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The Impact of Liquidity on Bank Profitability: Post Crisis Evidence from European Banks

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I hereby declare that the work submitted is mine and that where I have made use of another's work, I have attributed the source(s) according to the Regulations set in the Student's Handbook.

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Abstract

This study investigates the impact of liquidity on the profitability of 50 large European banks, measured by Return on Average Assets (ROAA), Return on Average Equity (ROAE), Net Interest Margin (NIM) and Profit Before Tax (PBT), during the period 2009-2015. The aforementioned relationship is examined during this period in order to determine the effect of liquidity, after a financial crisis in which liquidity had an important role. To this direction, seven bank specific and two macroeconomic variables were employed in a panel dataset with 350 observations. In the past, most studies used liquidity ratios to determine liquidity risk and thus in this study, we focus on employing not only ratios, but also liquidity measures derived directly from the banks' balance sheets, in order to get a more general view on the impact of liquidity in the banking sector. Regarding the results, they showed that for ROAA, ROAE and PBT, all liquidity measures derived from the balance sheet and the liquidity ratios had a negative impact on profitability. In contrast the capital ratio that was used as a proxy to regulatory imposed liquidity was positively related. On the other hand, regarding NIM, there were some differences in the results with Cash and Due from Banks and Net Loans to Total Assets be positively related with profitability, while the capital ratio of Tier1 to Total Assets was negatively related with NIM. According to the results of the study, banks should maintain their liquidity levels mostly though their capital reserves (e.g. Tier 1 Capital) and take actions to mitigate the credit risk of their investments, as well as their financing gap which imposes constraints in their funding procedure.

Keywords: Liquidity, Profitability, Capital, Ratios, Balance Sheet

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Introduction

Banks have a very important role in the modern globalized financial world. The effective performance of banks depends on a great extent on the financial environment in which they operate and on their reliability. The simplest indication for the financial health of a bank is the value of its assets, compared to the value of its liabilities but during the recent financial crisis another type of buffer was underlined, which is the liquidity that the banks have in order to cover any unexpected outflows (Elliott, 2014). The financial crisis that started in 2007 resulted in many problems and failures in the financial sector but also in many other business sectors.

This happened because the financial and banking system of a country or a union is a crucial element for the performance of the overall economy and since these sectors were in trouble in 2007, all the other sectors of the economy that were depended on them, started to face problems. This is an example of the importance of the modern banking and financial system and the effect they have on the real economy. In particular, the strength and the financial health of the banking industry is an important factor that can determine the economic stability and growth (Halling and Hayden, 2006). Thus, regulatory bodies are trying to achieve and maintain the financial stability via close assessment of the banks' financial condition and through regulations that ensure the stability and prevent failures that can occur under adverse circumstances.

Moreover, the significance of sound liquidity management was underlined during the financial turmoil of 2007 when the credit crisis due to the subprime mortgage lending led to a liquidity crisis, caused by the fall of housing prices and delinquencies in mortgage lending. Furthermore, the crisis deteriorated the performance of international stock markets and caused a drying liquidity in interbank markets since banks and other financial institutions were reluctant to make any transactions within these markets. Soon this adverse situation led to several failures in the US where the crisis started but also caused problems in the global financial system.

Before the recent crisis, financial intermediaries like banks were stable and had a good performance as funding was readily available and at a low cost (Marozva, 2015). This stable performance, indicated a healthy banking system, and thus bank managers did not pay the required attention to the vital element of liquidity (Committee of European Banking Supervision, 2008). Also this resulted to an insufficient cover of liquidity risk from the prevailing risk management practices (Crowe, 2009). In addition, during the crisis the rapid reversal conditions in the markets, illustrated that liquidity can quickly evaporate and illiquidity that follows can reserve profits and capital as financial institutions are trying to find the necessary funds to meet their obligations.

Overall, the reasoning behind the importance of liquidity is that a bank can have assets that exceed its liabilities, but it still faces the risk of a sudden bank run or any other situation where it will not be able to liquidate its assets in order to cover needs that may arise. This type of liquidity risk was examined by the Basel Committee which published *Liquidity Risk Management and Supervisory Challenges* in 2008, where it supported that many banks did neither have an adequate framework in order to assess liquidity risk, nor a sound liquidity management process. Furthermore, the bad condition of the overall financial system after 2007, revealed the need for the incorporation of prudential liquidity measures in the banking regulatory framework, since the importance of liquidity was not fully appreciated.

The third Basel accord reviewed the banking risk management practices in order to strengthen and make the financial and banking system more resilient to shocks. The latest Basel accord incorporated and examined carefully the liquidity risk that financial institutions face and introduced some new ratios: The "Liquidity Coverage Ratio" (LCR), the "Net Stable Funding Ratio" (NSFR) and the "Tier 1 Leverage Ratio". These regulatory standards ensure that banks will have adequate liquidity for the next 30 days, that bank have a stable funding for their long term assets and finally provide guidance on how much a bank can leverage its capital base. On the other hand, even though the lack of liquidity was proved to be a significant factor for bank failures, holding excess liquid assets can also have a negative impact through the opportunity cost of higher returns. In previous literature there has been found both

a positive and a negative relationship between bank liquidity and profitability. Thus regulators and bank managers have to take into consideration the trade off between adequate liquidity and resilience to external shocks and the cost of holding low return assets which limit and reduce banks' profitability.

That said, the aim of this dissertation is to examine the relationship between liquidity measures that banks hold and other regulatory imposed capital with the banks' profitability. This liquidity measures are both from the asset and liability side of the balance sheet. Furthermore, the period under examination is after the 2007 financial crisis, thus the results are interesting in terms of evaluating the impact of liquidity levels on the banks' performance, after a crisis in which low liquidity had a significant role in the deterioration of the whole financial system. Regarding the chapters of this study, the first chapter includes a theoretical approach of liquidity risk, its effect on profitability and a brief presentation of the European Banking System since Europe is the region under examination. The second chapter, presents a review of previous studies that examined the impact of liquidity on the profitability of banks and then, in chapter 3 there is a description of the variables that are used in the empirical part, the source of the data, as well as the research methodology. In chapter 4 there is the presentation of the empirical results and finally, chapter 5 includes the conclusions of this study and suggestions for further research.

Chapter 1: *Liquidity Risk, Regulation and recent developments in the European Banking System*

In this chapter, there is a presentation of the liquidity risk phenomenon in the banking sector, as well as a theoretical approach to the interaction between liquidity risk and the financial performance of banks. In addition, there is also a brief presentation of the recent developments and changes in the European Banking system, since this study examined the impact of liquidity on the profitability of European banks.

1.1 *Liquidity Risk*

Liquidity in the banking system is defined by the Basel Committee on Banking Supervision (BCBS) as the ability of a bank to have available cash or to readily find cash in order meet its obligations when they come due, without incurring any unexpected losses (BCBS, 2008). The banks' assets and the related liquidity obligations are very important because they can determine the weaknesses and strengths that are related to the ability of the institution to settle its obligations at a timely manner. In addition, a solvent bank can settle its liabilities when they come due by selling off its assets. If a bank has high liquidity then these sells will not incur any unexpected losses but on the other hand, if the bank has liquidity problems then the sale of these assets could lead to insolvency. Cash holdings in currency or on accounts at any central bank can be sources of liquidity and in addition another form of liquidity are highly creditworthy securities like government bills and other securities with short-term maturities. Moreover, short-term securities are relatively safer than other and can be traded in liquid markets which means that these securities can be sold at large volumes without incurring losses due to price changes.

Furthermore, according to Muranaga and Ohsawa (2002), liquidity risk is the risk of being unable to liquidate a position at a timely manner and a reasonable price and they divide liquidity risk into execution cost (cost of immediacy) and opportunity cost (the cost of waiting). From this definition it is clear that liquidity risk can arise from the management of the asset positions and from the general funding procedure of the bank's activities. Moreover, it includes both the inability of funding assets at appropriate maturities and rates and the inability to liquidate an asset in an appropriate time frame and at a price which is near its fair value. Also according to Goodhart (2008), the key elements in any bank's liquidity position are the maturity transformation which refers to the relative maturities of a bank's assets and liabilities and the inherent liquidity of a bank's assets which refers to the ability of any asset to be sold without any significant loss and under any market condition. In practice these two elements that are mentioned above are intertwined.

Apart from the aforementioned maturity mismatch that can result into less liquidity, liquidity is also affected by the general economic conditions which can cause less resource generation. For example, during recessionary economic conditions the depositors' demand increase creating liquidity risk. In particular, the phenomenon of a bank run can cause the failure of a specific bank that is in trouble or even the entire banking system due to contagion effects. Moreover, the problem arises from the fact that banks finance illiquid assets with demandable claims, which can cause a drying liquidity in cases of increased depositors' demand (Diamond and Rajan, 1999). Furthermore, Arif and Anees, (2012), supported that according to Jenkinson, (2008) the liquidity risk does not only threat the solvency and the financial performance of banks but it also affects its reputation. A bank that is in financial trouble due to liquidity risk may lose the confidence of its depositors regarding its ability to provide investors' funds at a timely manner. Thus the liquidity risk management is among the most important activities conducted at banks because it ensures that a bank will have the necessary liquidity reserves in order to meet any unexpected need and thus prevent panic dispersion among depositors and investors.

Recent financial and technological innovations have provided banks with new opportunities of accessing funding resources, but the recent crisis indicated that there are still many risks and challenges for liquidity management (Driga and Socol, 2009). In particular, the lack of funds that occurred due to the non-performing credits, affected the banks' ability to meet the increased obligations towards depositors. Thus, despite the technological innovations, liquidity risk is still present and depends on several factors.

Another important factor regarding the liquidity position of a bank is its size (Maaka, 2013). In particular, as supported by the author, the size of the bank can affect the attitude towards wholesale funding, including the access to the markets (Allen et al., 1989) and the cost of the funds that are obtained. Furthermore, the importance of the bank's size is derived by the economies of scope and scale that can be achieved. For example, a larger bank may have better access to financial markets and interbank markets because of its larger counterparty network and its wider range of collateral. Moreover, the business model of a bank, which distinguishes banks from other

financial institutions, can also affect the liquidity position because banks that accept on demand deposits and give loan commitments, might need to hold higher liquidity buffers in order to accommodate any unpredictable needs (Kashyap et al., 2002).

