, U.S Bancorp, PNC Financial services, TD Bank and Truist Financial.

4.2 Data description

Table 4.1

Descriptive statistics							
Variable	**Mean**	**Std. dev**	**Min**	**Max**	**Skew**	**Kurt**	**Variance**
ROA	0.018239	0.02692	0.0066181	0.130038	2.907463	10.12451	0.000725
Asset quality	0.023758	0.018135	0.0000193	0.101	1.129683	4.809893	0.000329
Size of bank	5.967395	0.354457	5.196008	6.511359	-0.46993	2.032625	0.12564
LCR	-16.3617	270.1734	-5248	92.92673	-18.7438	362.4946	72993.69

Return on assets has a mean of 1.8239% of total assets and a standard deviation of 0.02692. The asset quality has a mean of 2.3758% with a standard deviation of 0.018135. The size of bank has a mean of 5.967395 with a standard deviation of 0.354457 which is quite high which shows big deviation between banks' asset qualities. Asset quality has negative skewness which means that most of the banks have negative asset quality. Liquidity Coverage ratio has a negative mean which implies that most of the banks have low liquidity levels hence high liquidity risk. The liquidity coverage ratio also has a large standard deviation and negative skewness. This also shows that most of the banks' liquidity levels are low hence face high liquidity risk.

4.3 Empirical results

To test for the empirical relevance of the hypothesis regarding the relationship between liquidity risk and bank profitability, I adopt a multiple regression framework to analyze the panel data set that has already been constructed. The basic equations used for the study are:

$$ROA_{it} = \alpha + ROA_{i(t-1)} + \beta_1 LR_{it} + \beta_2 Asset\ quality + \beta_3 Size\ of\ bank + \mu_i + \varepsilon_{it}$$

.....equation 1

$$ROA_{it} = \alpha + \beta_1 LR_{it} + \beta_2 Asset\ quality + \beta_3 Size\ of\ bank + \mu_i + \varepsilon_{it}$$ ..... equation 2

Where:

LR_{it} is liquidity risk for cross-section I at time t.

Equation 1 is used for random/linear effects model and equation 2 is used for two-step system GMM.

4.3.1 Is there a relationship between liquidity risk and bank profitability?

At each stage of model building, I perform unit root tests and ensure all variables are stationary by differencing non-stationary variables before performing the regression. Only random effects' results are presented since they are the best estimates with all the variables presented. The sample is comprised of 380 observations. The explanatory power of the model is 0.1855. The Modified Wald test for heteroskedasticity shows that there is heteroskedasticity which is corrected for. Since the Wooldridge statistic is 1679.570 (0.0000), we assume that there is autocorrelation which is also corrected for. Based on the Hausman test, we conclude that random effects estimator is the appropriate choice as compared to fixed effects estimator.

After correcting for autocorrelation, cross-sectional dependence, and heteroskedasticity, I perform the multiple regression analysis using the random effects model. The coefficient of liquidity risk reveal a relatively negative insignificant relationship with ROA.

Table 4.2

Random effects model				
No. of observations = 380		Sum of squared residuals = 0.03099012		
R-squared = 0.1855		Variance of residuals = 0.02283521		
Modified Wald Test = 6877.55 (0.000)		Wooldridge test = 1679.5170 (0.0000)		
Variable	**Estimated Coefficient**	**Standard error**	**T-statistic**	**P-value**
Asset quality	-0.0491861	0.0491861	-1.1	0.27
Size of bank	-0.011376	0.0122479	-0.93	0.353
LCR	-5.45E-07	5.72E-07	-0.95	0.341
Constant	0.0195436	0.0086614	2.26	0.024

I also run the two-step system GMM model to test for the relationship between liquidity risk and bank profitability. Table 4.3 shows the regression analysis model on the relationship between profitability and liquidity risk using two-step system GMM rather than one-step GMM. From the

results, the coeficients reveal a negative significant relationship with bank profitability at 5% significance level. This indicates that liqudity risk influences the bank profitability negatively during the years 2011-2020. From the results, we can also deduce that the lag of ROA, size of bank, and constant also have significant effect on ROA. The lag of ROA and the constant have a positive significant effect while the size of bank and LCR have a negative significant effect on ROA.

