The impact of liquidity risk on bank profitability: some empirical evidence from the European banks following the introduction of Basel III regulations

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Abstract

Research Question: The study investigates the impact of liquidity on bank profitability following implementation of the Basel III regulations. ***Motivation:*** The theoretical framework of the paper draws upon previous research (Athanasoglou *et al.*, 2008; Arif & Nauman Anees, 2012 and Dietrich *et al.*, 2014) and assumes liquidity ratios to have a varying influence on bank profitability, depending upon a bank's specific and macroeconomic indicators. ***Idea:*** This study considers multiple proxies of bank liquidity, including Liquidity Coverage Ratio, a new measure inspired by the Basel III framework, and Loan-to-deposit and Financing gap ratio. Alongside traditionally-applied profitability measures, Earnings before Taxes, Depreciation and Amortisation are assumed to be alternative proxies. ***Data:*** In the study, a data set of 45 European banks with 180 observations during 2014-2017 and 37 observations for 2018 has been analysed. ***Tools:*** The study proposes a quantitative

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[2] Opinions reflected in this research paper are those of the authors and not represent the views of Ernst & Young (EY) and Willis Towers Watson

[3] The authors are indebted to Dr. Alan Wood (UK) for proof-reading assistance. We also express gratitude to Professor Nadia Albu, Editor-in- Chief, and to anonymous peer-reviewer(s) for their valuable comments and support during revision of the paper. We are, however, solely responsible for the paper's errors and omissions.

model based upon Ordinary Least Squires techniques complemented by Weighted Least Squares regressions analysis. *Findings:* The alternative liquidity risk measures have a significant and positive impact only on some profitability proxies, and an insignificant effect on others. The Basel III liquidity measure, LCR, was an insignificant contributor to all return proxies, which requires further investigation. The results also indicate that an increase in bank size and net provision for loan losses decreases profitability proxies. We also found mixed results concerning the effects of deposits and securities gains and losses on bank profits, and provided possible explanation.

Keywords: Bank profitability, Liquidity, Basel III regulations, Financial ratio analysis, Liquidity coverage ratio (LCR), European banking system

JEL codes: M41, M48, G21

1. Introduction

Liquidity crises are not new phenomena and banks have endured them throughout history. There are multiple types of liquidity but, when discussed in the banking sector, liquidity is commonly described as the possibility that a bank may become unable to settle its obligations (Drehmann & Nikolaou, 2013).

Banks perform monetary activities on both sides of the balance sheet. On the asset side, they enhance the flow of funds by lending needed cash to users whereas, on the liability side, they accumulate liquidity originating from savers (Diamond & Rajan, 2001). Athanasoglou *et al.* (2008) suggest that the need for liquidity risk management in the banking sector is simply inherent to the nature of the banking business.

The recent financial crisis of 2007-2009 has focused the attention of regulators, business community, academicians and public on the issues related to liquidity risk. Shortcomings in the funding and liquidity management at financial institutions motivated the creation of new rules under the Basel III regulatory framework for banks (BIS 2010; BIS 2013). Specifically, the Basel III regulations - initially announced during 2010 - cover additional capital, liquidity and debt requirements compared with its predecessors, Basel I and II. The newly prescribed liquidity restrictions are liquidity coverage ratio (LCR), which ensures that the banks hold enough liquid assets, and net stable funding ratio (NSFR), which enables banks to sustain a reasonable maturity mismatch (Bonfim & Kim, 2012; Hong *et al.*, 2014; Dietrich *et al.*, 2014).

Although much of bank financial accounting research is designed to understand the impact of a newly enacted or proposed change in either financial reporting or legislative regulation (Beatty & Liao, 2014), the effects of Basel III funding standards remain scarcely investigated (Dietrich *et al*., 2014). The new liquidity rules are generally expected to affect banks positively, including introducing more capital- and liquidity-efficient business models. On the other hand, the rules related to Basel III will probably limit a bank's ability to perform the maturity transformation which is one of the core functions of the banking system. Accordingly, complying with the new standards may also have an impact on bank performance, such as reducing profitability and squeezing lending margins. Several researchers, therefore, warn that if the outcomes of Basel III implementation are not carefully monitored, assessed and, if needed, corrected, then the cure of recently-introduced regulation will indeed "turn out to have been worse than the disease" (Allen *et al*., 2012: 159).

Despite the relationship between bank liquidity and profitability having been the subject of a vast body of empirical research, little consensus has been reached so far. One group of scholars (Arif & Nauman Anees, 2012; Chen *et al.*, 2018, Nguyen et *al.*, 2017) suggests that increased liquidity holdings are negatively associated with financial development. A second group of researchers argues that higher liquidity risk has an opposite (i.e. positive) effect (Molyneux & Thornton, 1992; Trujillo-Ponce, 2013). Furthermore, Bordeleau & Graham (2010) have suggested that liquid assets may have nonlinear relationship with bank profitability.

Given the ambivalence of previous findings, the primary purpose of this study is to fill the gap in research concerning the association between liquidity risk and bank profitability. In particular, this paper is among the first to provide empirical evidence following the introduction of Basel III prescribed liquidity structures on the performance of western European banks. In our study, a data set of 45 European banks with 180 observations during the period of 2014-2017 and 37 observations for 2018 has been analysed. Our framework is based upon previous literature (Athanasoglou *et al.*, 2008; Arif & Nauman Anees, 2012, and Dietrich *et al.,* 2014 amongst others) and allows liquidity ratios to have a variable influence on bank profitability depending upon a bank's specific and macroeconomic indicators.

This paper develops previous work by, firstly, reinforcing several findings from former studies on bank profitability through the presentation of empirical evidence after the introduction of Basel III regulations. Secondly, we apply multiple measures of bank liquidity including Liquidity Coverage Ratio (LCR), loan-to-deposit (LTD) and financing gap ratio (FGR). Thirdly, we extend the traditional financial ratios applied by previous studies to include pre-tax earnings, depreciation and amortisation (EBTDA) as a proxy for profitability. The paper provides evidence that different liquidity measures have significant impacts on some profitability proxies, while demonstrating only insignificant effects on others. We found that the Basel III liquidity measure, LCR, is an insignificant contributor to all return proxies, a point

which requires further investigation. The results also indicate that an increase in bank size and net provision for loan losses (NPLL) decreases profitability proxies. Results were mixed concerning the effects of deposits' and securities' gains and losses (SGL) on bank profits, for which we provide a possible explanation. Overall, this study found some evidence that an increased liquidity risk can raise profitability of the bank.

Beyond a theoretical overview of liquidity and profitability concepts and an empirical contribution through analysis of the post-Basel III environment, this study's findings are potentially relevant for practitioners. The Basel III rules are one of the most important sets of quantitative restrictions imposed on European banks and, therefore, knowledge about implementation and follow-up of outcomes is crucial for regulators and the business community. This is of particular importance as, according to Allen *et al*. (2012), approximately 60% of European banks from the sample analysed by those researchers did not (yet) fulfil the new Basel III liquidity requirements.

The rest of the paper is organised as follows: section 2 reviews and systemises the previous literature regarding banks' liquidity and profitability. The section starts with the presentation of liquidity risk as an unavoidable element of the banking business model. Afterwards, Basel III regulations aiming to minimise short-comings in liquidity management in the banking industry are presented. Finally, the relationship between liquidity risk and bank profitability is analysed. Section 3 provides a description of the methodology utilised, including the theoretical model, variables and empirical dataset. Section 4 establishes the descriptive statistics, regression outcomes and other empirical results. Lastly, section 5 provides our conclusions.

2. Literature review

2.1 Banks and liquidity risk

Modern financial theories have long recognised that banks exist because they perform two central activities in the economy: liquidity creation and risk transformation (Berger & Bouwman, 2009). Indeed, banks have a special intermediate role of transforming liquid liabilities (deposits) into illiquid assets (loans) (Bonfim & Kim, 2012; Athanasoglou *et al.,* 2008; Dietrich *et al.*, 2014). Banks use only a small part of their own resources (equity) to grant loans to consumers: most of their funds are liabilities to third parties including on-demand deposits (Diamond & Dybvig, 1983). When fund providers deposit cash, a liability is created in a bank's balance sheet and an asset is formed when the bank provides borrowers with funds (Hartlage, 2012). A bank must manage its liability and asset sides in order to be able to meet the additions to, and withdrawals from, the accounts.