Regarding the measurement of the liquidity risk and its effect, in the past, researchers have been focusing on liquidity risk that arises from the liability side of a bank's balance sheet and less attention was given on the asset side. Besides that, liquidity risk can also arise from the breakdown or delays in cash flows by the borrowers. Furthermore, in the past, many researchers focused on liquidity ratios in order to measure the risk. However, according to Poorman and Blake (2005) it is not enough to measure liquidity only by using ratios and banks need to develop new techniques for liquidity measurement. Therefore, the purpose of this study is to examine the effect of different liquidity measures that are derived both from the asset side and the liability side of the balance sheet and also to employ liquidity ratios, as well as a regulatory imposed liquidity buffer.

1.2 *Liquidity and Financial Performance of Banks*

The financial performance and profitability of banks is a function of internal and external factors. The differences in the performance among banks, indicate differences in their core business as well as in their management. Some of the internal factors that can determine the profitability of a bank are related with the management decisions, regulatory objectives like the levels of liquidity, expense management and the size of the bank. The external factors include industry characteristics, market concentration and other macroeconomic characteristics (Athanasoglou et al., 2006).

After the 2007 subprime mortgage crisis, it became clear that government regulation and appropriate supervisory practices are crucial for the banking system. It has also been proved that liquidity problems affect the banks' earnings and capital and in some extreme circumstances, such conditions may even result into bankruptcies of otherwise solvent banks. One of the causes of such bank failures, is the fact that liquidity problems may force banks to borrow from the markets even at an extreme

high rate in order to settle their obligations during a liquidity crisis which ultimately can cause a decrease in their earnings. Another element that affects a bank's earnings and is related with the liquidity is the fire sale risk of assets which can result in an impairment of the bank's asset value (Diamond and Rajan, 2001). The fire sale[1] risk arises when a financial institution has to sell a large number of its assets in order to meet its obligations or to reduce its leverage in conformity with the regulatory capital adequacy requirements (Arif and Anees, 2012). Furthermore, the maturity mismatch between demand in deposits and the corresponding resources may force a bank to generate these funds from alternative sources and at a higher cost, thus implying a negative impact on the bank's financial performance.

After 2007, regulators reviewed the liquidity risk management in the banking sector and proposed a stricter regulatory framework which required from banks to hold more liquid assets in order to become more resilient against potential liquidity or funding difficulties (Basel Committee of Banking Supervision, 2010). On the other hand, assets that are highly liquid like government securities and cash, usually have a relatively lower return and banks that hold such securities, face an opportunity cost and constraints in their profitability potentials. Apart from the negative impact of these constraints that liquid assets impose on the banks' profitability, there is evidence that these holdings are beneficial during adverse economic conditions. Thus, there is a dilemma that is faced by a bank's management since the ultimate objective is the maximization of profits, but preserving the liquidity of the bank is equally important. On the other side, as the liquidity of a bank increases the opportunity cost of forgone income due to the lower return assets, comes to predominate and eventually high liquidity lowers profitability. There is a non-linear relationship between the liquidity levels of a bank and its profitability (Growe et al., 2014). Overall the management of commercial banks is responsible for estimating and controlling the liquidity levels and maintain an appropriate level of liquid assets that will not reduce dramatically the profitability but at the same time ensure that the bank has enough liquidity to overcome any unexpected need.

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[1] The process of selling assets at heavily discounted prices, maybe because the seller is under financial distress.

The results of previous studies regarding the liquidity risk are limited and most studies usually investigate the determinants of banks' profitability. In addition, the results from these papers, regarding liquidity are mixed. In the literature review of this study there is a more detailed presentation of previous studies and their findings regarding the relationship between the liquidity risk and bank's performance.

1.3 *The effect of Regulation and Supervision on the Banking Industry*

In this study, except from the liquidity measures that are derived both from the assets the liabilities side of the balance sheet, there is also the examination of the regulatory imposed capital (Tier 1 capital) on the banks' performance. After 2007, regulatory authorities have tried to introduce a new regulatory framework with stricter rules regarding the liquidity risk, in order to make banks and other financial institutions more resilient in such shocks. Thus, this chapter presents the impact of regulation, on liquidity requirements and in turn, on profitability. The capital adequacy of banks is one of the most important elements of this new framework and regulators have paid much attention on it.

The Capital Adequacy Ratio is the ratio of a bank's core capital to the assets and off-balance sheet liabilities weighted by the risk (Bialas and Solek, 2010). The minimum level of core capital relative to the risk weighted assets that banks should hold is 8% and after the recent crisis, banks are obliged to take into consideration the liquidity risk requirements when they calculate the Capital Adequacy Ratio. Regarding the impact of the Capital Adequacy Ratio on the performance of the banks, Naceur and Kandil (2009), found a clear illustration of the regulatory capital on the cost of intermediation and the banks' profits. They supported that the ratio, internalizes the risk for shareholders and increases the return on assets and equity. Apart from the return on assets and equity there is no direct empirical evidence of capital adequacy on the net interest margin. Furthermore, Chortareas et al. (2012) supported that there is a positive relationship between the capital requirements/supervisory power and improved bank performance. This conclusion is based on the fact that capital requirements can have a positive impact on bank efficiency through the reduced likelihood of financial distress, market power and reduced agency problems.

Moreover, Repullo (2004) based on the Hellmann et al. (2000) approach, supported that the combination of deposit rate ceiling and capital requirements can reduce risk shifting[2] incentives but it reduces banks' profitability. The reason for the reduced profitability is that the cost of an increase in the capital requirements are fully transferred to the depositors. Earlier empirical studies that examined the relationship between bank performance and official supervision, provide mixed results. Furthermore, Femandez and Gonzalez (2005) argued that higher standards for accounting and auditing can reduce the banks' risk-taking behavior. Moreover, banks' risk-taking behavior is also affected by the regulatory framework via the moral hazard phenomenon. In particular, regulatory authorities, except from imposing and examining regulations they also try to avoid the systemic risk arising from any individual bank. Thus, moral hazard sometimes encourages banks to have a riskier behavior, especially when there are no limits in the activities they can undertake.

There are also some regulatory imposed rules that may create incentives for banks to hold less liquid assets. For example, according to Elliot, (2014) the leverage ratio which is considered one of the most important capital constraints, provides an incentive for banks to move to riskier assets with higher returns and low liquidity. These incentives are derived from the fact that the leverage ratio is not a risk-sensitive capital requirement. On the other hand, capital requirements that are more risk-sensitive like those that are based on the risk weighted assets or capital stress tests, provide incentives towards more liquid assets and higher overall liquidity.

In addition, regarding the interaction between liquidity and capital requirements, Elliot, (2014) supported that all else equal, when a bank holds high capital levels there is likely to be less need for simultaneously high liquidity levels. The higher capital levels are contributing towards the decrease of the likelihood that there will be a loss of confidence by funders and at the same time ensures and increases the likelihood and the ability of the central bank to perform the lender of last resort functions in case of trouble, as it will be clear that the bank is solvent. Of course this relationship is not guaranteed and banks need to maintain the appropriate level of

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[2] The transfer of risk to another party. It is mostly observed in companies under financial distress.

liquidity in order to meet unexpected obligations. On the other hand, in the case of low levels of liquidity there is a greater need for banks to maintain higher capital levels and thus be protected from a confidence shock by its funders. Overall, despite the levels of liquidity that a bank holds, there will always be the need for banks to maintain a certain amount of capital in order to be protected under adverse conditions.

1.4 *European Banking System and recent developments*

In this section of the study, there is a brief presentation of the European banking system, since the region that is under examination for the relationship between liquidity risk and bank performance is the European Union (28). Policymakers have been sought the financial and political integration of the European Union through a bank regulation framework, as a complement of the European internal market. Eventually, the European Banking Union was formed in 2012 as a response of the Eurozone crisis and the fragility of numerous of banks during that period.

After the creation of the banking union, the EU countries transferred the responsibility for banking policy and supervision from a national level to the European Union. From 2014, the European Banking Union consists of two main mechanisms. The first is the Single Supervisory Mechanism (SSM) which is one of the safety pillars of the banking union, and its aim is to grant the European Central Bank (ECB) a supervisory role, to monitor the financial stability of systemically important banks. The second mechanism is the Single Resolution Mechanism (SRM) which is based on the regulatory framework and its objective is the establishment of a Single Resolution Fund to finance the restructuring of bank that have bankrupted.

Furthermore, the whole European Banking System is under the authority and supervision of the European Central Bank, which consists of 19 member states and administers the monetary policy of the Eurozone. At last, another important institution is the European Banking Authority (EBA), which main task is to conduct stress tests to increase transparency and identify any weaknesses in banks' capital structures.

Regarding some characteristics and recent developments of the European Banking System, according to the 2015 report on the financial structures by the ECB, the number of credit institutions declined on a consolidated basis from 6,054 at the end of 2013 to 5,614 at the end of 2014. In 2008 when the crisis started there were 6,774 credit institutions. There was a mass decline in the number of solvent credit institutions due to many bankruptcies and failures of European banks. Furthermore, according to the ECB (2015) the market concentration as measured by the Herfindahl[3] index and the share of total assets, remained on an upward path, since the pre-crisis period. This increased concentration in the industry is a primarily result of the decline of the number of credit institutions and moreover the main causes of this increased concentrations are developments in Germany, Italy and Spain.

Regarding structural developments in the banking industry, in the previous years there was a gradual shift towards deposit funding which eventually came to a halt, but banks reduced the use of wholesale funding and their reliance on the central bank funding. These developments, indicated a trend towards a more traditional banking business model for banks in the euro area.

Despite the efforts towards a more stable financial system, the recent crisis still affects the financial health of banks. In particular, since 2008 there has been a deterioration in the loan quality which has resulted in a steady increase of Non Performing Loans (NPLs) (See Graph in Appendix **3.**). This situation is faced by many banks and causes liquidity problems which then affect their overall performance and the economy as a whole, since banks cannot proceed with mores credits, because they have tied up capital in order to resolve the problem with the NPLs.

