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DETERMINANTS OF LIQUIDITY RISK IN COMMERCIAL BANKS IN THE EUROPEAN UNION

In this paper we analyse the determinants of liquidity risk of commercial banks by comparing dependencies in two dichotomous groups, including banks operating in the countries of the so-called Old European Union (Austria, Belgium, Germany, Denmark, Spain, Finland, France, the UK, Greece, Ireland, Italy, Portugal) and the countries of the so-called New European Union (Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovenia, Slovakia). On the basis of two indicators of liquidity risk, we estimate the same group of determinants that co-create microeconomic factors (credit risk, effectiveness level, size of the bank, financial leverage level, engagement in the interbank market) and macroeconomic factors (weighted average for interest rates of the unsecured market of interbank O/N deposits, domestic credit provided by the banking sector to GDP, inflation, GDP). The determinants of liquidity risk specific for banks operating in the countries of the so-called Old European Union are slightly different from those for banks operating in the countries classified as the so-called New European Union. However, we can indicate a group of internal determinants that affect the level of liquidity risk, regardless of the form of liquidity risk measure adopted, and the country in which they operate (margin volume, credit risk level, and engagement in the interbank market). A significant difference in terms of the diagnosed flexibility is the effect of the weighted average interest rates of the unsecured market of interbank O/N deposits on the level of banks liquidity. In banks operating in the area of the Old European Union, the increase of O/N interest rates encourages intensifying the engagement in the money market. On the other hand, in countries from the group of the New European Union, the increase of this rate is not synonymous with the overall increase of liquid assets.

Keywords: liquidity risk, bank, determinants of liquidity risk

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1. INTRODUCTION

The identification of the determinants of liquidity risk of commercial banks is a relatively new area of research. Before the outbreak of the sub-prime crisis, liquidity risk was mostly regarded as a determinant (independent variable) influencing performance measures, estimated at the level of margin generated by commercial banks. The explosion of the crisis led to a significant interest in the issues of liquidity risk, including the

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factors determining this risk. Research undertaken by C. Shen, Y. Chen, Kao and Yeh (2010), proved that there is a relation between liquidity risk and the level of effectiveness in the two groups of banks operating in countries with different financial systems (bank-based and market-based). Wojcik-Mazur (2012) described the determinants of banks' liquidity risk and identified the optimal measure of liquidity risk, which can be applied in the space-time analysis. Vodova (2012, 2013) pointed to a group of factors affecting the level of liquidity risk in banks operating in Poland and the Czech Republic.

The main purpose of the conducted research is an attempt to identify the determinants of liquidity risk in the new approach by defining the direction and impact of the same group of factors in two groups of banks operating in the so-called "new" and "old" EU countries. The varied level of impact of the sub-prime crisis in various European Union countries, including the particular countries of the "New Union", on the liquidity of banks could suggest important differences in the group of factors affecting the level of liquidity risk. Independent variables constituting macroeconomic determinants include the following parameters: GDP, inflation, domestic credit to GDP, and additionally introduced weighted averaged O/N interest rates of the unsecured interbank deposit market, specific to individual countries. Microeconomic factors taken into account were the credit risk, leverage, efficiency and size of bank. Based on the existing literature studies we have adopted the following research hypotheses:

1. Credit risk has a negative correlation with liquidity risk, regardless of the study group of banks (both in the Old and the New Union),
2. Profitability has a positive relation with liquidity risk, regardless of the test group of banks,
3. Size of bank has a negative dependency with liquidity risk, regardless of the test group of banks,
4. Weighted, averaged interest rates of unsecured interbank deposit market is characterized by the negative relation with the level of liquidity risk, regardless of the test group of banks,
5. The group of external determinants is typical for the same relationship directions with liquidity risk in the two groups of banks operating in the area of the Old and the New Union.

2. DETERMINANTS OF LIQUIDITY RISK – LITERATURE REVIEW

The activity of banks in the area of funds and maturity transformation is the fundament for creating liquidity risk, including so-called “bank runs” (Diamond and Dybvig 1983, Rajan and Bird 2003, Goodhart 2008). The mismatch between maturities of assets and liabilities, both on balance sheet and off balance sheet, forms a classic mismatch gap which constitutes structural risk. This risk is determined by the character of funding sources, which are short or medium-term, in comparison to long-term lending (Bonfim and Kim 2012, Holmström and Tirole 1998). As a result, the banks are forced to continually roll over short or medium-term on-balance-sheet funding sources, to match them with the assets maturity profile (Bessis 2010).