Banks, therefore, are exposed to the risk that they will not have sufficient liquid assets to meet random demands from the depositors (Gatev *et al*., 2007). Moreover, liabilities of banks typically have shorter maturities than assets, and therefore banks must permanently control funding of their balance sheet structure depending upon maturity transformation. As a result, a repeatedly re-financing circle which is a part of the banking business unavoidably exposes banks to liquidity risk (Bonfim & Kim, 2012).

The topic of bank liquidity is one of long-standing interest to researchers. Already Keynes (1936) has explained that, given market constraints and exogenous shocks, liquidity needs are driven by three main motives: transactional (a bank's liquidity needs that arise during the ordinary course of business), precautionary (the need for a bank to have a buffer against adverse shocks) and speculative (allowing banks to profit from future investment opportunities).

Drehmann & Nikolaou (2013) broadly define liquidity as, "the possibility that over a specific horizon the bank will become unable to settle obligations with immediacy" (p.2174). Reflecting the balance sheet structure, funding liquidity measures a bank's ability to meet its financial obligations by raising funds at short notice; asset liquidity evaluates a bank's ability to convert assets into cash without losing its value (Brunnermeier, 2009). More specifically, the key dimensions of assets' liquidity are: (1) to liquidate the assets when required; and (2) to do so at a fair market value (Arif & Nauman Anees, 2012; Hartlage, 2012).

A key theme in the literature is that banks probably can afford to hold less asset liquidity when they have improved access to both retail (deposits) and wholesale (capital markets) funding (Nguyen *et al*., 2017). The 'efficiency hypothesis' states that dominant banks realise economies of scale and reward customers via more beneficial interest rates (Craig & Dinger, 2009). The alternative 'structure-conduct-performance hypothesis' argues that it is unrealistic to assume that efficiency gains are passed on to consumers instead of other stakeholders when banks are profit maximisers (Corvoisier & Gropp, 2002). It states that banks exploit their increased market power in a monopolistic setting and impose higher interest rates that disadvantage customers.

Despite the broad accumulation of knowledge concerning the liquidity concept, Dietrich *et al.* (2014) claim that banks are always part of an eternal liquidity problem irrespective of how much individual bank and systemic risk control systems have progressed over time. The banks' role as liquidity providers, transferring liquid liabilities into illiquid assets, unavoidably exposes banks to maturity mismatch and liquidity risk (Diamond & Dybvig, 1983; Goodhart, 2008; Drehmann & Nikolaou, 2013).

2.2 Basel III regulations and their possible impact on banks

Apart from the maturity mismatch noted above, several researchers have pointed that liquidity risk can arise due to recessionary economic conditions (Arif & Nauman Anees, 2012). Downsizing in the economy may create a possible "bank run" in which depositors rush to withdraw their funds because they believe that a bank failure is possible. Furthermore, sudden withdrawals may force the bank to liquidate its assets at a loss, leading eventually to bankruptcy (Diamond & Dybvig, 1983). Heavy reliance of banks on short-term borrowings to finance long-term loans accompanied by a "bank run" were witnessed during the financial crisis of 2007-2009 (Hartlage, 2012).

Shortcomings in the funding and liquidity management at financial institutions motivated the creation of new rules under the Basel III regulatory framework for banks (BIS, 2010; Acharya, *et al.*, 2011). Specifically, they cover additional capital, liquidity and debt requirements compared with Basel I and II (BIS, 2010). Furthermore, due to some inefficiencies concerning banking regulation during the 2007-2009 financial crisis, Basel III also addresses issues regarding business cycles and systematic risk. In particular, banks are required to maintain capital buffers during economic growth cycles to cover potential losses which arise from periods of economic distress (BIS, 2010).

Since the introduction of new capital and liquidity restrictions, a few studies which attempt to analyse the impact of the Basel III rules on banks have appeared, with mixed results being reported by scholars (Berger & Bouwman, 2009; Allen *et al.*, 2012; Dietrich *et al.*, 2014; Roulet, 2018). While the purpose of introducing the Basel III rules was to enhance more efficient and stable capital and liquidity structures in banking, these rules may potentially lead to the emergence of new problems. Härle *et al.* (2010) foresee that banks will have to increase their base of stable funding via optimised deposit gathering, secured funding instruments and stronger investor coverage to help them place long-term unsecured debt. On the asset side, the definition of eligible liquid assets is likely to mean that banking liquidity will be heavily concentrated in government securities and other liabilities of the public sector, such as deposits in the central banks. Liquidity in the government securities market could deteriorate rapidly due to inelastic demand from banks locking up eligible liquid assets in the banks' portfolios (Allen *et al.*, 2012). If a certain government nevertheless were to default, then its securities would suddenly become ineligible liquid assets on banks' balance sheets.

Hempel and Simonson (1999) established that one of the most significant external risks that banks face is legislative risk, which refers to the risk of changes in laws that affect the operations of banks. Complying with Basel III new standards could also have negative impacts on bank performance such as reduced profitability and a

squeeze on lending margins; implications of the introduction of Basel III framework undoubtedly warrant further exploration.

2.3 Profitability and liquidity

A sound and profitable banking sector is better able to withstand negative shocks and contribute to the stability of the financial system. Stressing the importance of profitability, Dietrich and Wanzenried (2011) suggested applying this concept as a measure of how well a bank is run. At the same time, a bank with good assets quality, strong earnings and sufficient capital may yet fail if it is not maintaining adequate liquidity (Arif & Nauman Anees, 2012). The relationship between the roles of liquidity and profitability in banking business has been at the centre of a vast body of research. Nevertheless, little consensus has been reached so far and the empirical evidence is mixed. One group of scholars (Arif & Nauman Anees, 2012; Chen *et al.*, 2018, Nguyen *et al.*, 2017) suggests that increased liquidity holdings are negatively associated with financial development. This is because banks with high liquidity risk commonly lack stable and cheap funding, and therefore may be forced to borrow from the capital markets at a higher interest rate. A second group of researchers argues that higher liquidity risk (i.e. larger portion of illiquidity) has the opposite effect since liquid assets have lower returns compared to illiquid ones (Trujillo-Ponce, 2013). Indeed, several scholars point out that those liquidity holdings, imposed by the regulatory authorities, represent an opportunity cost to the banks (Molyneux & Thornton, 1992).

Bordeleau and Graham (2010) have further suggested that liquid assets may have a nonlinear relationship with bank profitability. Scholars argue that it seems to be a tradeoff between short-term profitability gains of lower liquidity holdings and longer-term performance benefits of insurance against liquidity shocks. Ehiedu (2014) stresses the importance of balancing profit maximisation and sufficient liquidity holdings. Moreover, Olagunju *et al.* (2012) argue that both illiquidity and excess liquidity are fatal to the profits of any bank: pursuing high profitability without considering liquidity level can cause great illiquidity, which may in turn reduce the loyalty of customers. On the other hand, unnecessarily excessive liquidity can reduce bank profitability. Literature focusing on bank liquidity also suggests that by reducing profits which normally act as a "buffer" against external and internal shocks, competition precludes the creation of bank liquidity by limiting the volumes of both the loans granted and the deposits accepted (Berger & Bouwman, 2009).

Our literature review concludes that, despite numerous studies about the association between liquidity and profitability of banks, an appropriate theoretical model seems far from being established. The empirical evidence concerning the liquidity impact on the profitability of banks is also inconsistent.

2.4 Research limitations regarding possible impact of agency theory

Bank managers may choose to use accounting methods that deliberately impact the profits of the banks (Lambert, 2006). Earnings management research focuses on agency problems arising from the information asymmetry between banks, equity investors, regulators and bank customers, and on their implications for discretion in financial reporting. Recent accounting literature about modern banks provides some proof that managers are engaged in opportunistic earnings practices for income-smoothing purposes (Chong *et al.*, 2012; Hu *et al.*, 2015; Alhadab & Al-Own, 2019). Indeed, managers can have incentives to manipulate earnings due to the nature of their compensation contracts, or the banks can manage earnings to meet the expectations of capital markets (Jiraporn *et al.*, 2008; Cheng *et al.*, 2011; Zang, 2012). Furthermore, Albou El Sood (2012) found that banks used loan loss provisions more extensively during the crisis period of 2007-2009 to smooth incomes. In addition, Shrieves & Dahl (2003) concluded that Japanese international banks have managed provisions and gains on securities sales to comply with Basel capital regulation.