More recently, the new regulatory requirements that were imposed after the crisis had a profound impact on the banks' activities and business model (ECB, 2016). Banks were forced to quit some profitable but riskier business strategies in conformity with the new regulatory framework. This fact in combination with the

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[3] The Herfindahl-Hirschman Index (HHI) is defined as the sum of the squares of the market shares of all firms within the industry, where the market shares are expressed as fractions. When the index is below 1000 it indicates low concertation. On the other hand, an index above 1800 indicates high concentration and an index between 1000 and 1800 is considered to be as a moderate concentration in the industry.

weak macroeconomic and financial condition deteriorated their financial performance during the latest years and thus the stability of the banking sector depends on their ability to adapt their business models to the new operating environment (ECB, 2016). These business model adjustments have been mainly driven by the regulatory reforms which required from banks to hold more liquid assets, to contain more high quality capital and more stable funding sources.

Finally, one of the most important business model change in the European banking system is the shift from investment banking and wholesale banking towards retail businesses (ECB, 2016). Retail banking activities seem to have gained ground after the crisis, reversing a pre-crisis trend. Moreover, to support this trend, the EBA's risk survey on June 2015, shows that retail activities are frequently mentioned by banks as an area they are planning to expand in the future.

Chapter 2: *Literature Review*

In this section there is a review of the relevant literature related with liquidity risk and banks' performance. There is a very limited number of previous studies that specifically investigated the particular relationship between liquidity risk and bank performance. Most of the studies that are relevant to this study's topic, were mainly focused on examining the determinants of banks' profitability, and liquidity was usually one of the examined determinants

2.1 *Literature Review*

In the literature, banks' profitability was usually measured by Return on Assets (ROA) or Return on Equity (ROE) and in most of the studies it was expressed as a function of internal and external determinants. The internal factors were, profitability determinants, level of liquidity, capital adequacy, expense management, bank size and others, and they were mainly factors that are influenced by the banks' management decisions and policy objectives. On the other hand, the external factors were both industry related and macroeconomic determinants and overall they were variables that reflected the general economic and legal environment of the region

under examination. Liquidity risk can be generally calculated using balance sheet positions. In the past, researchers focused on the use of liquidity ratios in order to measure liquidity risk. However, Poorman and Blake (2005), indicated that researchers should not rely only on liquidity ratios when they try to measure the liquidity in banks.

According to the Committee of European Banking Supervisors (2008), during the past years banks did not pay the required attention through their risk management process on the liquidity risk. In addition, as it was mentioned above there were not many studies that examined the direct impact of liquidity on banks' performance. The first studies on liquidity risk were mainly focused on bank runs (Diamond and Dybvig, 1983). Since then many researchers and practitioners were interested in the relationship between bank performance and liquidity risk. Bourke (1989) examined the internal and external determinants of bank profitability in Europe, North America and Australia and included a liquidity measure in his analysis. The liquidity ratio that he employed was the ratio of liquid assets to total assets and he supported that there was a positive relationship between the ratio and banks' profitability.

In Europe, Molyneux and Thorton (1992), used a sample of eighteen European countries from 1986 to 1989 and examined the determinants of their bank performance. Their results demonstrated that the ratio of liquid assets to total assets is negatively related to return on assets (ROA). The same negative relationship was also supported by Guru et al. (1999), who investigated the determinants of commercial banks profitability in Malaysia. They supported that liquid assets are often associated with lower returns and thus high levels of liquid assets would be expected to be associated with lower profitability. Their results verified their expectations and in addition they supported that the difference between Bourke's (1989) results could be due to different elasticities of demand for loans in the two samples. In addition, Barth et al., (2003) examined the impact of the structure, the scope and the independence of bank supervision on the bank profitability. They employed a sample of 2300 banks from 55 countries. In their study, liquidity risk was measured again by the ratio of liquid assets to total assets. They found that this liquidity ratio had a negative and highly significant relationship with the profitability,

indicating a negative relationship between liquidity risk and profitability as measured by ROA. Another study that employed the ratio of liquid assets to total assets is the study of Demirguc-Kunt et al., (2003). They investigated the impact of bank regulation, concentration and institutions on bank profitability (Net Interest Margin) using a sample of 1400 banks from 72 countries. Their results demonstrated that high liquid asset holdings are related with lower net interest margins. They also supported that high liquid securities may receive lower interest income and thus there is a negative relationship with the bank profitability.

Moreover, some researchers used the ratio of loans to total assets which is similar to the aforementioned ratio. Demirguc-Kunt and Huizinga (1999), studied the determinants of banks' Net Interest Margins and profitability in 80 OECD countries. Their results showed that liquidity which was measured with the ratio of loans divided by total assets, is negatively related to profitability as measured by ROA and positively related to Net Interest Margin. In addition, Athanasoglou et al. (2006), examined the profitability behavior of bank-specific, macroeconomic determinants and industry related factors, using an unbalanced panel dataset. The banks that they investigated were from the South Eastern Europe and the period under examinations was from 1998-2002. The ratio of loans to total assets which was used as a proxy of liquidity, was found to have a positive but insignificant relationship with profitability (ROA & ROE). This was an unexpected result for the authors and the explanation given was related with the lack of resources of the SEE banking system to meet the liquidity standards of more developed banking systems, and thus these banks prevent failures by maintaining an illiquid position.

Except from the ratios of liquid assets to total assets and loans to total assets, other studies used different liquidity measures. Furthermore, despite the dominance of the negative relationship between liquidity ratios and profitability, there are also studies that found a positive relationship. Kosmidou et al. (2005) examined the impact of bank's characteristics, financial market structure and macroeconomic conditions, on the bank's profitability of UK domestic commercial banks, during the period 1995-2002. Their results were mixed, supporting a positive relationship between the ratio of liquid assets to customers and short-term funding and ROAA

and a negative relationship with Net Interest Margin. This positive relationship is consistent with Bourke (1989) and Kosmidou (2008) in which study there was also a positive relationship. In particular, the researcher's objective was to examine the determinants of performance in the Greek banking system during the EU financial integration period (1990-2002). An unbalanced pooled time series sample of 23 banks was employed and the results were mixed. The ratio of loans to customers and short term funding was negatively and significant related with ROAA but when financial structure and macroeconomic variables were employed in the equation the relationship became positive but insignificant. The negative and significant relationship of the ratio with ROAA, implied that less liquid banks have lower ROAA which was inconsistent with the author's expectations, but consistent with Bourke's (1989) research.

Other studies that measured liquidity using a ratio of assets to customer and short term funding, are, Pasiouras and Kosmidou (2007), who used the ratio of loans to customer and short term funding. In their research, they studied the effect of bank's specific characteristics and the overall banking environment on the profitability (ROAA) of commercial domestic and foreign banks operating in the 15 EU countries, for the period 1995-2001. The results showed that liquidity was statistically significant and positively related to the profitability of domestic banks which indicates a negative relationship between the level of liquid assets and bank profitability. On the other hand, in the case of foreign banks, liquidity is also significant but it is negatively related which indicates a positive relationship between liquid assets and profitability. In addition to the previous study, Naceur and Kandil (2009), investigated the effects of capital regulation on the cost of intermediation and profitability of banks in Egypt. Their sample contained 28 banks observed over the period 1989 to 2004. They found that liquidity had a positive and significant effect on the cost of intermediation, indicating that the increased liquidity imposed by regulations, induces higher cost of intermediation to increase earnings. They also concluded that banks' liquidity does not determine return on assets or equity (ROA and ROE) significantly.

Some other studies that used alternative measures for liquidity are the following. Shen et al. (2009), studied the determinants of bank performance in terms of liquidity risk management measured by the financing gap ratio and the ratio of net loans to customers and short term funding. The unbalanced panel dataset of banks from 12 advanced economies for the period 1994-2006 provided results showing that the liquidity risk is negatively associated with return on assets average (ROAA) and return on average equity (ROAE). This indicated that banks with larger financing gap, lack stable and cheap funding and they depend on liquid assets and external funding to meet their obligations. On the other hand, there was a positive relationship between liquidity risk and Net Interest Margin, which in contrary indicated that banks with high levels of illiquid assets, may receive higher income through interest than more liquid banks. Moreover, Ariffin (2012), analyzed the relationship between liquidity risk and financial performance of Islamic banks in Malaysia. The period under examination was during the crisis and in particular the period 2006-2008. The author measured the liquidity risk with the ratio of total assets over liabilities and found that in time of crisis, liquidity risk, return on assets (ROA) and return on equity (ROE) tend to behave in an opposite way and in particular, liquidity risk may lower the banks' profitability. An alternative study of David and Samuel (2012), examined the effect of liquidity management on the profitability of commercial banks. Their research methodology was based on structured and unstructured questionnaire on the management of banks. Moreover, they formulated a hypothesis which was then statistically tested through Pearson correlation data analysis. Their results, which were derived direct from the banks' management, indicated that profitability in banks is significantly influenced by liquidity and vice versa.

In this study apart from the impact of liquidity of banks on their financial performance, there is also the examination of the impact of regulatory imposed capital (Tier 1 Core Capital) on the banks' performance. The literature review regarding the relationship between the available capital of a bank and its financial performance, indicates mainly a positive sign. Berger (1995), examined the capital-earnings relationship and tried to determine the most important explanation of this

relationship. By employing annual data from 1983 to 1989 for US Commercial banks, the researcher came to the conclusion that there is a positive relationship between capital and earnings (ROE). According to the author, this means that well capitalized banks face lower expected bankruptcy costs and thus they can have access to cheaper funding and increase their profitability. In addition, Saunders and Schumacher (2000), investigated the determinants of interest margins in 7 OECD countries for the period 1988-1995. The results concerning the capital ratios, demonstrated that there is a significant and positive relationship between capital and bank profitability and that banks seek to reduce the cost that derives from the relatively high capital holdings, by demanding higher NIMs. Finally regarding the impact of capital on the banks' financial performance, Goddard et al., (2004) employed data from European banks (1992-1998) in order to investigate their profitability. Regarding the impact of capital on earnings, the author found a positive relationship which can be explained as the aforementioned study of Berger (1995), by the costs of insurance against bankruptcy and a signaling hypothesis (managers use capital in order to send signals about future profitability).