Table 4.3

Two-step system GMM				
No. of observations = 340				
Variable	**Estimated Coefficient**	**Standard error**	**Z-statistic**	**P-value>z**
L1.ROA	0.9735069	0.0045138	215.67	0.000000
Asset quality	-0.016809	0.0106793	-1.57	0.115000
Size of bank	-0.0316363	0.0059467	-5.32	0.000000
LCR	-7.15E-08	2.60E-08	-2.75	0.006000
constant	0.0010926	0.0002862	3.82	0.000000

4.3.2 Does the relationship change depending on the time horizon?

For this study, I divided the data into two: medium-term horizon and long-term horizon. In this study, the medium-term horizon is 5 years (2011-2015), and the long-term horizon is 10 years (2011-2020). For all the horizons, summary statistics, normality tests, non-stationarity tests, Hausman test, test for autocorrelation, test for cross-sectional dependence, and tests for heteroskedasticity have been done and corrected for.

4.3.2.1 Five-year horizon

The regression analysis focused on the relationship between bank profitability and bank profitability in a five-year horizon (2011-2015).

Table 4.4

Descriptive statistics							
Variable	**Mean**	**Std. dev**	**Min**	**Max**	**Skew**	**Kurt**	**Variance**
ROA	0.0174631	0.026468	-0.00662	0.12013	2.8897	10.1324	0.0007
Asset quality	0.0271624	0.0230423	0	0.101	0.75539	2.90133	0.00053
Size of bank	5.927059	0.3657207	5.19601	6.41114	-0.4376	1.95013	0.13375
LCR	-3.950105	42.50669	-458.775	89.1577	-6.9363	71.0043	1806.82

From the above descriptive statistics, we can deduce that liquidity coverage ratio has a negative mean which means most of the cross sections have negative liquidity coverage ratios. The liquidity coverage ratio also has a large standard deviation which implies that the cross sections have large deviations from the mean. According to Bryne (2010), normally distributed data should have skewness of between -2 and 2 while kurtosis should be between -7 and +7. From the table above, ROA and LCR are not normally distributed.

I performed unit root tests and ensured all variables are stationary by differencing non-stationary variables before performing the regression. Only random effects' results are presented since they are the best estimates with all the variables presented. The sample is comprised of 190 observations. The explanatory power of the model is 0.0208. The Modified Wald test for heteroskedasticity shows that there is heteroskedasticity which is corrected for. Since the Wooldridge statistic is 592.929 (0.0000), we assume that there is autocorrelation which is also corrected for. Based on the Hausman test, we conclude that random effects estimator is the appropriate choice as compared to fixed effects estimator.

Table 4.5 shows the multiple regression analysis models on the relationship between profitability and liquidity risk using random effects model rather than fixed effects model. The coefficient reveals a negative significant relationship with bank profitability during the years 2011-2015. The effect is, however, insignificant. From the results, asset quality and size of bank do not, however, have any significant effect on ROA.

Table 4.5

Random effects model				
No. of observations = 190		Sum of squared residuals = 0.00518341		
R-squared = 0.0208		Variance of residuals = 0		
Modified Wald Test = 3.7e+05 (0.0000)		Wooldridge test = 592.929 (0.0000)		
Hausman test Ho: RE vs FE chi2(3) = 0.19 prob>chi2 = 0.9796				
Variable	**Estimated Coefficient**	**Standard error**	**Z-statistic**	**P-value>z**
Asset quality	0.0043764	0.0166436	0.26	0.793
Size of bank	0.0116607	0.0249337	0.47	0.64
LCR	-1.73E-05	8.03E-06	-2.16	0.031
Constant	-1.20E-06	0.0001957	-0.01	0.995

Table 4.6 shows regression analysis model on the relationship between bank profitability and liqudity risk using two-step system GMM rather than one-step system GMM. The coefficients reveal a negative significant relationship between bank profitability and liquidity risk at 5% significance level. This indicates that liqudity risk influences bank profitability negatively during the years 2011-2015. The results are similar to the results from the random effects model for the five-year horizon. Other findings from the results show that the first lag of ROA, and asset quality have significant effects on ROA. The first lag of ROA and asset quality have positive significant effects on ROA while LCR has a significant negative effect on ROA. Size of bank, however, has no significant effect on ROA.