Although constraints associated with the introduction of Basel III liquidity rules potentially could create additional incentives for earnings management, we decided to exclude the possible impacts of agency problems and earning management techniques. Due to the complexity of theoretical and empirical investigations of earning management techniques in banking (Beatty & Liao, 2014), they obviously deserve a separate study and would not fall within the scope of a single article.

3. Methodology and research design

3.1 Measurements of liquidity

Just as there are several definitions of liquidity risk, there are also many measures of such risk. Hempel and Simonson (1999) propose that a general approximation of liquidity risk of a bank can be obtained by comparing accounts that represent the liquidity sources of a bank (short term securities) and liquidity needs (mainly deposits) in a short-term horizon. Bonfim and Kim (2012), however, argue that the ratio between granted loans and accumulated deposits provides an overall measure of liquidity risk in a bank. Given that deposits are a relatively stable source of funding, the banks that finance most liabilities with deposits should, *ceteris paribus*, be less exposed to liquidity risk. Correspondingly, the banks that have higher LTD ratio should be more exposed to such risk since they must rely on wholesale funding markets (Bonfim & Kim, 2012). A similar measure for liquidity risk is the ratio of financing gap to total assets (FGR), as the financing gap is the difference between loans and deposits (Chen *et al.*, 2018). Banks with higher FGR must use their liquid assets to fund this gap, and thereby bear greater liquidity risk. Other studies have

applied different proxies for measuring liquidity risk, such as a maturity gap between assets and liabilities and a loans-to-total assets ratio (e.g. Arif & Nauman Anees, 2012; Trujillo-Ponce, 2013), as well as a ratio of unused loan commitments to total commitments plus total loans (e.g. Nguyen *et al.*, 2017). Furthermore, Nguyen *et al.* (2017) have pointed out the advantages of calculating separately the asset liquidity ratio (liquid assets to total assets) and the funding ratio (interbank funding liquidity) in order to reflect the situation on both sides of the balance sheet.

The additional liquidity regulations of Basel III encompass two new measures for liquidity risk: LCR, which ensures that the banks hold enough liquid assets; and NSFR, which ensures that banks sustain reasonable maturity mismatch (Bonfim & Kim, 2012; Dietrich *et al*. 2014). Even though both ratios measure funding liquidity risk, they have different objectives: LCR's objective is to strengthen the short-term liquidity risk profile of a bank by ensuring that the bank maintains sufficient high-quality liquid assets to cover cash outflows over a 30 day period in a distress scenario (BIS, 2010). NSFR's objective is to strengthen the liquidity risk profile of a bank over the long-term. NSFR requires banks to hold sources of stable funding on an ongoing basis in order to exceed the required stable funding sources with one-year maturities (BIS, 2010; Bonfim & Kim, 2012). Initially, the LCR became a minimum requirement at the beginning of 2015, with a requirement level of 60%. This minimum figure is intended to rise by 10 percentage points annually, in order to attain 100% in 2019 (BIS, 2013). Although these transitional arrangements for the minimum LCR requirements have been already in effect, the disclosure of the LCR in annual reports was not mandatory until January 2019 (BIS, 2013).

From the literature review, we note that liquidity risk preferably should not be measured by applying just a single proxy due to its complexity and its array of potential risk sources. Based upon the outcomes of previous studies, we have chosen to investigate the impact of liquidity risk on bank profitability by applying LCR (a ratio invented by Basel III framework), and two alternative measures: LTD and FGR.

The choice of LCR is influenced by the importance of this ratio in the Basel III framework as the rules require banks to hold 100% liquid asset coverage against net cash outflows over the next 30 day period in a hypothetical stressed situation (BIS, 2010). As a result, inter-bank borrowing and repo borrowing for maturities of less than one month will have to be fully backed by liquid assets. Furthermore, LCR will also require banks to hold 100% liquid asset coverage against liquidity commitments (e.g. back-up lines) made to non-financial corporates and retail customers. Although Allen *et al.* (2012) and Nguyen *et al.* (2017) chose to include NSFR in their investigations, we decided to exclude NSFR from our analysis. Our decision is based upon the fact that the data about NSFR is not disclosed in the annual reports of the majority of banks in our sample, and because the manual calculation of this liquidity measure would require so many estimations that the validity of the results could be undermined. It is also worth mentioning that Dietrich *et al.* (2014) found the NSFR

ratio to be insignificant in explaining bank performance. Unlike NSFR, LCR, LTD and FGR do not take into consideration the maturity mismatch between assets and liabilities but instead measure the amount of liquid assets held by the bank (Bonfim & Kim, 2012). Thus, in this study, the liquidity risk is limited to measuring the banks' ability to cover immediate obligations by using its liquid assets rather than assessing maturity mismatch between assets and liabilities.

3.2 Accounting for profitability through financial ratios

The aim of this study is to investigate whether liquidity risk has an impact on the profitability of banks. Therefore, it seeks an answer using an experimental research design which examines the probability that independent variables (liquidity measures) cause changes in the dependent variables (profitability proxies) (Saunders *et al.*, 2015). By reviewing the literature, we identified various liquidity measures. (See Table 1 for definitions of variables.) Next, we briefly explain the choice of dependent variables.

Application of financial ratios analysis is a commonly applied technique to research bank performance (Halkos & Salamouris, 2004; Rahman, 2016). Horrigan (1965) divides financial ratios into two main categories - liquidity and profitability - which serve as key concepts within our study. Accounting scholars emphasise ***return on assets*** (ROA) to be one of the most crucial ratios for measuring the profitability of banks (Hempel & Simonson, 1999; Rose & Hudgins, 2012; Trujillo-Ponce, 2013). This ratio measures profit generated per currency unit of an asset (Athanasoglou *et al.*, 2008; Trujillo-Ponce, 2013; Dietrich *et al.*, 2014). Another widely used return proxy is a ***return on equity*** (ROE) ratio, which measures the return on shareholders' funds (Athanasoglou *et al.*, 2008; Trujillo-Ponce, 2013; Dietrich *et al.*, 2014). Besides ROA and ROE, ***net profit margin*** (NPM), which is measured by dividing net income by total revenue, is a common measure of profitability (Rose & Hudgins, 2012). Unlike ROA and ROE, NPM is an indicator of management control, as it measures the cost efficiency of a financial institution. Chen *et al.* (2018), investigating the relationship between bank liquidity risk and bank performance, have found not only that higher liquidity risk decreases the ROA and ROE but also that liquidity risk increases banks' NPM. The results of Chen *et al.* (2018) contrast strongly with the findings of Trujillo-Ponce (2013), who concluded that the larger loan portfolio of a bank (and respectively, the lower liquidity level) will lead to higher ROA and ROE.

Alongside traditionally-applied profitability measures, ***Earnings before Taxes, Depreciation and Amortization*** (EBTDA) are introduced in our study as an alternative proxy. Contrasting with NPM, EBTDA takes into account the effects of taxes, depreciation and amortisation. As most revenues and expenses of a bank arise from the interest, these were added back by authors to the EBITDA measure. By

including this proxy as a dependent variable, we aim to illustrate the effects of the taxes, depreciation and amortisation.

3.3 Bank control variables chosen for the study

The banking literature has long recognised numerous internal and external factors that influence the profitability of banks. ***Deposits*** seem to be undisputed contributors to profitability because they provide cheap and stable sources of funding (Arif & Nauman Anees, 2012; Trujillo-Ponce, 2013). During the recent crisis period it was found that the higher the banks' reliance was on non-deposit funding, the lower was their ROA (Demirguç-Kunt & Huizinga, 2009). The decisive role of deposits has been questioned recently by some scholars due to the emergence of negative interest rate environments (Bech & Malkhozov, 2016).

Based upon the previous literature, ***equity*** (***capital)*** seems to affect bank profitability in various ways. Sufian & Chong (2008) found that a capital strength ratio (equity divided by assets) has a positive and highly significant relationship with profitability proxies. Trujillo-Ponce (2013) concluded that while capital strength ratio has a positive impact upon ROA, it has a significant and negative relationship with ROE. The reason for such a relationship may be explained by considering that ROE equals ROA multiplied by the leverage ratio (which is measured by dividing total assets by equity). As equity increases, ROA increases and the leverage ratio decreases (Trujillo-Ponce, 2013). Regarding the impact of the introduction of stricter capital ratios, Roulet (2018) warns that they have a significant and negative impact upon the lending of large European banks. Depressed lending margins can pressure banks' ROE, which, according to Härle *et al.* (2010), is projected to decline by an average of 4% across Europe.