All the aforementioned studies regarding liquidity risk, were mainly focused on finding the determinants of banks' profitability and they used different proxies of liquidity in order to examine its effect. Apart from these studies, there are some research papers that directly examined the impact of liquidity on the banks' performance. In particular, a recent study of Bordeleau and Graham (2010), in a working paper for the Bank of Canada, analyzed the impact of liquid assets holdings on bank profitability. Their sample consisted of US and Canadian banks and the period under examination was 1997-2009. This study used ROA and ROE as dependent variable of profitability, which was then regressed against a non-linear expressions of liquid asset holdings and a set of bank specific and macroeconomic control variables. Results suggested that banks that hold some liquid assets, have improved profitability. However, according to the authors, there is a cut off point where further liquid asset holdings, diminish the profitability. In addition, results provided evidence that the aforementioned relationship between liquid assets and profitability, depends on business model of each bank and risk of funding market

difficulties. Moreover, Arif and Anees (2012), investigated the liquidity risk in the banking system of Pakistan and evaluated its effect on banks' profitability. In their research, they employed different liquidity measures that were derived from the banks' balance sheets, like deposits, liquidity gap and NPLs. The sample included 22 banks and the period under examination was 2004-2009. Their findings, demonstrated that the liquidity risk significantly affects the profitability of banks, with liquidity gap and NPLs being the two factors that exacerbate the risk. However, according to the authors, this liquidity risk can be mitigated by raising the deposit base, maintaining sufficient cash reserves and decreasing the liquidity gap and the NPLs. Another research of Ferrouhi (2014), evaluated the effect of banks' liquidity positions on their profitability in Marocco which was measured by ROA, ROE, ROAA and NIM. In order to specify the relationship between liquidity risk and profitability, the author used the aforementioned profitability ratios, six liquidity ratios and other macroeconomic and bank specific variables for the period 2001-2012. The results were mixed and the relationship derived between profitability and liquidity risk was dependent on the model used. Overall, according to the results the authors could not determine whether a liquid bank is more efficient than an illiquid bank.

Finally, a recent study that examined the impact of liquidity is the study of Marozva (2015). This study examined the impact of liquidity on bank performance for South African banks and for the period 1998-2014. In particular, in this study liquidity was measured in the context of funding liquidity risk and market liquidity risk. According to the results, there is a negative significant relationship between net interest margin and funding liquidity risk. Besides that, there is an insignificant co-integrating relationship between NIM and the two liquidity measures.

Chapter 3: *Variable Description, Data and Empirical Methodology*

In this section there is a presentation of the dependent and independent bank specific and macroeconomic variables that were used in this study. Regarding the bank specific dependent variables, they consist of both liquidity indicators from the banks' balance sheet as well as liquidity ratios. The sample that was used in the empirical part, consists of 50 banks. Detailed presentation of the sample is reported in part 3.3 *Data*.

3.1 *Dependent variables*

In this study, the banks' liquidity will be examined on ROAA, ROAE, NIM and PBT in order to get an overall and robust indication regarding the relationship between liquidity and profitability. Next there is a presentation of the three performance measures, together with three graphs that depict the differences of these indicators during 2009-2015. The value of each year is derived as an average value of the 50 banks that were used in the study's sample.

3.1.1 *Return on Average Assets (ROAA)*

The main model that is going to examine the impact of liquidity on the financial performance of banks will have as a dependent variable the ROAA. This ratio is defined as the net profit after tax divided by the average total assets. It reflects the ability of any bank's management to generate profits from the value of assets. Return on average assets is used instead of return on assets, in order to control for differences in the value of assets that occur within the fiscal year. Moreover, ROAA is considered the most important profitability measure, when it comes to compare the financial performance of banks.

In the literature, many researchers have used ROA and ROAA in their models, like Molyneux and Thorton (1992), Demirguc-Kunt and Huizinga (1999), Barth et al. (2003), Kosmidou et al. (2005), Pasiouras and Kosmidou (2007), Kosmidou (2008), Naceur and Kandil (2009), Shen et al. (2009), Bordeleau and Graham (2010), Ariffin (2012), Ferrouhi (2014).

Figure 1 shows that the average ROAA of the sample (50 banks) increased from 2009-2010 and then it sharply decreased until 2012 when it started to increase again.
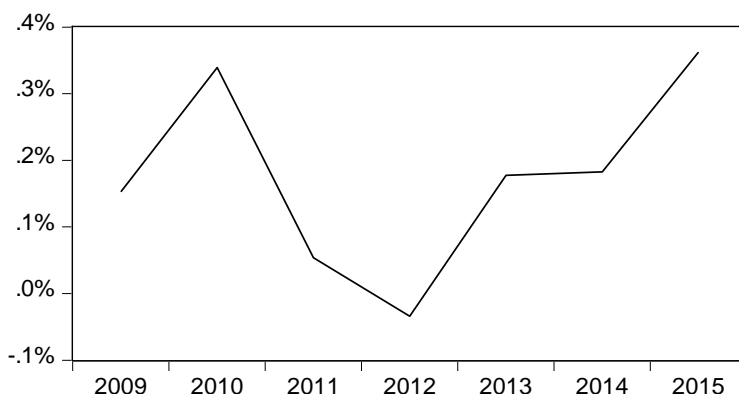
Figure 1. ROAA, Source: Bankscope, Software: Eviews 9

3.1.2 *Return on Average Equity (ROAE)*

Another measure that is employed to depict the performance of banks, is the Return on Average Equity which is defined as Net Income over the average shareholders' equity. As it was mentioned before, the average value of shareholders' equity is used in order to capture any differences in the equity value during the fiscal years (or season effects). This ratio indicates the profitability of a financial institution or corporation by demonstrating the percentage of profit that was generated compared to the invested money that shareholders contributed. In Figure 2 there is the corresponding graph, regarding ROAE.

Furthermore, there are several studies that used ROE and ROAE as a dependent variable: Berger (1995), Naceur and Kandil (2009), Shen et al. (2009), Bordeleau and Graham (2010), Ariffin (2012), Ferrouhi (2014).

Figure 2. ROAE, Source: Bankscope, Software: Eviews 9

The ROAE graph shows a similar trend as the ROAA. This means that banks' profitability significantly decreased during 2009-2012 and then it started to recover.

3.1.3 *Net Interest Margin (NIM)*

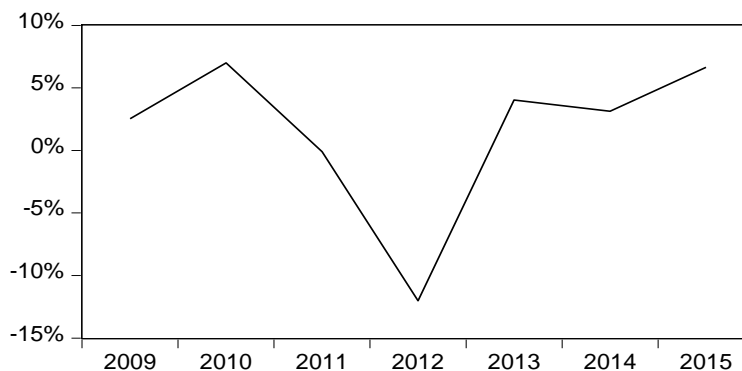We also use the Net Interest Margin as a proxy of profitability, which is calculated by the ratio of net interest income over the total earning assets and thus it shows the profitability of a bank's interest earning business. This performance metric, demonstrates how successful a bank manages its investments decision (mainly regarding its loan portfolio), compared to its debt obligations. Figure 3 shows how the average NIM of the sample changed over the period 2009-2015.

In previous literature the authors that employed this ratio are the following: Demirguc-Kunt and Huizinga (1999), Demirguc-Kunt et al., (2003), Kosmidou et al. (2005), Shen et al. (2009), Marozva (2015).
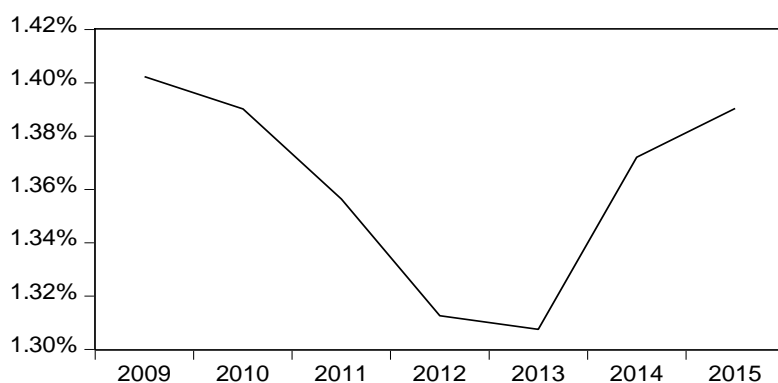
Figure 3. NIM, Source: Bankscope, Software: Eviews 9

3.1.4 *Profit Before Tax (PBT)*

Finally, the last dependent variable is Profit Before Tax. This profitability measure is taken directly from the banks' financial statements and reflects the profits before the banks have to pay any corporate tax. This is because, each bank has different debt obligations and thus different tax shields. Previous studies mostly used the three aforementioned profitability ratios and Profit Before Tax was used by Arif and Anees (2012) to directly examine the impact of liquidity on profitability. Next, Figure 4 demonstrates the changes on the average PBT of the sample. This graph has a similar trend with ROAA and ROAE during the years, with slight differences.
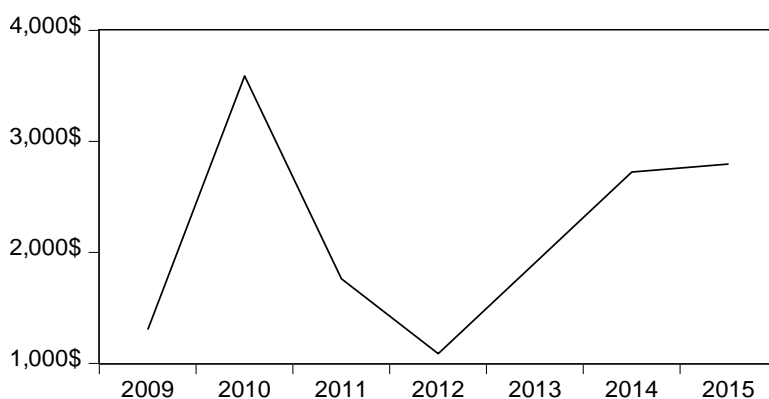
Figure 4. PBT (mil), Source: Bankscope, Software: Eviews 9

3.2 *Independent Variables*

There are two categories of independent variables that are used in this study. First of all, there are seven bank specific variables that are related with the banks' core activities and management's decisions and in addition there are two macroeconomic variables which capture the effect of the overall economy on the banks' performance. The macroeconomic variables correspond to the country in which each bank has its headquarters.