Such a dependency was indicated in Figure 1, which presents the taxonomy of liquidity risk. Its analysis shows that the foundation for creating liquidity risk is the mismatch of cash flows that cause the liquidity gap. The mismatch gap is the result of the process of the adopted credit-deposit policy and the generation of the balance sheet structure. This gap may be broadened by not anticipating the customers behaviour and the improper process of assets and liabilities management. As a result, it can lead on one hand to the too low share of liquidity reserves, including assets classified as liquid, or to difficulties in selling them at a fair price, and on the other hand, to the improper diversification of funding sources or the low level of their stability as well as to the “freezing” of the market (Wójcik-Mazur, 2012).

Liquidity risk is therefore directly linked to the generation of loss, which results from the inability to sell assets, as well as to raise funds at an economic, moderate cost in order to cover expected and unexpected liabilities (Banks 2005). This definition of liquidity risk illustrates its two basic types, which are funding risk and market liquidity risk. (Brunnermeier and Pedersen 2009).

Market liquidity risk is defined as the ability to convert assets into cash at a given price in a short period of time, while funding liquidity risk refers to the ability to raise money mainly through wholesale markets allowing to finance the lending activity (Haan and van den End 2012). The occurrence of market disruptions can limit the possibilities to raise additional capital primarily through the sale of liquid assets. Therefore, the crucial element is the reduced or absent possibility to sell liquid assets at a fair price (or at a similar level) (Matz and Neu 2008, Tirole 2011, Daszyńska-Zygadło 2012).

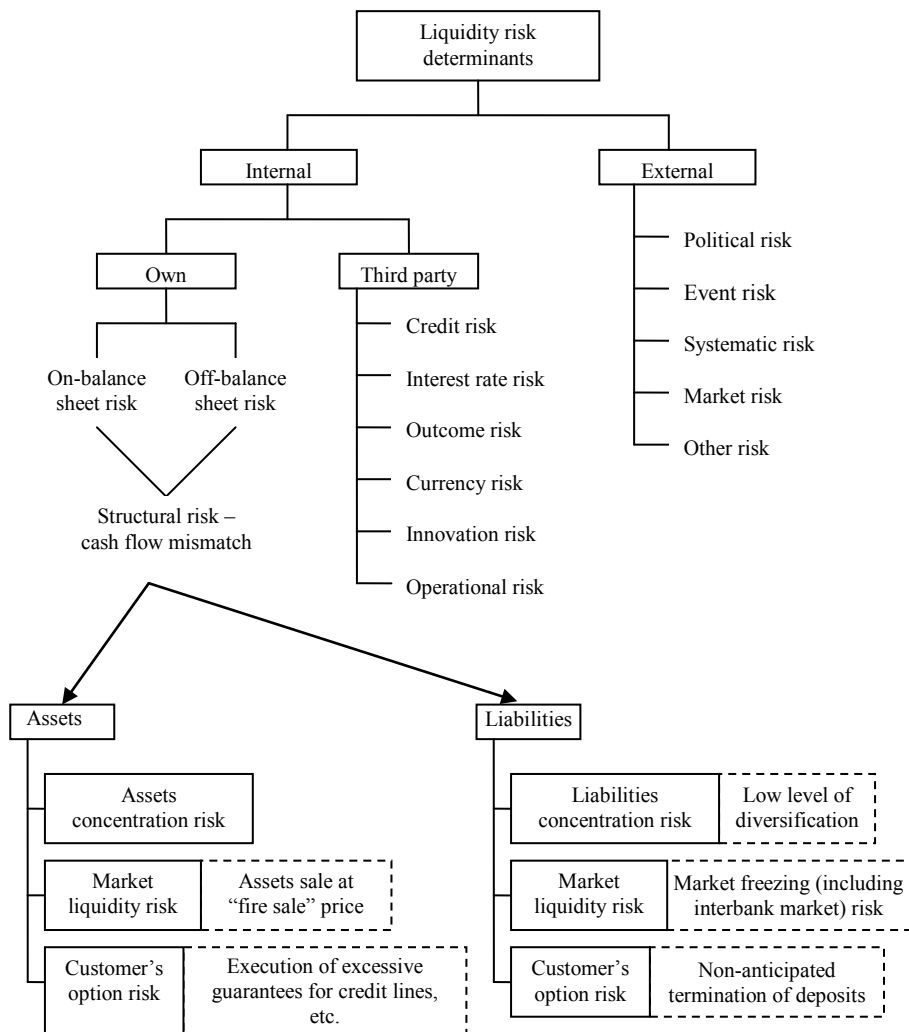


Figure 1. Taxonomy of liquidity risk

Source: Wójcik-Mazur (2012)

In normal circumstances, when the turnover volume is sufficient, market liquidity is not a source of risk. This risk may appear with a substantial decrease of turnover and sales that results in a major decline of market prices (Allen et al., 2004). Allen and Gale (1998), referring to the Diamond and Dybvig (1983) model, showed that in an adverse environment the prices of

assets may decrease below their fundamental value and lead to pricing called “cash-in-the-market” (fire sale).