Table 4.6

Two-step system GMM				
No. of observations = 140				
Variable	**Estimated Coefficient**	**Standard error**	**Z-statistic**	**P-value>z**
L1.ROA	0.3996448	0.0453515	8.81	0.0000
Asset quality	0.0188907	0.0050405	3.75	0.0000
Size of bank	-0.0192053	0.0109857	-1.75	0.0800

LCR	-1.80E-05	1.74E-06	-10.35	0.0000
constant	0.0000817	0.000069	1.18	0.2360

4.3.2.3 Ten-year horizon

The regression analysis focused on the relationship between bank profitability and bank profitability in a ten-year horizon (2011-2020).

Table 4.7

Descriptive statistics							
Variable	**Mean**	**Std. dev**	**Min**	**Max**	**Skew**	**Kurt**	**Variance**
ROA	0.018239	0.02692	0.0066181	0.130038	2.907463	10.12451	0.000725
Asset quality	0.023758	0.018135	0.0000193	0.101	1.129683	4.809893	0.000329
Size of bank	5.967395	0.354457	5.196008	6.511359	-0.46993	2.032625	0.12564
LCR	-16.3617	270.1734	-5248	92.92673	-18.7438	362.4946	72993.69

I performed unit root tests and ensured all variables are stationary by differencing non-stationary variables before performing the regression. Only random effects' results are presented since they are the best estimates with all the variables presented. The sample is comprised of 380 observations. The explanatory power of the model is 0.1855. The Modified Wald test for heteroskedasticity shows that there is heteroskedasticity which is corrected for. Since the Wooldridge statistic is 1679.5170 (0.0000), we assume that there is autocorrelation which is also corrected for. Based on the Hausman test, we conclude that random effects estimator is the appropriate choice as compared to fixed effects estimator.

Figure 4.8

Random effects model	
No. of observations = 380	Sum of squared residuals = 0.03099012

R-squared = 0.1855		Variance of residuals = 0.02283521		
Modified Wald Test = 6877.55 (0.000)		Wooldridge test = 1679.5170 (0.0000)		
Variable	**Estimated Coefficient**	**Standard error**	**T-statistic**	**P-value**
Asset quality	-0.0491861	0.0491861	-1.1	0.27
Size of bank	-0.011376	0.0122479	-0.93	0.353
LCR	-5.45E-07	5.72E-07	-0.95	0.341
Constant	0.0195436	0.0086614	2.26	0.024

After correcting for autocorrelation, cross-sectional dependence, and heteroskedasticity, table 4.8 shows the multiple regression analysis models on the relationship between bank profitability and liquidity risk using random effects model rather than fixed effects model and all the explanations are based on the results from table 4.8. The coefficients reveal a relatively negative insignificant relationship with ROA.

Table 4.9

Two-step system GMM				
No. of observations = 340				
Variable	**Estimated Coefficient**	**Standard error**	**Z-statistic**	**P-value>z**
L1.ROA	0.9735069	0.0045138	215.67	0.000000
Asset quality	-0.016809	0.0106793	-1.57	0.115000
Size of bank	-0.0316363	0.0059467	-5.32	0.000000
LCR	-7.15E-08	2.60E-08	-2.75	0.006000
constant	0.0010926	0.0002862	3.82	0.000000

Table 4.9 shows regression analysis model on the relationship between profitability and liquidity risk using two-step system GMM rather than one-step GMM. From the results, the coeficients reveal a negative significant relationship with bank profitability at 5% significance level. This indicates that liqudity risk influences the bank profitability during the years 2011-2020. From the

results, we can also deduce that the lag of ROA, size of bank, and constant also have significant effect on ROA. The lag of ROA and the constant have a positive significant effect while the size of bank and LCR have a negative significant effect on ROA.

4.3.4 Is there a lag relationship between liquidity risk and bank profitability?

This regression analysis is to analyze whether lags of liquidity risk and bank profitability have an effect on bank profitability. As shown in figure 4.10, the Arellano-Bond test for AR (1) and AR (2) in first differences report a p-value > 0.05 which implies that there is no serial correlation in first and second orders. The Hansen test of overidentifying restrictions produces a p-value>0.05 which means that the instruments used are not correlated to the difference in error terms. The model is hence fit since no re-identification is not needed.