The bank specific variables that are used in this analysis are the following: 1) Cash and Due from Banks divided by Total Assets (CTTA), representing the liquidity from the asset side of the balance sheet. The variable of cash was transformed into a ratio due to the high correlation with the variable of Total Customer Deposits. 2) Total Customer Deposits (DEP), representing the liquidity that is derived from the liability side of the balance sheet. 3) The ratio of Impaired Loans to Gross Loans (ILTGL) which shows the effect of credit risk on the banks' performance. 4) The ratio of Net Loans to Total Assets (LTTA), representing liquidity and the annual growth of the loan portfolio. 5) The ratio of Loans less Customer Deposits to Total Assets (FGAPR) which represents a bank's financing gap (standardized by Total Assets). 6) The ratio of Tier1 Capital to Total Assets (T1TTA), representing the regulatory imposed level of liquidity. 7) The Cost to Income ratio (COST), which is included as a bank specific control variable.

The profitability of banks in not determined only by internal factors, but also by external macroeconomic factors that affect the whole economy. Thus the research of this study incorporates two macroeconomic variables, the annual real Gross Domestic Product Growth (GDPGR) and the Inflation Rate (INF), measured as the percentage annual change of consumer prices including all items.

Regarding the first variable, of Cash holdings to Total Assets, it is used as a proxy of liquidity, since any bank has to keep sufficient funds in order to meet any unexpected demand, mainly from depositors. Thus increased cash holdings and in turn increased liquidity indicates a more resilient bank. On the other hand, maintaining high cash reserves can be expensive (Holmstrom and Tirole, 2000) since banks that maintain high cash levels, face the opportunity cost of forgone income from other alternative investments. Due to this opportunity cost, the relationship of cash holdings with profitability is expected to have a negative sign. The other variable that is also derived from the banks' balance sheet, is the Total Customer Deposits. As it was mentioned in the study of Arif and Anees (2012), according to Gatev and Strahan (2003), deposits can provide a natural hedge for banks, against liquidity risk, because deposit inflows provide funding for loan demand shocks or for cases of mass withdrawals. In addition, banks can increase their profitability by increasing their loan portfolio and other activities with the use of deposits. On the other hand, Dietrich and Wanzenried, (2011) found an overall negative and significant impact of the yearly growth of deposits on the bank profitability. Thus the expected sign can be positive or negative.

The ratio of Impaired Loans to Gross Loans, demonstrates the annual growth of non-performing loans (NPLs). The NPLs directly affect the liquidity and the profitability of a bank, by reducing its cash inflows from its loan portfolio which is usually the biggest asset of a commercial bank. Thus as this ratio increases, profitability is expected to decrease. Furthermore, the ratio of Net Loans to Total Assets, represents liquidity in the form of the percentage of total assets, that is invested in the loan portfolio. The management of a bank should have established a maximum goal for this ratio in order to avoid liquidity problems. An increase of this ratio could result into increased profitability for banks but on the other hand, according to Staikouras and Wood

(2004), banks which increase this ratio may face higher cost for their funding requirements. Overall someone should expect this ratio to have a negative sign as previous studies demonstrated, Demirguc-Kunt and Huizinga (1999) and Staikouras and Wood (2004).

Moreover, the standardized Financing Gap ratio that is employed in this study, is used to proxy liquidity risk. Banks with a high financing gap, must use their cash, or even sell some liquid assets in order to fund this gap. It consequently increases the cost of funding and reduce the banks' profitability. In previous studies, Shen et al. (2009) found a negative relationship of this ratio with ROAA and ROAE and a positive relationship with NIM. Ferrouhi (2014), found a negative relationship with ROA, indicating that banks with high financing gap ratio, lack stable and cheap funding.

In addition to the previous liquidity measures, this study examines also the effect of regulatory imposed capital on the banks' profitability. The ratio of Tier1 Capital over Total Assets is employed which also consists one of the regulatory standards regarding the liquidity risk (leverage ratio). According to Berger (1995) and Goddard et al., (2004) there is a positive relationship between capital and profitability. This positive effect of capital on the banks' profitability is also confirmed by a more recent study by Bandt et al., (2014), and thus there is a positive sign expected in this study. Finally, the last independent bank-specific variable, is the Cost to Income ratio, which is used as a control variable to the banks' characteristics. It is defined as operating cost over the total generated revenues and it shows how efficient a bank manages its expenses. The anticipated effect of Cost to Income ratio as supported by Kosmidou et al., (2005) and Pasiouras and Kosmidou (2007), is negative since higher expenses mean less profits.

Regarding the external variables which are related to the performance of the overall economy, this study employs two measures. First, the real Growth rate of Gross Domestic Product, which shows the annual percentage change of each country's GDP, depicts the state of the economic cycle. When there is growth in the economy, it is usually supported by a credit expansion which enhances this growth and also increases banks' profitability. Overall, a positive relationship is expected, which is

also supported by Demirguc-Kunt and Huizinga (1999) and Kosmidou et al., (2005). On the other hand, the Inflation Rate is another important macroeconomic variable, affecting the real value of revenues and costs. The impact of inflation on the profitability of banks is ambiguous and Kosmidou (2005), supported that according to Perry (1992), it depends on whether the inflation is anticipated or not. Previous studies reported both a positive (Molyneux and Thorton, 1992; Athanasoglou et al., 2006; Shen et al.,2009) and a negative (Kosmidou, 2008) relationship between inflation and profitability.

Table 1. Variable Summary. Source: Bank Specific variables were obtained from Bankscope; Macroeconomic Variables were obtained from the OECD database.

	Variable	**Notation**	**Expected effect**
Dependent Variables	Return on Average Assets	ROAA	
	Return on Average Equity	ROAE	
	Net Interest Margin	NIM	
	Profit Before Tax	PBT	
Bank Specific Independent Variables	Cash to Total Assets	CTTA	Negative
	Total Customer Deposits	DEP	Positive / Negative
	Impaired Loans to Gross Loans	ILTGL	Negative
	Net Loans to Total Assets	LTTA	Negative
	Financing Gap Ratio	FGAPR	Negative
	Tier1 Capital to Total Assets	T1TTA	Positive
	Cost to Income ratio	COST	Negative
Macroeconomic Independent Variables	Real Growth Rate of Gross Domestic Product	GDPGR	Positive
	Inflation Rate	INF	Negative/Positive

3.3 *Data*

As it was mentioned above, there is a separation in the variables between bank specific and macroeconomic variables. Bank specific variables were derived from the Bankscope Database of Bureau and Dijk's company. On the other hand, the data for the macroeconomic variables were derived from the OECD database.

Considering the recent financial crisis, and the important role of the liquidity risk in the deterioration of the crisis, the period under examination is during the crisis and in particular the recent years from 2009 to 2015. In addition, the sample consists of 50 large European banks. In order to form the sample, the banks were sorted by the value of their total assets in the Bankscope database. The selection criteria of this study are the following: 1) The institutions have to be active commercial banks. 2) In addition, only banks that had continuously data during the period under examination were selected. 3) These continuously data have to be reported under the Banksope's C2 consolidation code, which consists of the financial statement of a mother bank which in turn integrates the statements of its controlled subsidiaries or branches with an unconsolidated companion. The sample does not include subsidiaries but only the whole group of each bank. Some banks were excluded from the sample due to the aforementioned criteria. Finally, the overall sample consists of 50 large banks (See Appendix **1.**) from the European Union (28). These 50 banks are in general, among the 150 largest banks in the European Union (28). Overall, these data created a balanced panel dataset with 350 observations for each variable, which allows us to study the particular relationship between liquidity and profitability, within multiple banks and using data that are periodically observed over a defined time frame (Yaffee, 2003). Next, in Figure 5 there is a graph, presenting the average value of total assets (in thousands of dollars) for the sample banks during 2009-2015. As we can see from the graph, the average total assets value has decreased over these seven years, indicating a decline in the banks' core activities.
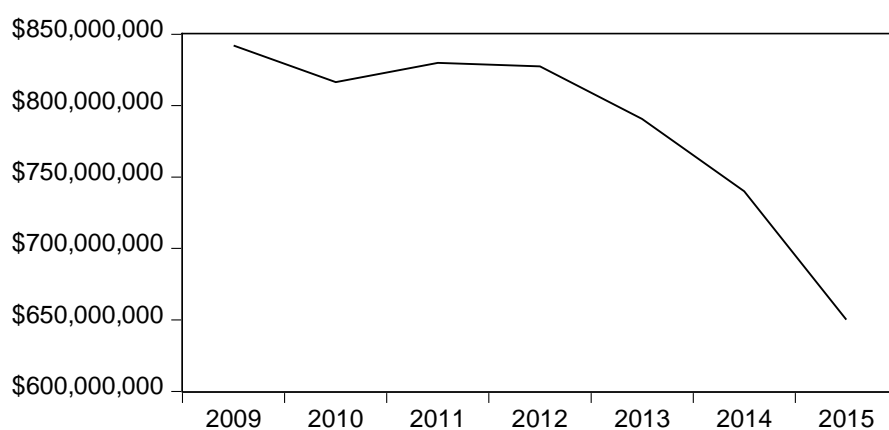
Figure 5. Average Total Assets, Source: Bankscope, Software: Eviews 9

3.4 *Descriptive Statistics*

Table 2. presents the descriptive statistics of the internal and external variables that are used in this study. The CTTA, the FGAPR, the T1TTA and the LTTA variables are expressed as a percentage of total asset. Deposits and Profit Before Tax, are expressed in millions of USD dollars. Next there is a presentation of the most significant inferences from Table 2.