Funding liquidity risk relates to a situation where the bank is unable, in a given time perspective, to meet its obligations when they fall due. Drehmann and Nikolaou (2009) indicate in particular, that funding liquidity risk includes two elements: future (random) money inflows and outflows, and future (random) prices of various sources that provide funding liquidity. Brunnermeier noticed that in certain circumstances market and funding liquidity risk can reinforce each other (Brunnermeier and Pedersen 2009, Brunnermeier 2009). That may create a phenomenon called liquidity spiral, especially in the presence of systematic risk. A bank may be forced to sell some of its assets in case it is not able to roll over its liabilities. Unfortunately, such a fire sale causes the depreciation of asset prices. If the assets of the bank are marked-to-market, they will be shrinking, which makes raising funds even more difficult (Nikolaou 2009).

Therefore the difficulties of one bank may cause an extreme impact on other banks and even the entire economy. The significance of this risk relates to the fact that the probability of liquidity shocks is low, yet they can create severe negative effects, so in prosperous times this risk is often underestimated (Bonfim and Kim 2012). Such an exemplification is the financial crisis in 2007.

The sub-prime crisis caused liquidity difficulties for many banks in its early phase. This happened despite the proper capital levels in those banks, as they were not prudent enough while managing their liquidity. The crisis proved how important liquidity is for the operation of financial markets and the banking sector. Before the crisis spread, it was relatively easy to raise financing in the market at a low cost. After the crisis changed the market, it became clear that liquidity can disappear immediately and its lack can be prolonged for a long period of time. The banking system was put under significant pressure which required the direct actions of the central bank (Jajuga 2009, Basel Committee 2013).

The empirical studies include a vast stream of analyses which evaluate the multi-level dependencies between liquidity level and assets price in the context of asset returns and aggregate market liquidity risk or financial market runs. It should be noted that in that approach the liquidity is determined externally. In the narrow group of exploration in the area of liquidity risk there are attempts to isolate microeconomic determinants affecting its level. The problem of liquidity risk determinants is poorly explored. This area of study was dominated by the approach in which the

liquidity risk was an independent variable, estimated in relation to the effectiveness level and credit risk of individual financial institutions.

We can indicate here the study results for Rhoades (1985), who found a positive dependency between risk and profit for banks in 1969-1978 in the U.S. In another study Bourke (1989), using international data for 1972-1981, noticed that profitability was positively related to both capital and liquidity ratios. On the other hand, Molyneux and Thornton (1992), while researching the European market for 1986-1989, discovered that there was a negative dependency between liquidity and profitability.

Meanwhile, Angbazo (1997) indicated that the ratio of liquidity risk and interest rate risk measures are found to significantly augment loan to deposits rate spreads. A study undertaken by Samy et al. (2009) revealed that there is a non-significant effect of liquidity on assets and equity returns. Spathis and Kosmidou (1999) used Tobin's Q ratio to evaluate the competitiveness of small and large banks in Greece in 1990-1998. They found the following determinants of Greek banks competitiveness: assets and liabilities management effectiveness, current assets to loans ratio, and the total assets being a measure of the bank's size.

Valverde and Fernández (2007) examined the determinants of bank margins in seven European countries. As a proxy for liquidity risk they used the ratio "liquid assets / short term funding". Liquidity risk, according to their analysis, is significantly and positively related not only to the spread¹ but also to three dependent variables: LMSPR², LERNER³, MRKUP⁴.

Alper and Anbar (2011) analyzed the influence of external and internal factors on bank profitability (ROA, ROE) in the Turkish banking system from 2002 to 2010. They used liquidity as one of the independent variables. Their research shows that low asset quality decreases profitability and the asset size has a significant effect on a bank's profitability.

Das (2013) examined the impact of the financial crisis on the net margin of Indian banks. He indicates that only during the second half of the sub-

¹ Loan-to-deposit rate spread, i.e. the difference between the price of loans – calculated as the ratio "interest income/loans" and the price of deposits – calculated as the ratio "interest expense/deposits".