Table 4.10

Two-step system GMM				
No. of observations = 268 Arellano-Bond test for AR (1) in first differences: z = -1.10 Pr > z = 0.272 Arellano-Bond test for AR (2) in first differences: z = -0.80 Pr > z = 0.427 Hansen test of overid. restrictions: chi2(13) = 7.89 Prob > chi2 = 0.851 (Robust but weakened by many instruments.)				
Variable	**Estimated Coefficient**	**Standard error**	**Z-statistic**	**P-value>z**
L1.ROA	0.9306092	0.0386816	24.06	0
Asset quality	-0.0377024	0.0288428	-1.31	0.191
Size of bank	-0.0238757	0.0090321	-2.64	0.008
LCR	-6.37E-08	1.69E-08	-3.77	0
L1.LCR	-2.33E-07	1.29E-08	-18.04	0
constant	0.0022102	0.0012166	1.82	0.069

From table 4.10, the first lag of return on assets has a significant positive effect on bank profitability. The liquidity coverage ratio has a significant negative effect on bank profitability which is also the case for its first lag.

CHAPTER 5: CONCLUSION

5.1 Summary of findings

The aim of this paper is to test for the impacts of liquidity risk on bank profitability in the United States of America in the period between 2011 and 2020. To check for the robustness of the results, two estimators namely: random effects estimator and two-step system GMM estimator have been used. Besides the analysis on the effects of liquidity risk on bank profitability, effects of liquidity risk on bank profitability have been analyzed over two different horizons: a medium-term horizon which is a five-year period between 2011 and 2015 and a long-term horizon which is a ten-year period between 2011 and 2020. The test on whether lags have an effect on bank profitability has also been performed.

The results suggest that liquidity risk has a negative significant effect on bank profitability. This can be attributed to the depositors calling their funds at an inconvenient time which would cause sale of institution's assets to meet these obligations that would in turn negatively affect the profitability of a bank (Chaplin et al., 2000). These results do not support the economic theory which states that higher risks should be associated with higher returns. The results, however, support empirical results from Staikouras and Wood (2004) and Sufian and Chong (2008). The findings further imply that the effect of liquidity risk on bank profitability does not change with different time horizons. The effect remains negative and significant over the five-year horizon and ten-year horizon. From the analysis of the presence of lag relationship between liquidity risk and bank profitability, the results imply that the first lags of both ROA and LCR have negative significant effects on ROA.

Tests for the relationship between liquidity risk and bank profitability during the global COVID-19 pandemic (2019-2020) were performed but not reported. This is because the panel is small which is prone to small panel bias and the results would therefore not be precise. The results from the analysis suggest a positive relationship between liquidity risk and bank profitability. This supports the economic theory and empirical results from Sufian (2011). This could be due to higher profitability owing to new products and services offered during a pandemic or crisis which could exceed the losses from liquidity risk. During a crisis, most institutions would introduce new products and services to mitigate further risks resulting to profits yielded from these new products and services, which would then reduce or exceed losses.

In contrast, the results from the random effects estimator are different from the results of the two-step system GMM. Random effects report a negative significant effect between liquidity risk and bank profitability during the five-year horizon and an insignificant effect of liquidity risk on bank profitability during the ten-year horizon.

5.2 Conclusion

The findings have policy implications to the government and bank managers in order to improve bank profitability. Bank managers should ensure low liquidity risk which entails having optimum liquidity levels to ensure profitability in the bank. During a crisis/pandemic, bank managers and governments should ensure innovation of new products and services that are tailored to their customers' needs to ensure bank profitability. Areas of studies to be studied further include examination of differences in the effects of liquidity risk in on bank profitability between small and large or high and low profitability banks.

Some of the challenges experienced during the research of this paper is the availability of data. The data required for the study is relatively short between 1960 to 2010 for most commercial banks which restricted the cross-sections used in the study to 10. The other challenge is the length of the pandemic which leads to a small panel. Small panels are prone to small panel bias and lack of precision. Finally, the difference in reporting of financial statements made it difficult to collect data. This led to reduced cross-sections which are often used in the study to obtain balanced panels.

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