Although several scholars have included ***size*** as a determinant of a banking profitability, the research findings vary. Athanasoglou *et al.* (2008), Brissimis *et al.* (2008) and Trujillo-Ponce (2013) found size to be insignificant whereas Sufian & Chong (2008) contrarily concluded that size is significant and negatively affects bank profitability. Scholars suggest that the negative relationship between size and profitability captures the diseconomies of scale in the banking sector. This may be explained, for example, by the existence of an extensive bureaucracy in a larger bank. Regarding an association with liquidity, Berger & Bouwman (2009) argue that liquidity creation varies according to the size of the bank: larger banks create substantially more liquidity than smaller banks, and also that those banks which create more liquidity have significantly higher market value and earnings than those banks which create less liquidity. Nguyen *et al*. (2017) and Chen *et al*. (2018) have also found that total assets (as a proxy for a bank size) have a significant and negative impact on liquidity risk. Trujillo-Ponce (2013) hypothesises that some banks are "too big to fail", and therefore are tempted to conduct aggressive lending without carefully monitoring the quality of the assets.

European supervisory authorities consider that a loan is non-performing when it has become more than 90 days overdue despite instalments being required in line with the terms and conditions of the credit contract. The level of non-performing loans should be as low as possible because of the impact upon bank profitability (Istrate & Ionescu, 2018). Similarly, Arif & Nauman Anees (2012) and Trujillo-Ponce (2013) found that earnings of banks decrease with an increase in ***net provision for loan loss*** (NPLL). This conclusion seems to be logical as the more that financial institutions are exposed to high-risk loans then the higher is the allocation of their gross margins to NPLL accounts to balance expected credit losses (Athanasoglou *et al.*, 2008). NPLL represents the most prevalent and, typically, the largest bank accrual (Beatty & Liao, 2014). Sufian & Chong (2008) point out that a decline in NPLL is the primary catalyst for an increase in profits. Despite the fact that provisions can be adjusted by management at year-end and can be subject to discretionary accounting techniques (Moyer, 1990; Pérez *et al.*, 2008), NPLL ratio is commonly used by scholars as a proxy for the credit risk of a bank (Chen *et al.*, 2018). Following the recommendations of previous scholars, we chose to include NPLL in the model as a proxy for credit risk.

Liquidity and profitability concepts are related to tradable portfolios of securities (Arif & Nauman Anees, 2012; Beatty & Liao, 2014). Moyer (1990) provides a description of the general content of the net income of banks, which is interest income, service revenues, and ***securities gains and losses*** (SGL) less interest expenses, operating costs, loan loss provision and income tax expense. Due to the importance of SGL to profitability (Ahmed & Takeda, 1995), we have incorporated this ratio in the profitability regression as a control variable and proxy for credit risk. We have applied realised SGL as, compared to non-realised losses, the latter variable directly affects net income and impacts profitability ratios. Moreover, the induction of alternative securities (compared with conventional commercial banking products) as well as the expansion of trading activities by financial institutions significantly contributed to the financial crisis of 2007-2009 (Petersen & Wiegelman, 2014).

3.4 Macroeconomic control variables

The majority of banking crisis theories are based on changes in economic fundamentals as a natural consequence of business cycles, with credit amounts changing pro-cyclically (Makri & Papadatos, 2016). The macroeconomic origins of a banking crisis lie in unsustainable macro policies and global financial conditions. Several studies have included macroeconomic variables in their research (Molyneux & Thornton, 1992; Bordeleau & Graham, 2010; Trujillo-Ponce, 2013). Nguyen *et al.* (2017) advocated that, besides bank-specific proxies, country-specific control variables are required to explain the profitability of banks. Istrate and Ionescu (2018) argue that macroeconomic variables significantly influence credit risk, and Makri and Papadatos (2016) suggest that the macroeconomic environment appears to be closely linked to non-performing loans in the Euro area. Athanasoglou *et al.* (2008)

also included industry-specific variables (represented by industry concentration and the ownership of banks) but found that they are not important in explaining bank profitability. Based upon findings from the literature, we decided to include GDP growth rate and inflation rate, sourced from the World Development Indicators Metadata, as proxies that describe the macroeconomic environment within which the banks operate.

Table 1 summarises all the variables that have been selected to impact bank profitability in our model.

Table 1. Variables to be included into OLS regression in order to determine the impact of liquidity and other control variables upon bank profitability

Variables	Definition/calculation	Data source / period
Profitability (dependent variables)		
ROA (return on assets) %	Net income/total assets	Eikon data base, annual reports, calculated by authors
ROE (return on equity) %	Net income/total equity	Eikon data base, annual reports, calculated by authors
NPM (net profit margin) %	Net income/revenue	Eikon data base, annual reports, calculated by authors
EBTDA (earnings before taxes, depreciation and amortization) margin %	(EBITDA + interest income - Interest expense) / revenue	Eikon data base, annual reports, calculations by authors
Liquidity (independent variables)		
LCR (loan cover ratio), a measure inspired by Basel III rules to estimate risks from potential liquidity shortages, times	High quality liquid assets/ total net cash outflows expected within 30 days	Eikon data base, LCR is applied only for 2018 as banks have not disclosed their LCR ratio prior to that year
LTD (loans-to-deposit), an alternative liquidity ratio, times	Net loans/total deposits	Eikon data base, annual reports, calculated by authors for the years 2014-2017
FGR (financing gap ratio), an alternative liquidity ratio	(Net loans – total deposits)/total assets	Eikon data base, annual reports, calculated by authors for the years 2014-2017
Bank-specific determinants (Control variables)		
Deposits (non-interest-bearing deposits, interest bearing deposits and other deposits)	Total deposits/total liabilities	Eikon data base, annual reports, calculated by authors

Variables	Definition/calculation	Data source / period
Equity (capital of preferred shareholders, general and limited partners, common shareholders; does not include minority shareholders' interest)	Total Equity/total assets	Eikon data base, annual reports, calculated by authors
Size	Natural logarithm of total assets, Ln (total assets)	Eikon data base, annual reports, calculated by authors
NPLL Represents provisions established for possible defaults by customers on loans from banks (a proxy for a credit risk of a bank)	Loan loss provision/net loans	Eikon data base, annual reports, calculated by authors
Securities gains and losses, a realised net (as a measure of a bank's credit risk)	Securities gains minus securities losses / total bank revenue	Eikon data base, annual reports, calculated by authors
Macro-economic variables (Control variables)		
GDP growth (annual %)	Annual percentage growth rate of GDP at market prices based on constant 2010 U.S. dollars	World Development Indicators Metadata
Inflation (annual %)	Inflation as measured by the consumer price index	World Development Indicators Metadata

3.5 Theoretical framework

The majority of studies on bank profitability, such as that of Goddard *et al.* (2004), use linear models to estimate the impact of various factors that may be important in explaining profits. According to the model suggested by Arif & Nauman Anees (2012), banks' earnings depend upon deposits, cash, liquidity gap and NPLs. Dietrich *et al.* (2014) included market characteristics, ownership and bank variables in the framework explaining bank performance. Besides these two models, bank-specific characteristics, as defined by Athanasoglou *et al.* (2008), are taken into consideration in our study.