² Spread between bank loan rates and the interbank market (three months) rate.

³ The ratio is defined as "(price of total assets-marginal costs)/price of total assets". The price of total assets is calculated as "total (interest and non-interest) revenue/(total assets + off-balance sheet activities)" using the distribution of on-balance sheet and off-balance sheet assets as a weighting factor for both on-balance and off-balance sheet prices. The HHI (according to authors) were obtained from the ECB Report on EU banking structure.

⁴ The numerator of LERNER (price of total assets minus marginal costs).

prime crisis big banks with high capital and adequate liquidity increased their margins.

On the other hand, Fan and Shaffer (2004) studied the sample of large commercial banks in the U.S. in terms of their profitability and how it is affected by various aspects of bank risks, such as credit risk, liquidity risk, and insolvency risk. They found a positive relationship between profit efficiency and credit risk and insolvency risk, but a negative relationship with liquidity risk or with the mix of loan products.

We should also emphasize the research conducted by Wetmore (2004). The relation between liquidity risk and loans-to-core deposits ratio in large holdings of commercial banks was the subject of his study. He noticed an increase in the average loan-to-core deposits ratio in the examined period of time, which is reflected in the process of managing assets and liabilities in banks. The conclusion was that there was a positive relation between market risk and changes in loan-to-core deposits ratio after 1994, while before 1994 this relation was negative.

Aspachs et al. (2005) analysed the determinants of the liquidity buffer of the UK banks, observing that the level of liquidity is cyclical. The level of liquidity, relative to both total assets and total deposits, is determined by the phase of economic growth. The higher economic growth is accompanied with the lower level of bank liquidity.

It should be noted that this increased interest in studies of liquidity risk and in particular of determinants of that risk was caused by the breakout of the sub-prime crisis. This trend in literature is represented by the results provided by Shen et al. (2010). The purpose of the study is to use a dataset of twelve advanced economies' commercial banks in 1994-2006 to research the causes of the liquidity risk (causes of liquidity risk model), employing alternative liquidity risk measures (gap ratio) besides liquidity ratio. The panel data instrumental variables regression is used, with two-stage least squares (2SLS) estimators to estimate bank liquidity risk and performance model. The authors came to the conclusion that liquidity risk is the inevitable factor that determines the performance of banks. Liquidity risk is caused by various determinants such as elements of liquid assets or dependence on external funding, as well as factors of a supervisory, regulatory or macroeconomic character. The study also reveals that liquidity risk may be a cause of the decreased profitability of a bank because of higher funding cost, both in terms of return on average assets and return on average equities, but at the same time it can raise the net interest margin in a bank. In this study the authors make a dichotomous division of the countries being analyzed,

taking into account the characteristics of their financial systems. They distinguish countries with a financial system based on the securities market, and countries with a banking orientation of the financial system. They indicate that in the market-based financial system the relation between liquidity risk and bank's performance is negative, while in bank-based financial system the liquidity risk has rather no effect on that performance.

In contrast to previous studies, Wójcik-Mazur (2012) estimates four models for liquidity risk determinants, on the basis of balanced data for banks operating in a bank-based model (for 13 countries) and in a market-based model (for eight countries) for a study period of 1999–2009. In those models the liquidity risk is determined by the following indicators: financing gap, levels of very highly liquid assets, highly liquid assets, liquid assets in relation to total assets, and modelled in reference to fixed set of independent variables. The study indicated that the classic dependencies between liquidity risk level and generated profitability, including the margin, are determined by the type of the financial model in which the banks operate. The unambiguous effect of credit risk on the liquidity level diagnosed the secondary nature of risk, regardless the type of the financial model specific for the banking sector. The observed conversion of behaviour in terms of keeping the liquidity buffer in case of economic downturn, also reinforced by the change of the level of financial leverage, clearly confirmed the cyclical nature of liquidity risk determined by the economic activity in both types of financial systems (Wójcik-Mazur 2012).

Sawada (2010) studied the liquidity risk for the Japanese market between 1926 and 1932. The panel data was used with regression tests and the author came up with the suggestion that in face of a liquidity stress which requires the increase of banks' cash, banks do not liquidate their credit but rather trade securities on the market. He also noticed that such an improvement in the security market is especially important in the case of countries with weak financial structures. He noticed that if the security-asset ratio or the liquid asset ratio is a dependent variable then the coefficient of bank size is positive and significant. On the other hand this ratio is insignificant in cases where the cash-assets ratio is a dependent variable.