Table 2. Descriptive Statistics

	Mean	Median	Maximum	Minimum	Std. Dev
ROAA	0.176629	0.27	1.06	-6.83	0.6018
ROAE	1.606086	6.01	27.2	-724.67	40.74147
NIM	1.362029	1.265	2.97	0.27	0.595805
PBT	2,165.975	1,438.354	22,565.0	-33,035.89	5,252.402
CTTA	3.285771	2.27	16.14	0.0042	2.832466
DEP	291,788.40	193,762.70	1,361,297	357.57	265,764
ILTGL	5.419714	3.915	33.84	0.38	4.896033
LTTA	51.1472	52.76	87.7	14.7	16.78778
FGAPR	12.07229	10.79251	81.47418	-68.17835	20.26572
T1TTA	4.363654	4.35923	6.942073	1.776051	1.12419
COST	64.68391	63.2	195.35	24.88	17.23353
GDGGR	0.549212	1.19665	26.2761	-8.269	2.815848
INFL	1.281231	1.1898	4.5	-4.4819	1.221251

Regarding the profitability measures of ROAA and ROAE, we can observe that the average values for our sample are 0.176% and 1.606% accordingly. These values are smaller than the median values which are 0.27% and 6.01% accordingly, indicating that there are significant profitability differences among the banks in the sample (Dietrich and Wanzenried ,2011). In addition, ROAE has a high standard deviation indicating high variance among the banks' data, which is also observed by the difference between the maximum and minimum value. The same high standard deviation holds also for Profit Before Tax and Total Customer Deposits, which are expressed in millions of USD dollars. In addition, the ratio of impaired loans has a mean value of 5.41% which is quite low and close to the European average in 2015 (Mesnard et al., 2016), but it is still higher than other developed countries (USA, Japan). Furthermore, Net Loans consist on average the 51.14% of total assets but there is a high standard deviation, indicating differences in the banks' business models. Next, the Financing Gap ratio has a positive mean, indicating that on average banks have more loans than deposits, but there exist banks that also have a negative gap. Finally, the Tier 1 ratio, has a positive mean, higher than 3% which is the minimum requirement imposed by the Basel Committee (BCBS, 2014).

3.5 *Correlation Matrix*

In order to test our sample data for high correlation that could affect the results, Table 3 presents the correlation matrix for the independent bank specific and macroeconomic variables. Considering the nature of the data, we can observe that the correlations are quite low. That's because some variables (e.g. Cash and Due from Banks) were transformed into ratios. The highest correlation exists between LTTA and FGAPR (0.61), but it still is lower than the threshold of 0.7. Overall, according to Table 3. there is nothing important than could affect the results of this analysis.

Table 3. Correlation Matrix

Correlation	CTTA	DEP	ILTGL	FGAPR	LTTA	T1TTA	COST	GDGGR	INFL
CTTA	1								
DEP	0.271434	1							
ILTGL	-0.12921	-0.07469	1						
FGAPR	-0.19874	-0.38016	0.064403	1					
LTTA	-0.05995	-0.30927	0.138634	0.616102	1				
T1TTA	0.340641	0.047532	0.255217	0.034454	0.349098	1			
COST	-0.00847	0.064725	-0.01277	-0.26941	-0.26842	-0.30983	1		
GDGGR	0.159717	0.005515	-0.07134	-0.11984	-0.08261	0.011208	0.005551	1	
INFL	-0.00837	0.169426	0.079968	0.014238	0.065822	-0.00545	0.058891	0.078046	1

3.6 *Research Methodology*

In order to examine the impact of the bank specific and macroeconomic factors on the banks' profitability, we employ the following econometric models. These are the extended equations that reflect all the variables that are used:

1) $ROAA_{it} = C + \beta_1 CTTA + \beta_2 DEP + \beta_3 ILTGL + \beta_4 LTTA + \beta_5 FGAPR + \beta_6 T1TTA + \beta_7 COST + \beta_8 GDPGR + \beta_9 INFL + \delta_i + \varepsilon_{it}$

2) $ROAE_{it} = C + \beta_1 CTTA + \beta_2 DEP + \beta_3 ILTGL + \beta_4 LTTA + \beta_5 FGAPR + \beta_6 T1TTA + \beta_7 COST + \beta_8 GDPGR + \beta_9 INFL + \delta_i + \varepsilon_{it}$

3) $NIM_{it} = C + \beta_1 CTTA + \beta_2 DEP + \beta_3 ILTGL + \beta_4 LTTA + \beta_5 FGAPR + \beta_6 T1TTA + \beta_7 COST + \beta_8 GDPGR + \beta_9 INFL + \delta_i + \varepsilon_{it}$

4) $PBT_{it} = C + \beta_1 CTTA + \beta_2 DEP + \beta_3 ILTGL + \beta_4 LTTA + \beta_5 FGAPR + \beta_6 T1TTA + \beta_7 COST + \beta_8 GDPGR + \beta_9 INFL + \delta_i + \varepsilon_{it}$

The dependent variable refers to the profitability (ROAA, ROAE, NIM, PBT) measure of bank i at time t, δ_i reflects the fixed effects in the bank i and ε_{it} is the error term. All the calculations and the regressions were performed with the Eviews 9 software.

Each of the three models was initially tested for the cross section effects. In order to do so, the Hausman test (Baltagi, 2001) was performed in the four models. According to the results, the null hypothesis which indicates that random effects are more appropriate, is rejected and thus fixed effects are used instead (See Appendix **2.**). In addition, in order to test the significance of each model's effects, we conduct the Redundant Fixed Effects – Likelihood Ratio. This ratio tests the joint significance of the cross – section effects that are used. The p-values, obtained by the test strongly reject the null hypothesis that the cross – section effects are redundant. Furthermore, in order to get robust results regarding the standard errors and the significance of each variable, we performed two residual diagnostic tests. First, we employed the Breusch-Pagan test to check for heteroscedasticity in the residuals. The results demonstrated that the null hypothesis of homoscedasticity is rejected in all models and thus the presence of heteroscedasticity is assumed.

Moreover, a manual process was employed in Eviews 9, to check the residuals for serial correlation. The test was performed with the help of an auxiliary regression which was estimated using the variables in their first differences. Then the residuals series of this regression were regressed on the lagged residuals (*residuals on residuals (-1)*). Under the null hypothesis which suggests that the original idiosyncratic errors are serial uncorrelated, the autocorrelation coefficient should be -0,5. Using a Wald Coefficient Restriction test, we can conclude that in the models that have as dependent the ROAA, ROAE the null hypothesis cannot be rejected, while regarding PBT there is not enough evidence to reject the null hypothesis, thus there is no serial correlation among the residuals. In the model that has NIM as dependent the null hypothesis is rejected indicating the presence of serial correlation (See Appendix **2.**).

Finally, according to the Redundant Variable Test, which tests the joint significance of the variables that are included in the equation, the null hypothesis that assumes

that the bank specific variables are redundant, is rejected in all models. Regarding the estimation of the models, all models were estimated using fixed effects. Moreover, to get robust results, we estimated the models 1), 2) and 4) using the White Cross –Section coefficient covariance method to control for the presence of heteroscedasticity in the residuals. The third model (NIM) was estimated, using the White Period method, which assumes that the errors are heteroscedastic and serially correlated.

Chapter 4: *Empirical Results*

The empirical results regarding the estimation of the four models are presented in **Table 4**, **Table 5**, **Table 6** and **Table 7** (at the end of this chapter). First of all, the explanatory power, measured by the R^2 is quite high in models 1), 3) and 4) which examine the impact of liquidity on ROAA, NIM and PBT respectively, but it is not as high when the dependent variable is ROAE. Moreover, we can observe that the models 1), 2) and 4) (ROAA, ROAE and PBT) have similar results concerning the sign of each variable while there are differences in their significance. On the other hand, model 3) which examines NIM has differences in the variables' signs and also in their significance.

The variable of Cash to Total Assets is negatively related with the banks' profitability, represented by ROAA, ROAE, PBT. This result is opposite to the positive relationship, supported by the research of Arif and Anees, (2012), but consistent with Holmstrom and Tirole, (2000) who supported that high cash reserves can be expensive due to the opportunity cost of forgone income from other alternative investments. Moreover, this variable is statistically insignificant in the models 2) and 4) and significant in the first model (ROAA) at 10%. Thus, even though cash reserves increased as a percentage of total assets during 2009-2015 (See Appendix **3.**), this increased liquidity did not enhance the banks' profitability. On the other hand, the third model (NIM) has a positive sign in this variable but it is statistically insignificant.

In addition, Deposits and Due from Banks is also negatively related with profitability in all four estimated models which is consistent with Dietrich and Wanzenried,

(2011). In the models that have ROAA and NIM as dependent, Deposits are statistically significant at 1%, in the model with PBT as dependent it is significant at 5% while in the second model (ROAE) it is insignificant. After 2013 there is on average, a steep reduction in total customer deposits (See Appendix **3.**) which contributed to the decreased profitability by decreasing the resources that were available for investments.

Next the ratio of Impaired Loans to Gross Loans, has also a negative sign in all models as expected and it is consistent with Kashyap et al., (2002). The variable of ILTGL was statistically significant at 1% in models 2), 3) and 4), while in the first model it was significant at 5%. The results show that as the percentage of impaired loans increased (See Appendix **3.**) during 2009-2015, banks suffered by reduced cash inflows from their loan portfolio which then caused a reduction in their profits. Furthermore, the ratio of Net Loans to Total Assets has also a negative impact on the banks' profitability, when it is measured by ROAA, ROAE and PBT, but it is positively related with NIM. This variable is statistically significant at 1% only in the third model (NIM). The negative impact, is consistent with Demirguc-Kunt and Huizinga (1999) and Staikouras and Wood (2004), and indicates that banks which have a high ratio may face higher cost for their funding requirements. In addition, the increased percentage of NPLs during this crisis, reduced the returns that banks expected from their loan portfolio. On the other hand, the positive sign on NIM, can be explained by the fact that this ratio is depended on interest income. Thus, when this ratio increases, NIM also increases.

Regarding the FGAPR variable, we found a negative relationship with profitability in all models. The results are statistically significant (at 1%), in model 1) (ROAA) and (at 5%) in model 4 (PBT). This negative sign indicates that illiquid banks that have a high financing gap ratio, may face funding difficulties, which in turn reduce their profitability. These results are consistent with Shen et al. (2009), regarding ROAA and ROAE, but inconsistent with their result regarding NIM where they found a positive impact. In addition, our results are also consistent with Ferrouhi (2014).

Furthermore, the variable that was used as a proxy for the regulatory imposed capital (T1TTA), has a positive but insignificant impact on profitability when it is measured by ROAA, ROAE and PBT and a negative and insignificant impact when the depended variable is NIM. The positive impact is consistent with Berger (1995), Goddard et al., (2004) and Bandt et al., (2014) and according to Berger (1995), it shows that well capitalized banks face lower expected bankruptcy costs and thus they can have access to cheaper funding. In contrast, the negative impact of this capital ratio is consistent with the aforementioned characteristic of NIM. Since it depends on the interest income, higher capital requirements may shrink the interest earning business of a bank and thus decrease NIM.