The theoretical framework of the paper therefore draws upon previous research (Athanasoglou *et al*., 2008; Arif & Nauman Anees, 2012 and Dietrich *et al*., 2014), and allows liquidity ratios to have a varying influence on profitability depending upon a bank's specific and macroeconomic indicators. The other independent variables (deposits, equity (capital), bank size, NPLL, GLS, GDP growth rate and inflation rate) are control variables.

$$Y_{i,2014-2017} = a + \beta_1 \text{ LTD }_{i,2014-2017} + \beta_2 \, DEPOSITS_{i,t} + \beta_3 \, EQUITY_{i,t}$$
$$+ \beta_4 \, SIZE_{i,t} + \beta_5 \, NPLL_{i,t} + \beta_6 \, GLS_{i,t} + \beta_7 \, GDP_{i,t} + \beta_8 \, INFL_{i,t}$$
$$+ \varepsilon_i \qquad (1)$$

Equation 1: LTD as liquidity risk measure (for the period 2014-2017)

$$Y_{i,2014-2017} = a + \beta_1 \text{ FGA }_{i,2014-2017} + \beta_2 \, DEPOSITS_{i,t} + \beta_3 \, EQUITY_{i,t}$$
$$+ \beta_4 \, SIZE_{i,t} + \beta_5 \, NPLL_{i,t} + \beta_6 \, GLS_{i,t} + \beta_7 \, GDP_{i,t} + \beta_8 \, INFL_{i,t}$$
$$+ \varepsilon_i \qquad (2)$$

Equation 2: FGA as liquidity risk measure (for the period 2014-2017)

$$Y_{i,2018} = a + \beta_1 \, LCR_{i,2018} + \beta_2 \, DEPOSITS_{i,t} + \beta_3 \, EQUITY_{i,t}$$
$$+ \beta_4 \, SIZE_{i,t} + \beta_5 \, NPLL_{i,t} + \beta_6 \, GLS_{i,t} + \beta_7 \, GDP_{i,t} + \beta_8 \, INFL_{i,t}$$
$$+ \varepsilon_i \qquad (3)$$

Equation 3: LCR as liquidity risk measure (for the year 2018)

In equations (1), (2) and (3), i and t are, respectively, the individual bank and time in years. Y denotes the dependent variable, which can be represented by ROA, ROE, NPM and EBTDA. Alpha (α) represents the intercept, beta (β) is the regression coefficient and epsilon (ε) is the error term. This study applies three measures for liquidity risk: LCR, LTD and FGA. All these liquidity risk measures have their own regressions to compare their impacts on bank profitability. The paper recognises that different liquidity risk measures may have different effects on different return ratios. The main reason why we excluded the year 2018 from the equations 1 and 2 was that the Basel III liquidity restrictions (LCR) came into effect only at the beginning of that year. Thus, we wanted to consider whether this new regulation for liquidity risk somehow changed its effect on profitability.

The Null and Alternative hypotheses for the study are formulated as follows:
H_0: There is no impact of liquidity on the profitability of banks
H_{Alt}: There is an impact of liquidity on the profitability of banks

This study conducts several quantitative OLS regressions with different dependent variables. It is expected that some variables demonstrate significant relationships with some dependent variables while not with others. OLS regression techniques in the study are also followed up by WLS regressions of selected variables.

Robustness tests for multicollinearity, autocorrelation and heteroscedasticity for the two above mentioned regression periods are performed to strengthen the validity of the results.

3.6 Empirical setting and data

In the study, a data set of 45 European banks with 180 observations during the period of 2014-2017 and 37 observations for 2018 has been analysed. Annual reports of the banks have been retrieved from the Thomson Reuters Eikon database from which 45 of the largest European banks with the highest amounts of assets were chosen (see Table 2). The sample selection was motivated by the intention to obtain a generalisable result, as large differences between the sizes of the banks could lead to a distorted output from the model. Furthermore, this sample allows to address "too big to fail" concerns expressed in the literature by scholars arguing that larger banks may benefit from implicit guarantees from their governments and therefore be attempted to invest in riskier assets (Nguyen *et al*, 2017).

The sample choice is also determined by the fact that European banks are expected to be more strongly impacted by the Basel III liquidity requirements than banking institutions elsewhere, particularly those in the USA (Härle *et al.*, 2010). This is, among other reasons, because the US banking industry has less proportional weight in its national financial system than do the European banks, and US banking has already been subject to liquidity rules for some time. Beatty and Liao (2014) have also indicated that most studies concerning the financial analysis of banks use the pre-Basel III period sample. The empirical contribution of our study is therefore to update research on the latest developments.

LTD ratio and FGR are calculated for the years 2014-2017, while LCR is calculated only for 2018, due to a lack of disclosure for an LCR ratio prior to that year. Calculations have been adjusted for the missed data.

Table 2. Sample of Banks

HSBC Holdings PLC	UniCredit SpA	Commerzbank AG
Banco Santander SA	Standard Chartered PLC	Julius Baer Gruppe AG
Sberbank Rossii PAO	Societe Generale SA	Mediobanca Banca di credito Finanziario SpA
BNP Paribas SA	Skandinaviska Enskilda Banken AB	Bankia SA
Lloyds Banking Group PLC	Svenska Handelsbanken AB	Komercni Banka as
ING Groep NV	Swedbank AB	FinecoBank Banca Fineco SpA
Intesa Sanpaolo SpA	Caixabank SA	Bank Polska Kasa Opieki SA
Royal Bank of Scotland Group PLC	Deutsche Bank AG	Raiffeisen Bank International AG

Banco Bilbao Vizcaya Argentina SA	Danske Bank A/S	Bank VTB PAO
Nordea Bank Abp	Erste Group Bank AG	Bankinter SA
Barclays PLC	OTP Bank Nyrt	ING Bank Slaski SA
Credit Agricole SA	Powszechna Kasa Oszczednosci Bank Polski SA	Bank of Ireland Group PLC
DNB ASA	AIB Group plc	Banco de Sabadell SA
Credit Suisse Group AG	Santander Bank Polska SA	mBank SA
KBC Groep NV	ABN AMRO Group NV	Banco Comercial Portugues SA

4. Presentation of research findings

4.1 Descriptive statistics

Table 3 presents the descriptive statistics summary of different variables for the two regression periods, 2014-2017 and 2018.

Table 3. Descriptive statistics for 2014-2017 and 2018

	Mean		Median		SD		Min		Max	
	2014-2017	2018	2014-2017	2018	2014-2017	2018	2014-2017	2018	2014-2017	2018
ROA	0.67%	0.72%	0.57%	0.60%	0.52%	0.42%	-1.32%	0.02%	2.85%	2.29%
ROE	9.04%	9.29%	8.70%	9.10%	6.88%	3.65%	-28.05%	0.41%	40.80%	18.39%
NPM	20.69%	27.66%	19.23%	25.25%	21.41%	14.45%	-78.60%	0.67%	83.63%	62.14%
EBTDA	97.80%	97.44%	95.61%	98.82%	37.75%	28.90%	11.29%	21.57%	287.90%	175.19%
Deposits	64.98%	64.50%	67.18%	67.32%	18.41%	17.80%	30.57%	30.61%	94.85%	95.55%
Equity	7.19%	7.25%	6.33%	6.42%	2.79%	2.64%	3.15%	3.62%	15.11%	15.14%
Size	26.41	26.66	26.49	26.80	1.33	1.18	23.71	24.33	28.60	28.57
GLS	2.71%	1.09%	1.94%	0.28%	3.12%	3.68%	-3.88%	-13.61%	16.47%	10.83%
NPLL	0.66%	0.27%	0.42%	0.18%	0.93%	0.35%	-1.46%	-0.34%	7.69%	1.50%
LTD	93.00%		88.68%		31.23%		5.07%		202.62%	
FGR	-6.85%		-7.20%		18.00%		-83.89%		37.33%	
LCR		144.49%		139.00%		26.22%		100.0%		207.00%
GDP	2.86%	2.67%	2.26%	2.36%	3.32%	1.65%	-2.31%	0.86%	25.12%	6.65%
Inflation	0.94%	1.72%	0.38%	1.81%	2.08%	0.61%	-1.14%	0.49%	15.53%	2.88%

According to Table 3, output figures for the means for ROA, ROE, NPM and EBTDA margin are 0.67%, 9.04%, 20.69% and 97.80% respectively. It shows relatively high standard deviations for most of the dependent variables. ROA, ROE and NPM, for example, have standard deviations that are close to the mean value, implying that these return measures for each individual bank could deviate from the average by almost as much as the mean itself. EBTDA margin has the lowest degree of variation amongst the profitability proxies. The difference in the standard deviations between the return proxies could arise because ROA, ROE and NPM consider taxes whereas EBTDA margin does not.