Vodova, who conducts interesting research, examines the determinants of liquidity risk of Czech banks in the period 2006-2009. The dependent variables are four measures of liquidity risk estimated on the basis of data balance sheet. The study showed the positive relationship between liquidity level and capital adequacy, and interest rate on interbank transaction. Nevertheless, the analyzed size of the bank does not influence unequivocally

the maintained level of liquidity, because it is dependent on the adopted measure of liquidity. This relationship is positive both for the indicator that reflects loans to deposits, and short term financing ratio, and for measure of liquid assets to deposits and short-term borrowing (Vodova 2012).

There are also some studies worth mentioning, in the area of liquidity risk determinants identification for banks operating in the Islamic banking model and classic banks. Akhtar et al. (2011), applied a descriptive, correlations and regression analysis to examine the impact of independent variables on a dependent variable of liquidity risk. They defined the liquidity risk as a relation of cash to total assets. Then they applied this analysis to investigate, measure and compare liquidity risk for a sample of banks in Pakistan, both conventional and Islamic banks. The regression results in cases where both types of banks showed the positive correlation between the bank's size and liquidity risk, while also evidencing the insignificance of the first. Another parameter that is positively related to the liquidity risk, yet insignificant, is the net-working capital ratio⁵. The analysis of return on equity (ROE) relation to the liquidity risk revealed that in the case of conventional banks it is positive and insignificant, and significant for Islamic banks. Another ratio – of capital adequacy, demonstrated the positive relation to liquidity risk and the significance in the group of conventional banks, while for Islamic banks it proved to be insignificant. Finally the relation of return on assets (ROA) was positively related to liquidity risk, insignificant for conventional banks, and significant for Islamic banks.

Another study in this field was performed by Ahmed et al. (2011), who examined a sample of six Islamic banks in Pakistan in 2006-2009. The data was obtained from secondary sources. The authors used the Pearson correlation to determine variables relations, and regression to calculate the coefficients. The size of the bank was proved to be directly related to credit and liquidity risk, however negative and insignificant in relation to the operational risk. Both liquidity risk and operational risk were found positively related to the asset management. Two ratios that have a negative and significant relation to liquidity and operational risk were gearing ratio and non-performing loans ratio. Those two were directly linked with credit risk. As for the capital adequacy – it demonstrated a negative and significant relation to credit and operational risk, and its relation to liquidity risk was positive.

⁵ Ratio of short-term claims less short-term debt to net assets.

In this approach, a slightly different trend of studies should be noted which indicates a significant variation in banks' liquidity size that is determined (as suggested by the authors) by the level of development of the local financial system. The empirical study by Freedman and Click (2006), suggests that banks in developing countries devote a much lower amount of their funding for lending to the private sector, holding a relatively high level of liquid assets treated as cash, deposits in the central bank and other banks, and short-term government securities. The authors reason that such a situation may be caused by the inefficiency of the credit market resulting from factors such as higher reserve requirements, greater macroeconomic risk and volatility, and some legal and regulatory deficiencies that make contracts harder to enforce and collateral to foreclose. Banks are also discouraged from lending to the private sector in some developing countries, as the market risk-free rate is set at a very high level.

Acharya et al. 2009, expanding this study, connects bank liquidity with a group of institutional variables that include the financial development of a country regarding the quality of disclosures together with the extent of stock and credit intermediation (related to the size of a country). They find in the cross-section of countries, the correlation of the average for the ratio of banking system of liquid assets to total deposits with such macroeconomic ratios such as accounting standards, total capitalization to GDP, domestic credit and deposits to GDP and stock market capitalization to GDP, is uniformly and significantly negative. They also examine data on international stock market liquidity measured (three measures of stock market liquidity) by the correlation to a banking system liquidity ratio.

In this paper, due to evidenced higher levels of liquidity for banks operating in developing countries, the authors decided to analyse the effect of external and internal determinants on the level of liquidity risk being adopted, with the distinction for countries, that are classified as so-called Old European Union, and those which have been members of the EU since 2004.