The Cost to Income ratio, which was used as a control variable to the bank specific characteristics, was found to be negatively related with the four banks' profitability measures. The variable was statistically significant at 1% in model 1 (ROAA), 2 (ROAE) and 4 (PBT), while in model 3 it is significant at 10%. The final result is the one that was anticipated for this variable, and consistent with the studies of Kosmidou et al., (2005) and Pasiouras and Kosmidou (2007).

Regarding the macroeconomic variables that were used in the regression, the results are the following. The annual growth rate of GDP was found to be positively related with the banks' performance, in all models. Moreover, it was statistically significant at 1% in the first model (ROAA) and at 5% in the fourth model (PBT), while in the other two estimations it was statistically insignificant. When there is growth in an economy, this also affects positively the banks' profits through the increasing of credits and the reduction of credit risk. The results regarding the variable of GDPGR is also supported by Demirguc-Kunt and Huizinga (1999), Kosmidou et al., (2005) and Athanasoglou et al., (2006).

Finally, the results the second macroeconomic variable that was used (INFL) were mixed. Inflation, was positively related with ROAA, ROAE and PBT but negatively related with NIM. Moreover, this relationship was insignificant in all four models. The positive association is supported by previous studies, like Molyneux and Thorton, (1992), Athanasoglou et al., (2006), Shen et al., (2009). It also supports the

theory that inflation was anticipated and thus banks had the opportunity to adjust their interest rate accordingly and eventually increase their profitability. Besides that, Kosmidou, (2008), found a negative relationship of inflation with the banks' profitability. In our results, the negative sign on NIM can be possibly explained by the fact that inflation essentially decreases the interest income of a bank.

Following there is a presentation of the empirical results in Tables 4 to 7, which demonstrate the results from the regressions:

Table 4. DEPENDENT VARIABLE: ROAA, MODEL 1

Independent Variables	Coefficient	Std. Error	Prob.
C	1.689296	0.518863	0.0013
CTTA	-0.015369	0.008781	0.0811
DEP	-9.22E-07	3.59E-07	0.0106
ILTGL	-0.044975	0.018605	0.0162
LTTA	-0.004316	0.009237	0.6407
FGAPR	-0.013948	0.004982	0.0055
T1TTA	0.215085	0.140699	0.1274
COST	-0.023435	0.001479	0.0000
GDPGR	0.024370	0.005405	0.0000
INFL	0.002845	0.015974	0.8588
R^2	0.6048		
Adjusted R^2	0.5261		
TESTS	Statistic	Prob.	
Breusch-Pagan Test (LM)	1659,52	0.0000	
Redundant Fixed Effects Test 1) Cross-Section F 2) Cross-Section Chi-Square	1) 1.856954 2) 95.225611	1) 0.0010 2) 0.0001	
Redundant Variable Test (F-statistic)	27.34281	0.0000	

Table 5. DEPENDENT VARIABLE: ROAE, MODEL 2

Independent Variables	Coefficient	Std. Error	Prob.
C	62.19509	39.86366	0.0198
CTTA	-0.952510	0.621859	0.1267
DEP	-5.13E-06	2.51E-05	0.8385
ILTGL	-1.869336	0.547125	0.0007
LTTA	-0.695584	0.535727	0.1952
FGAPR	-0.225884	0.435217	0.6041
T1TTA	21.46071	14.04158	0.1275
COST	-1.601372	0.470560	0.0008
GDPGR	0.441291	0.423993	0.2988
INFL	1.690464	1.343184	0.2092
R^2	0.4815		
Adjusted R^2	0.3781		

Tests	Statistic	Prob.	
Breusch-pagan test (LM)	1980.28	0.0000	
Redundant Fixed Effects Test			
1) Cross-Section F	1) 2.8676	1) 0.0000	
2) Cross-Section Chi-Square	2) 137.8908	2) 0.0000	
Redundant Variable Test (F-statistic)	22.6413	0.0000	

Table 6. DEPENDENT VARIABLE: NIM, MODEL 3

Independent Variables	Coefficient	Std. Error	Prob.
C	0.957930	0.243090	0.0001
CTTA	0.003975	0.005507	0.4710
DEP	-7.24E-07	2.05E-07	0.0005
ILTGL	-0.018650	0.003955	0.0000
LTTA	0.020474	0.004245	0.0000
FGAPR	-0.008376	0.005302	0.1152
T1TTA	-0.030887	0.026027	0.2363
COST	-0.001608	0.000959	0.0946
GDPGR	0.007099	0.005549	0.2018
INFL	-0.006147	0.011080	0.5794
R^2	0.9458		
Adjusted R^2	0.9350		

Tests	Statistic	Prob.
Breusch-Pagan Test (LM)	1982.41	0.0000
Redundant Fixed Effects Test 1) Cross-Section F 2) Cross-Section Chi-square	1) 42.436 2) 734.121	1) 0.0000 2) 0.0000
Redundant Variable test (F-statistic)	14.665	0.0000

Table 7. DEPENDENT VARIABLE: PBT, MODEL 4

Independent Variables	Coefficient	Std. Error	Prob.
C	18295.99	4039.693	0.0000
CTTA	-135.3482	84.34066	0.1096
DEP	-0.009830	0.004941	0.0476
ILTGL	-326.7948	64.38973	0.0000
LTTA	-60.12604	62.91371	0.3400
FGAPR	-93.98454	40.11103	0.0198
T1TTA	372.6691	811.1249	0.6463
COST	-132.8939	16.62812	0.0000
GDPGR	213.2950	91.25838	0.0201
INFL	13.05280	108.5171	0.9043
R^2	0.7053		
Adjusted R^2	0.6466		

Tests	Statistic	Prob.
Breusch-Pagan Test (LM)	1612.86	0.0000
Redundant Fixed Effects Test 1) Cross-Section F 2) Cross-Section Chi-square	1) 4.5323 2) 198.4918	1) 0.0000 2) 0.0000
Redundant Variable test (F-statistic)	14.4593	0.0000

Chapter 5: *Conclusions*

This study investigated the impact of liquidity, which was measured by several balance sheet measures (e.g. cash, deposits), liquidity ratios (e.g. Loans to Total Assets, Impaired Loans to Gross Loans), capital ratio, and external macroeconomic factors, on the profitability of 50 European banks, measured by ROAA, ROAE, NIM and PBT. In addition, since there is a limited number of previous studies that addressed this particular topic, this study is intended to contribute to the relevant literature, through an overall and robust assessment of liquidity on banks' profitability, after the recent financial crisis, where liquidity played a very important role.

In order to do so, a balanced panel data set was used, including 50 large European banks for the period 2009-2015, resulting into 350 observations. The results of this study, showed that the liquidity measures, had the same impact regarding the sign of each variable on ROAA, ROAE and PBT, while there were some differences in the NIM equation. In particular liquidity measures that were used directly from the banks' balance sheet, Cash and Due from Banks and Total Customer Deposits, were found to have a negative relationship with ROAA, ROAE and PBT, providing support that the opportunity cost of holding low yield assets and on the other hand holding deposits which can not be invested appropriately or are invested in high risk assets, comes to dominate the increased resilience of the banks due to increased liquidity. In the equation were NIM was depended variable, Cash and Due from Banks was found to be positively but insignificantly related with profitability.

Furthermore, regarding the liquidity ratios that were used as different proxies of liquidity, they all had the expected outcome on the banks' profitability. The ratio of Impaired Loans to Gross Loans was found to have a negative and statistically significant relationship with all profitability measures, indicating that the problem of increased NPLs during the financial crisis, affected the liquidity and eventually the banks' profitability. Moreover, the ratio of Loans to Total assets, was negatively related with ROAA, ROAE and PBT, but positively related with NIM. Next, the

financing gap ratio that was used, was also found to have a negative relationship with all profitability measures. These findings are consistent with Shen et al., (2012) and Ferrouhi, (2014) and indicates that banks with large gap, may face problems with their stable and cheap funding resources.

The variable that was used as a proxy to the regulatory imposed liquidity was the ratio of Tier 1 Capital to Total Assets. The results showed that there was a positive relationship between this variable and profitability, when measured with ROAA, ROAE and PBT. This result is consistent with Berger (1995), and shows that well capitalized banks, are considered safer and thus they can have access to cheaper funding. The relationship with NIM was negative, because the more capital is held as a safety buffer the less resources are invested in the banks' interest earning business. Finally, regarding the bank specific factors, Cost to Income ratio which was used as a control variable, was negatively related. The macroeconomic variables of annual Growth Rate of GDP and Inflation, had a positive sign when we examined ROAA, ROAE and PBT while in the NIM equation, inflation had a negative sign.

Overall, we can conclude that our study demonstrated that in European Banks, during the period 2009 – 2015, liquidity as measured by the balance sheet measures, mostly had a negative impact on profitability, measured as a return on invested funds or as absolute profits (ROAA, ROAE, NIM, PBT). The Non Performing Loans phenomenon contributed towards this result by deteriorating the performance of the loan portfolio of each bank. According to this study, banks should maintain their liquidity levels mostly though their capital reserves (e.g. Tier 1 Capital) and take actions to mitigate the credit risk of their investments, as well as their financing gap which imposes constraints in their funding procedure. At the end, further research could be conducted in this particular topic, regarding the impact of liquidity before and after the crisis on profitability and whether the liquidity condition of European banks after 2007 is adequate to prevent a similar crisis.

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Appendix

1.