Regarding the independent variables for the years 2014-2017, the means for equity, deposits, LTD, FGR, size, GLS, NPLL, GDP and inflation are 7.19%, 64.98%, 93%, -6.85%, 26.41%, 2.71%, 0.66%, 2.86% and 0.94% respectively. Deposits have the lowest standard deviation followed by equity (18.41% and 2.79% respectively). The equity portion in financing operations ranges between 3.15% and 15.11%. As deposits have a relatively high mean and low standard deviation, deposits seem to represent the majority of banks' liabilities. LTD also has a rather a low standard deviation, although the range between the minimum and maximum values is 197.5%. As the mean for LTD is 93%, banks tend to offset deposits by an almost equal amount of net loans. Conversely, FGR, GLS and NPLL have standard deviations above their mean (18%, 3.12% and 0.93% respectively), indicating a high degree of variation of these variables amongst the banks. The high standard deviations for GLS and NPLL are not a surprising phenomenon, as these items are subject to managers' potential alterations. Similarly, the standard deviations are also high for GDP growth and inflation rate, probably due to macroeconomic differences between countries. The negative mean for FGR confirms that deposits are higher than net loans on average, which coincides with the findings for LTD ratio. Interestingly, several researchers who applied FGR as a proxy for liquidity risk have also reported a negative mean for this ratio (e.g. Chen *et al.*, 2018). The low standard deviation for size may also be explained by a certain homogeneity of our sample with its strict focus on larger European banks.

As seen from Table 3, the mean, median, standard deviation, minimum and maximum values for 2018 are rather similar to those of the previous regression period (years 2014-2017). The standard deviation for LCR is 26.22% compared to the mean of 144.49%. The LCR ratio is required to be at least 90% from 2018 onwards, which legally limits the range of possible values for LCR and decreases deviation of this proxy. Indeed, we report that the observed minimum value for LCR is 100% and maximum 207%, demonstrating full compliance with current liquidity restrictions.

4.2 Correlation matrixes

When conducting OLS regression, it is probable that two independent variables are highly correlated. Multicollinearity can occur when two or more predictors (independent variables) are closely related, which can make it difficult to separate out the effect of the independent variable upon the dependent one (Bertsimas & Freund, 2004). In order to avoid multicollinearity, correlation matrixes have been estimated in our study. Pearson correlation coefficients are provided in Tables 4 and 5 for both regression periods. Table 4 indicates that equity, deposits and GDP growth are positively correlated with profitability. Size, GLS and NPLL are negatively related to profitability. Finally, calculations for LTD, FGR and inflation provided mixed results. Table 5 indicates that equity, LCR and GDP growth are positively correlated with profitability; a negative correlation has been observed between

profitability proxies and size of the bank. Deposits, GLS, NPLL and inflation have shown a mixed pattern.

Table 4. Correlation matrix for 2014-2017

	ROA	ROE	NPM	EBTDA	Deposits	Capital	Size	GLS	NPLL	LTD	FGR	GDP	Inflation
ROA	1												
ROE	0.73	1											
NPM	0.66	0.75	1										
EBTDA	0.24	0.17	0.17	1									
Deposits	0.44	0.19	0.23	0.10	1								
Equity	0.64	0.06	0.24	0.15	0.54	1							
Size	-0.56	-0.35	-0.51	-0.09	-0.69	-0.59	1						
GLS	-0.02	-0.18	-0.01	0.00	0.02	0.22	-0.11	1					
NPLL	-0.07	-0.29	-0.35	-0.27	0.25	0.22	-0.16	0.025	1				
LTD	0.01	-0.06	0.11	0.30	-0.50	0.00	0.09	0.062	-0.16	1			
FGR	-0.11	-0.25	-0.09	0.26	-0.56	0.01	0.26	0.108	-0.15	0.94	1		
GDP	0.14	0.06	0.02	0.15	0.07	0.19	-0.12	0.087	-0.25	0.04	0.06	1	
Inflation	0.07	-0.04	-0.05	0.03	0.08	0.13	0.07	-0.205	0.22	0.06	0.08	-0.24	1

Table 5. Correlation matrix for 2018

	ROA	ROE	NPM	EBTDA	Deposits	Capital	Size	GLS	NPLL	LCR	GDP	Inflation
ROA	1											
ROE	0.73	1										
NPM	0.51	0.68	1									
EBTDA	0.09	0.03	0.01	1								
Deposits	0.54	0.30	0.08	-0.06	1							
Equity	0.76	0.25	0.34	0.19	0.56	1						
Size	-0.68	-0.49	-0.57	-0.17	-0.63	-0.67	1					
GLS	0.16	-0.08	0.15	0.04	0.35	0.44	-0.18	1				
NPLL	0.34	0.14	-0.30	-0.05	0.29	0.20	0.01	0.075	1			
LCR	0.20	0.06	0.15	0.16	0.00	0.19	-0.21	0.188	-0.04	1		
GDP	0.39	0.19	0.16	0.19	0.53	0.50	-0.55	0.176	-0.03	0.20	1	
Inflation	0.34	0.30	-0.01	0.06	0.06	0.01	0.04	-0.074	0.38	0.10	-0.35	1

Within the dataset used in this study, correlation coefficients vary from weak to moderate (as defined by Vatcheva *et al*., 2016), with the exception of the correlation between FGR and LTD, which is 0.94. Previous literature suggests that there are different views as to what level of correlation between independent variables is acceptable before multicollinearity becomes a possibility. Bertsimas & Freund (2004) claim that if the correlation between two variables is above 0.70 or below minus 0.70, there is evidence of multicollinearity. A typical cut-off in regression analysis of 0.9 has been proposed (El-Fallah & El-Sallam, 2010). This advice has

been followed by Arif and Nauman Anees (2012), former researchers in our field. Since the correlations for all other variables in our study are below 0.90, co-linearity statistics are probably satisfactorily suggesting that multicollinearity is not a critical issue despite one high correlation coefficient being indicated by the test. The risk of possible multicollinearity indicated by this ratio (0.94) was mitigated in the study by running separate regressions for FGR and LTD variables.

4.3 Output of multiple OLS regressions

Table 6 presents the coefficient values and their significance for each corresponding response variable for the years 2014-2017 and 2018, assuming that ROA, ROE, NPM and EBTDA are dependent variables and proxies for profitability. Empirical evidence resulting from different OLS models suggests that a coefficient of multiple determinations (R-squared) is the highest for ROA, followed by NPM, ROE and EBTDA margin. For example, regression (1) with ROA as a dependent variable and containing eight independent predictors (equity, deposits, LTD, size, GLS, NPLL, GDP growth and Inflation rate), has an R-squared value of 0,543. This means that 54,3% of variation in the dependent factor, ROA, is explained by suggested independent variables. Although R-squared values are moderate, the levels are probably acceptable (and in line with previous studies) as there might be a plethora of different internal and macro-economic variables that could impact bank profitability.

Interestingly, there are only two independent variables - size and NPLL - that demonstrate statistical significance (at the 99% confidence level) in all regressions where different proxies for profitability have been applied. We have to keep in mind that R-squared is a relative - not an absolute - measure of regression quality, and does not demonstrate causality between the variables (Bertsimas & Freund, 2004). The standard error for regressions (SE) is also presented in Table 6.

The Durbin-Watson test (DWtest) was computed for regressions (1), (2) and (3) to test for autocorrelation. The outcome of the DWtest should range between 0 and 4, where a value near 2 indicates non-autocorrelation, a value close to 0 indicates a positive autocorrelation and a value close to 4 indicates a negative autocorrelation. According to Table 6, there could be some negative autocorrelation for EBTDA margin for the regression period of 2014-2017. However, all values for autocorrelation are acceptable, as they are close to the benchmark (around 2).

Table 6. Output of OLS multiple regressions 2014-2017, 2018

Independent and control variables	Dependent (Response) Variables			
	ROA reg1,reg2,reg3	**ROE** reg1,reg2, reg3	**NPM** reg1,reg2, reg3	**EBTDA** reg1,reg2, reg3
Equity$_{reg1}$	0.106***	-0.213	0.441	0.590
Equity$_{reg2}$	0.114***	-0.017	0.832	-0.083

Independent and control variables	Dependent (Response) Variables			
	ROA reg1,reg2,reg3	ROE reg1,reg2, reg3	NPM reg1,reg2, reg3	EBTDA reg1,reg2, reg3
Equity$_{reg3}$	0.086***	-0.201	0.092	1.279
Deposits$_{reg1}$	-0.001	-0.039	-0.125**	1.132***
Deposits$_{reg2}$	-0.002	-0.090**	-0.278	0.985***
Deposits$_{reg3}$	-0.001	-0.020	-0.367**	-0.732
LTD	0.000	-0.000	0.000	0.006***
FGR	-0.003*	-0.112***	-0.131	0.979***
LCR	0.000	-0.012	-0.049	-0.013
Size$_{reg1}$	-0.001***	-0.028***	-0.105***	0.065**
Size$_{reg2}$	-0.001***	-0.027***	-0.110***	0.019
Size$_{reg3}$	-0.001**	-0.019**	-0.105***	-0.046
GLS$_{reg1}$	-0.026***	-0.418***	-0.409	-0.254
GLS$_{reg2}$	-0.025***	-0.384***	-0.360	-0.503
GLS$_{reg3}$	-0.016	-0.075	0.797	0.577
NPLL$_{reg1}$	-0.144***	-2.703***	-11.104***	-11.936***
NPLL$_{reg2}$	-0.148***	-2.771/***	-11.353***	-12.426***
NPLL$_{reg3}$	0.154	0.824	-10.101	-2.026
GDP$_{reg1}$	-0.007	-0.087	-1.068***	0.529
GDP$_{reg2}$	-0.006	-0.061	-1.023***	0.390
GDP$_{reg3}$	0.023	0.290	-0.424	5.909
Inflation$_{reg1}$	0.007	0.174	0.477	0.174
Inflation$_{reg2}$	0.011	0.248	0.704	0.434
Inflation$_{reg3}$	0.220***	2.084*	3.622	10.809
Intercept$_{reg1}$	0.031***	0.934***	3.132***	-2.030**
Intercept$_{reg2}$	0.033***	0.897***	3.348***	-0.036
Intercept$_{reg3}$	0.026	0.611**	3.360***	2.265
Observations $_{reg1}$ reg2	180	180	180	180
Observations $_{reg3}$	37	37	37	37
R$^2_{reg1}$	0.543	0.309	0.491	0.277
R$^2_{reg2}$	0.550	0.347	0.497	0.253
R$^2_{reg3}$	0.784	0.382	0.545	0.161
Adjusted R$^2_{reg1}$	0.521	0.276	0.468	0.243
Adjusted R$^2_{reg2}$	0.529	0.317	0.473	0.218
Adjusted R$^2_{reg3}$	0.723	0.206	0.415	-0.079
SE$_{reg1}$	0.003	0.058	0.156	0.328
SE$_{reg2}$	0.003	0.056	0.155	0.333
SE$_{reg3}$	0.002	0.032	0.110	0.300
DWtest$_{reg1}$	1.840	1.904	1.837	2.634
DWtest$_{reg2}$	1.833	1.877	1.841	2.575
DWtest$_{reg3}$	1.943	1.852	2.055	1.676

*Significance at the 90% confidence level, ** at the 95% confidence level, *** at the 99% confidence level*

To test for heteroscedasticity[i], the White's Test (White, 1980) was performed. Typically, the White's Test assumes that heteroscedasticity may be a linear function

of one or more of independent variables. A significance level below 10% indicates that there is a heteroscedasticity. Table 7 presents the outcomes of the White's Test for three regressions and for both periods.

Table 7. White's Test for 2014-2017 and 2018

	R-square	Significance
ROA$_{reg1}$	0.008	0.470
ROA$_{reg2}$	0.010	0.428
ROA$_{reg3}$	0.304	0.002*
ROE$_{reg1}$	0.145	0*
ROE$_{reg2}$	0.142	0*
ROE$_{reg3}$	0.000	0.994
NPM$_{reg1}$	0.052	0.009*
NPM$_{reg2}$	0.052	0.009*
NPM$_{reg3}$	0.000	0.996
EBTDA$_{reg1}$	0.041	0.024*
EBTDA$_{reg2}$	0.042	0.022*
EBTDA$_{reg3}$	0.047	0.438

* Indication of presence of heteroscedasticity according to White's Test

As shown in Table 7, we have indications of presence of heteroscedasticity for ROE, NPM and EBTDA margin for regressions (1) and (2) for the years 2014-2017 and for ROA for regression (3) for the year 2018 (marked in Table 7). To overcome heteroscedasticity, weighted least squares regression[ii] (WLS) was performed for these dependent variables.

4.4 Regressions' outputs for WLS

Table 8 presents the results for the WLS regressions for both regression periods. After correcting for heteroscedasticity, the goodness of fit has improved for both regression periods. Furthermore, the DWtest statistic has strengthened for all variables as they are closer to the benchmark (around 2), indicating more reliable results compared with the initial outcomes of OLS regression.

The results from the WLS regressions are slightly different to the initial OLS results. Equity has become a significant factor with the negative impact on ROE and positive effect on NPM for the period 2014-2017 (Table 8). On the other hand, OLS regression (Table 6) provided evidence that ROA has a significant and positive relationship with equity. These findings are in line with previous studies suggesting that capital has a positive effect on ROA, but a negative effect on ROE (e.g. Sufian & Chong, 2008; Trujillo-Ponce, 2013). The decrease in ROE caused by raised equity ratio can be explained by the reduced leverage of the banks rather than by shrinking profitability. Our findings also provide evidence that equity is a statistically significant factor when NPM ratio is applied in the regression. Equity is therefore a significant variable with an impact on profitability through multiple proxies. This is

in line with conclusions from previous studies: researchers found capital to have a positive effect on bank earnings because, among other reasons, the higher creditworthiness of well-capitalised banks leads to a lower cost of funding (e.g. Athanasoglou *et al.*, 2008; Trujillo-Ponce, 2013; Chen *et al.*, 2018).

The impact of deposits on bank profitability remains inconclusive. Most regressions indicate that deposits are insignificant contributors to bank profitability. These results contrast with the previous literature, several scholars having found that deposits are among the main contributors to bank profitability as they act as a cheap and stable source of funding (e.g. Arif & Nauman Anees, 2012; Trujillo-Ponce, 2013). In our view, one of the possible explanations of the controversial outcome regarding deposits may originate within the negative interest rate environment, which seems to be the case across the sample period of this study. When the policy interest rate is negative, commercial banks do not acquire any payment for their deposits at the central banks and, simultaneously, financial institutions are reluctant to pass on the negative rates to retail depositors, since this could lead to substantial liquidity withdrawals (Bech & Malkhozov, 2016). Thus it seems that banks must bear additional costs during a period of negative interest rates in order to avoid potential "bank runs". This additional cost might have made deposits a more expensive source of funding for banks during recent years. The negative interest rate environment can refute the argument that deposits serve as a cheap source of funding, thereby explaining this study's inconclusive results regarding deposits and bank profitability.

Table 8. Weighted least squares' regression for 2014-2017 and 2018

Independent and control variables	Dependent (Response) Variables			
	ROE $_{reg1,reg2}$	NPM $_{reg1,reg2}$	EBTDA $_{reg1,reg2}$	ROA $_{reg3}$
Equity$_{reg1}$	-0.610***	1.477***	0.247	
Equity$_{reg2}$	-0.519***	1.902***	0.654	
Equity$_{reg3}$				0.078***
Deposits$_{reg1}$	0.037*	0.010	0.259*	
Deposits$_{reg2}$	-0.012	-0.199**	0.141	
Deposits $_{reg3}$				-0.002
LTD	0.000***	0.001***	0.004***	
FGR	0.003	-0.049	0.555***	
LCR				-0.001
Size$_{reg1}$	-0.020***	-0.063***	-0.028	
Size$_{reg2}$	-0.025***	-0.077	-0.054**	
Size$_{reg3}$				-0.001***
GLS$_{reg1}$	-0.066**	-0.543***	1.847***	
GLS$_{reg2}$	-0.073**	-0.442***	1.327***	
GLS$_{reg3}$				-0.005
NPLL$_{reg1}$	-2.413***	-14.510***	-4.752***	
NPLL$_{reg2}$	-3.369***	-16.287***	-6.934***	
NPLL$_{reg3}$				0.239**
GDPgrowth$_{reg1}$	-0.047	-1.465***	0.761	
GDPgrowth$_{reg2}$	-0.207***	-1.841***	0.816	
GDPgrowth$_{reg3}$				0.026