The following table presents the banks that are included in this study's sample:

	Banks	Total Assets 2015		Banks	Total Assets 2015
1	HSBC Holdings Plc	2,409,656,000	26	ABN AMRO Group N.V.	424,950,470
2	BNP Paribas	2,171,141,028	27	Svenska Handelsbanken	298,802,598
3	Crédit Agricole Group	1,849,601,556	28	Nationwide Building Society	297,337,403
4	Deutsche Bank AG	1,773,685,387	29	Skandinaviska Enskilda Banken AB	295,702,299
5	Barclays Bank Plc	1,660,828,428	30	Crédit Industriel et Commercial SA	276,511,709
6	Banco Santander SA	1,459,183,477	31	KBC Group	274,747,963
7	Société Générale SA	1,452,793,711	32	Landesbank Baden-Wuerttemberg	254,779,536
8	BPCE Group	1,270,043,571	33	Swedbank AB	254,579,539
9	RBS	1,208,369,913	34	La Banque Postale	238,114,321
10	Lloyds Banking Group Plc	1,195,447,565	35	BFA Tenedora de Acciones SAU	232,660,646
11	UBS AG	950,767,093	36	Banco de Sabadell SA	227,139,688
12	UniCredit SpA	936,781,072	37	Erste Group Bank AG	217,466,961
13	ING Bank NV	912,931,970	38	Nykredit Realkredit A/S	202,604,532
14	Credit Suisse Group AG	827,341,023	39	Norddeutsche Landesbank NORD/LB	197,058,251
15	BBVA SA	816,633,656	40	Belfius Banque SA	192,664,239
16	Credit Mutuel	805,453,471	41	Banca Monte dei Paschi di Siena SpA-Gruppo	184,008,713
17	Intesa Sanpaolo	736,522,604	42	HSBC France SA	183,405,556
18	Cooperatieve Rabobank	729,856,300	43	Banco Popular Espanol SA	172,727,167
19	Nordea Bank AB	704,265,663	44	Deutsche Postbank AG	163,959,720
20	Standard Chartered Plc	640,483,000	45	Raiffeisen Zentralbank Oesterreich AG - RZB	150,708,549
21	Commerzbank AG	579,903,113	46	Le Crédit Lyonnais SA	148,927,602
22	KfW Group	547,602,622	47	Crédit Foncier de France SA	146,403,922
23	Bank of Scotland Plc	505,828,404	48	Bank of Ireland	142,580,296
24	Danske Bank A/S	482,119,749	49	OP Financial Group	136,249,322
25	DZ Bank AG	444,573,769	50	Banco Popolare - Società Cooperativa- Banco Popolare	131,202,615

2.

The following tables show the results from the Hausman test and the manual autocorrelation test that were performed for each model. The tables are derived from Eviews 9 software.

- **MODEL 1: ROAA**

Correlated Random Effects - Hausman Test

H_0: Random effects are more appropriate

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	40.435638	9	0.0000

Manual Autocorrelation Test Results (Auxiliary Regression)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DRESIDROAA(-1)	-0.439682	0.058914	-7.463089	0.0000

DRESIDROAA(-1): The lagged value of residuals that were derived from the initial equation (1), using the variables in their first differences. Following there is also the Wald test that was employed.

Wald Test:

H_0: Coefficient = -0.5

Test Statistic	Value	Df	Probability
t-statistic	1.023833	249	0.3069
F-statistic	1.048234	(1, 249)	0.3069
Chi-square	1.048234	1	0.3059

- **MODEL 2: ROAE**

Correlated Random Effects - Hausman Test

H$_0$: Random effects are more appropriate

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	50.494340	9	0.0000

Manual Autocorrelation Test Results (Auxiliary Regression)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DRESIDROAE(-1)	-0.405108	0.057852	-7.002543	0.0000

DRESIDROAE(-1): The lagged value of residuals that were derived from the initial equation (2), using the variables in their first differences. Following there is also the Wald test that was employed.

Wald Test:

H$_0$: Coefficient = -0.5

Test Statistic	Value	df	Probability
t-statistic	1.640258	249	0.1022
F-statistic	2.690445	(1, 249)	0.1022
Chi-square	2.690445	1	0.1010

- **MODEL 3: NIM**

Correlated Random Effects - Hausman Test

H$_0$**:** Random effects are more appropriate

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	81.556678	9	0.0000

Manual Autocorrelation Test Results (Auxiliary Regression)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DRESIDNIM(-1)	-0.019968	0.056957	-0.350579	0.7262

DRESIDNIM(-1): The lagged value of residuals that were derived from the initial equation (3), using the variables in their first differences. Following there is also the Wald test that was employed.

Wald Test:

H$_0$**:** Coefficient = -0.5

Test Statistic	Value	df	Probability
t-statistic	8.428007	249	0.0000
F-statistic	71.03131	(1, 249)	0.0000
Chi-square	71.03131	1	0.0000

- **MODEL 4 PBT**

Correlated Random Effects - Hausman Test
H_0: Random effects are more appropriate

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	25.495720	9	0.0025

Manual Autocorrelation Test Results (Auxiliary Regression)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DRESIDPBT(-1)	-0.388528	0.055836	-6.958432	0.0000

DRESIDPBT(-1): The lagged value of residuals that were derived from the initial equation (4), using the variables in their first differences. Following there is also the Wald test that was employed.

Wald Test:
H_0: Coefficient = -0.5

| Test Statistic	Value	df	Probability
t-statistic	1.996440	249	0.0490
F-statistic	3.985774	(1, 249)	0.0470
Chi-square	3.985774	1	0.0459

3.

Next there are seven graphs that present the evolution of the liquidity measures that were used in this study, over the period 2009 – 2015. Each year's value is calculated as an average of the 50 sample banks data.
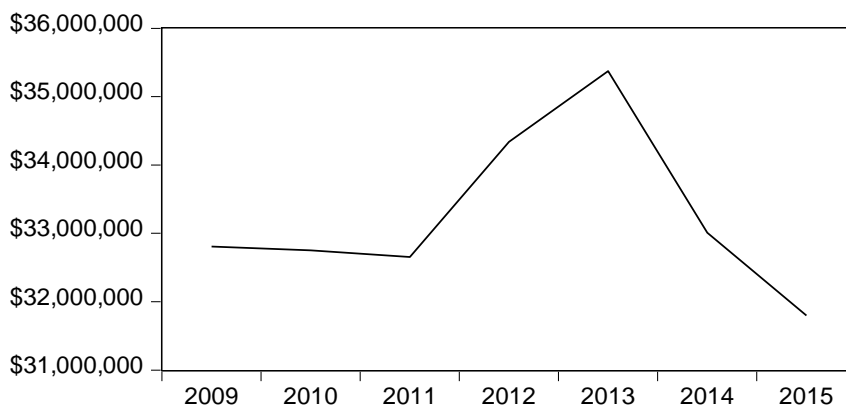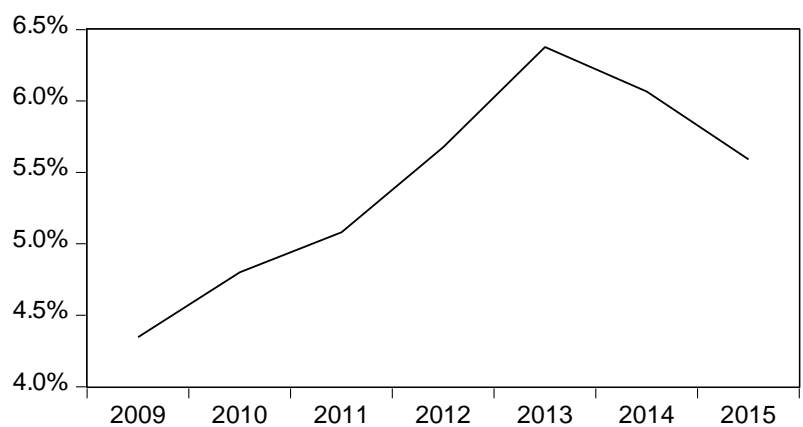
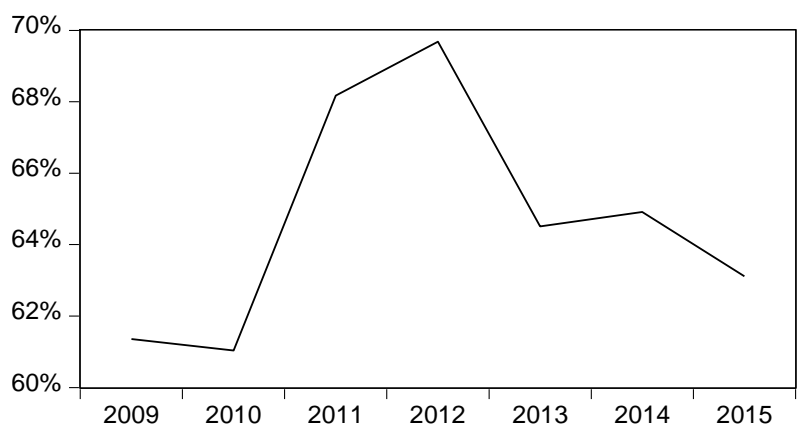**Cash and Due from Banks**
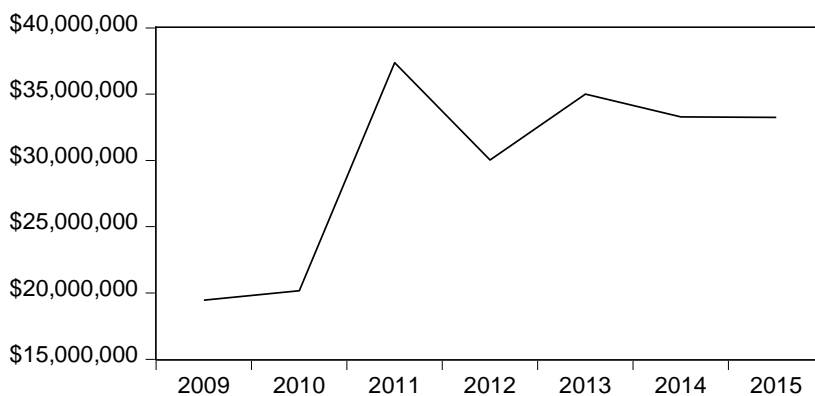
Total Customer Deposits
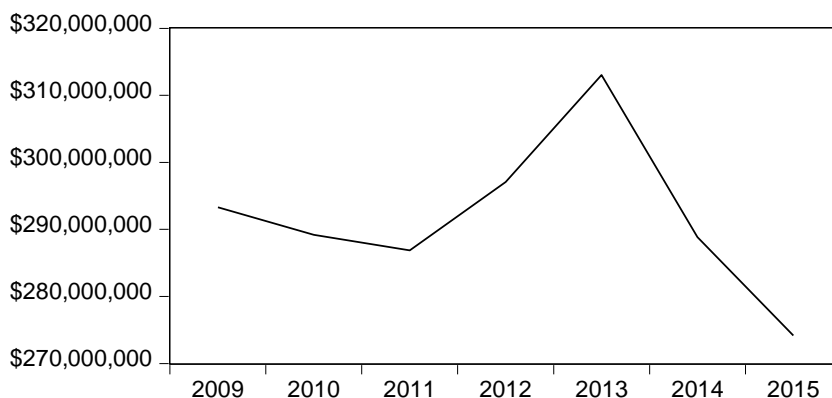
Tier 1 Capital

Impaired Loans to Gross Loans

Cost to Income Ratio

Net Loans to Total Assets

Financing Gap Ratio