Independent and control variables	Dependent (Response) Variables			
	ROE reg1,reg2	**NPM** reg1,reg2	**EBTDA** reg1,reg2	**ROA** reg3
Inflation$_{reg1}$	0.549**	0.278	-0.538	
Inflation$_{reg2}$	0.610	0.718	0.126	
Inflation$_{reg3}$				0.160***
Intercept$_{reg1}$	0.627***	1.798***	1.097*	
Intercept$_{reg2}$	0.835***	2.395***	2.298***	
Intercept$_{reg3}$				0.038**
Observations	180	180	180	37
R^2_{reg1}	0.403	0.649	0.637	
R^2_{reg2}	0.357	0.687	0.459	
R^2_{reg3}				0.791
Adjusted R^2_{reg1}	0.376	0.633	0.620	
Adjusted R^2_{reg2}	0.327	0.672	0.434	
Adjusted R^2_{reg3}				0.732
SE$_{reg1}$	1.183	1.273	1.442	
SE$_{reg2}$	1.224	1.302	1.401	
SE$_{reg3}$				1.523
DWtest$_{reg1}$	1.985	1.915	2.395	
DWtest$_{reg2}$	1.911	1.918	2.456	
DWtest$_{reg3}$				1.672

* Significance at the 90% confidence level, ** at the 95% confidence level, *** at the 99% confidence level

WLS regressions indicate a significant and negative relationship between bank size and profitability, which is consistent with results reported by several scholars. Pasiouras and Kosmidou (2007) and Sufian and Chong (2008) found that the bank size (measured as in our study by a natural logarithm of total assets) negatively impacts ROA, suggesting that larger banks tend to earn lower profits and to encounter diseconomies of scale. Such diseconomies of scale may be explained by diversification, which decreases credit risk and the returns of larger banks (Sufian & Chong, 2008). Another interpretation of diseconomy of scale in banking can be related to the bureaucratic factor, which can negatively affect profits. Additionally, larger banks may have greater possibilities of using accounting methods to decrease profitability in order to avoid political scrutiny of their operations (e.g. Moyer, 1990).

Regarding liquidity proxies, LTD has highly a significant and positive impact on ROE, NPM and EBTDA margin in WLS regressions. These results indicate that an increase in the loans-to-deposits ratio results in higher liquidity risk and leads to higher profitability, as represented by the multiple proxies ROE, NPM and EBTDA margin. The influence of FGR on EBTDA proxy is proved to be statistically significant with a positive sign; FGR has a significant and negative effect on ROA. Our findings therefore suggest that an increase in the financing gap ratio (accompanied by a higher liquidity risk) leads to higher EBTDA margin but to a lower ROA.

The impact of GLS in WLS regressions is significant and positive on EBTDA margin, while proving negative on the other return proxies, ROE and NPM. The significant and negative relationship between NPLL and all profitability proxies persists. It means that the increase in NPLL, which represents the expected credit losses that the bank must eventually cover, causes a reduction in profits. Our research thus confirms results of the previous literature that an increase in net provisions for loan losses has a negative impact on bank profitability (e.g. Sufian & Chong, 2008; Trujillo-Ponce, 2013; Pasiouras & Kosmidou, 2007).

A surprising outcome of our study is that according to WLS regression, GDP growth has a significant negative impact on ROE and NPM and an insignificant (although positive) effect on EBTDA and ROA. It seems that when multiple proxies of profitability have been applied, the impact of the macroeconomic environment has become more uncertain and difficult to interpret. Inflation in our study seems to be an insignificant contributory factor towards bank profits.

5. Conclusions

This study investigates the impact of liquidity risk levels on the profitability of banks. Several of our findings are consistent with outcomes reported by previous literature. In particular, other researchers have found similar results regarding the impact of equity, size and NPLL on profitability. However, many of the previous studies have found that an increase in deposits should lead to an increase in bank profitability. Our study, on the other hand, reported only inconclusive results regarding whether deposits impact bank profitability positively or negatively. We suggest that a well-motivated assumption that deposits contribute to profitability through cheap and stable funding may not be true when in a negative interest rate territory. Furthermore, this changing economic environment can explain this study's inconclusive results regarding deposits and bank profitability. Additionally, although there is some evidence from previous literature that larger banks tend to be more profitable, our study warns that the "too big to fail" argument has its limitations. Analysis of the largest Europeans banks in our paper supports the idea that the effect of size for this particular group of financial institutions (i.e. banks that have become extremely large by assets) has a negative impact on profitability and we offer a few explanations as to this observation.

Regarding the liquidity risk measures, this study found somewhat mixed results: empirical evidence indicates that an increased liquidity risk may be a catalyst for banks' income and can lead to higher profitability. Conversely, our results also show that an increase in FGR leads to lower ROA, which can be explained by the fact that banks with a larger financing gap ratio lack stable and cheap funding, and therefore must use expensive external sources to meet their funding demands. In turn, this decreases the profitability of the banks. At the same time, this study found that the financing gap ratio has a positive impact on EBTDA margin, which largely consists

of interest income. Empirical evidence thereby supports an assumption that banks with high levels of illiquid assets in loans may obtain higher interest income than banks with less illiquid assets. As a result, an increase in illiquid assets could raise interest income and thereby boost the EBTDA margin.

Additionally, different liquidity and profitability proxies applied in the study report contrasting outcomes. LTD ratio was found to have a positive relationship with EBTDA margin and ROE but an insignificant one with ROA and NPM. FGR, on the other hand, was found to have a positive impact only on EBTDA margin. Although the empirical results regarding impact of liquidity risk on profitability are uncertain, they correspond with some other studies that have reported similar ambiguity (like Căpraru & Ihnatov, 2015).

The Basel III liquidity measure, LCR, was an insignificant contributor to all return proxies, and this requires further investigation. Firstly, the regulation to disclose LCR liquidity measure is new, and the banks may have slightly different methods of calculating this liquidity measure. There may be variance in how the banks estimate the ratio, and, if this is the case, the results concerning how LCR impacts the profitability proxies will be affected. It is also plausible to assume that bank managers might have attempted some type of earnings management as a precaution to Basel III liquidity restrictions, including for LCR. This topic falls outside the scope of our research project but it does provide a suggestion for future investigation concerning how compliance with newly-introduced requirements affects banks' financial reporting choices. Interestingly, Dietrich *et al.* (2014), similarly found NSFR (another Basel III liquidity restriction ratio) to be insignificant in explaining bank performance. It seems that outcomes of implementation of Basel III regulations remain uncertain and deserve further attention.

Since it was found that an increase in NPLL decreases bank profitability and that the increased liquidity risk can be a catalyst for bank profitability, the reduction in profits caused by lower liquidity risk could be offset by cutting down NPLL. Ahmed *et al.* (1999) have found evidence that bank managers adjust to bank capital adequacy requirements imposed during the 1990s through NPLL. The regulatory changes during the 1990s are, in our view, rather comparable to the ongoing Basel III liquidity risk regulation reforms. Thus, since Basel III requires banks to increase their LCR to 100% (that is, to decrease liquidity risks) starting from 2019, it is possible that bank management may also alter their estimations of NPLL to compensate for the changes in liquidity risk levels and to avoid decreased profitability. We advise scholars to closely examine this issue.

Our findings regarding the impact of liquidity risk on bank profitability are rather diverse; therefore, we are not able to reject (or fail to reject) our hypothesis statement. Nevertheless, although it cannot be concluded that liquidity risk is a statistically significant contributor to banks' profits through all proxies representing profitability,

this study found some evidence that an increased liquidity risk can enhance the profitability of banks. The existing literature has not reached a consensus on whether liquidity risk has a negative or positive effect on bank profitability, and the results of our study reflect the ambiguity that exists within this area of research. The question of liquidity impact on banking profitability is a complex issue which could depend upon many factors, including the bank's business model (Bordeleau & Graham, 2010) and different financial systems within which the bank is operating (Chen *et al.*, 2018).

The deviation of empirical outcomes also suggests that liquidity risk might potentially be an endogenous variable. Indeed, both Chen *et al.* (2018) and Bordeleau and Graham (2010) point out that endogeneity could be present with respect to liquidity risk since profits may be a source of additional liquidity for banks. Potential endogeneity of liquidity and profitability concepts can therefore explain why our study found that liquidity risk has a variable impact on profitability, depending upon the profitability measure.

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[i] Heteroscedasticity refers to the circumstance in which the variance associated with the residuals of the dependent variable is not homogenous across the range of values of independent variables. A test of heteroscedasticity of error terms determines whether a regression model's ability to predict a dependent variable is consistent across all values of that dependent variable.

[ii] WLS is based on the implicit assumption that the errors are uncorrelated with each other and with the independent variables and have equal variance.