3. THE MODEL

In this paper it was assumed, that because of evidenced higher levels of liquidity for banks operating in developing countries, the analysis will examine the effect of external and internal determinants on the level of liquidity risk being adopted, with the distinction of various levels of countries development. The key element of the model's construction was the

choice of ratios identifying the liquidity risk of the individual financial institution. Due to the heterogeneous approach presented in the empirical studies, in particular in space-time analyses, to ratios identifying the liquidity risk or liquidity level, it was accepted that the classic balance sheet indicators will constitute the dependent variables. In the first model, the predictor for liquidity risk is the ratio demonstrating the level of liquid assets in relation to deposits and short term funding (used among others in the following publications: Aspachs et al. 2005; Shen et al. 2001; Freedman and Click 2006; Acharya et al. 2009; Kosmidou et al. 2005; Vodowa 2012; Bunda and Desquilbet 2008; Deléchat et al. 2012). On the other hand in the second model the dependent variable illustrated the relation between the level of net loans to total deposits. (Bonfim and Kim 2012; Vodowa 2012; Pasiouras and Kosmidou 2007; Kosmidou 2008; Naceur and Kandil 2009; Bunda and Desquilbet 2008).

On the basis of the literature studies and the empirical research, a group of elements constituting independent variables was also selected. This group included macroeconomic and microeconomic indicators. The same group of independent determinants was analysed in the case of both models. The group of macroeconomic variables used in the model adopted the macroeconomic indicators proposed in particular by Rajan and Zingales (2003), Friedman and Click⁶ (2006), Acharaya et al. (2009), Bonfim and Kim (2012); Shen et al. (2001); Vodova (2012), expressing the level of domestic credit provided by the banking sector (% of GDP), inflation, consumer prices (annual %), and Gross Domestic Product. Our model also used the interest rate for O/N deposits on the interbank market. The introduction of this additional variable was dictated in particular by the undertaken empirical study, which indicates the relationship between the liquidity level and the interest rate. Research conducted in the field of European banks Lucchetta (2007), prove that the level of interest rates of interbank market affects the liquidity level and the interbank interest rate is an incentive for holding liquid assets. Moreover, the relation between monetary policy interest rate and the decision of a bank to hold liquidity and to lend in the interbank market is negative. The research of Munteanu (2012), on the basis of banks operating in Romania in terms of the identification of liquidity risk determinants in the group of independent

⁶ Their comparative analysis for banking systems development used indicators related to: accountancy standards, total market capitalization in relation to GDP, local credits in relation to GDP, total value of deposits in relation to GDP, and stock market capitalization in relation to GDP.

variables, uses the interest rate of the Romanian interbank market (ROBOR). Our model, due to the fact that the official reference rates of the interbank market do not reflect the actual level of rates for transactions between banks, uses the reference rates reflecting the real cost of money, determined on the basis of the average interest rate of O/N deposits weighted by the volume of transactions made in the unsecured interbank deposits market. Therefore the following rates were included: SONIA⁷, EONIA, POLONIA, LEONIA, HUFONIA and CZEONIA.

The group of internal determinants included: credit risk level, interbank market engagement, profitability level, equity share, and bank size (Table 1).

Table 1
Source of variables

Variables definition	Source
INTERNAL	
Equity / Total Assets	Bankscope
Net Interest Margin	Bankscope
Return on Average Assets	Bankscope
Interbank Ratio	Bankscope
Loan Loss Reserve / Gross Loans	Bankscope
Total Assets (log)	Bankscope
EXTERNAL	
Domestic credit provided by banking sector (% of GDP)	IMF
Gross Domestic Product (annual % change)	IMF
Overnight Index Average	National banks
DEPENDENT	
Liquid Assets / Deposits & Short Term Funding	Bankscope
Net Loans / Total deposits	Bankscope

Source: authors' own elaboration

The database contains 84 banks representing seven countries (Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovenia, Slovakia) – new members of the EU and 392 banks representing the “old” 12 members (Austria, Belgium, Germany, Denmark, Spain, Finland, France, the UK, Greece, Ireland, Italy, Portugal). In fact we have available the sample of 443 banks for old members and 84 banks for new members for 5–7 year long time-series. In practice, when for some objects the time-series was shorter than five years, we rejected this individual object (bank). A sample due to a

⁷ Overnight Interbank Average Rate for similar countries

single missing data is regarded as unbalanced. The length used in the time series (finally) was not less than five. In the estimation process, the backward stepwise selection procedure was used.

According to the theory presented by Engle and Granger (1987) econometric modelling should be preceded by an analysis of the time series properties – mainly in terms of stationarity. Inference for stationarity with so short (seven periodic) time series is doubtful (Szajt 2010)⁸. Therefore, in the paper we propose the use of an error correction model. The basic issues describing the construction of this kind of models can be found at Wooldridge (2012). This kind of model is taking into account both short- and long-term relationships. The following form of a model was proposed:

$$\begin{aligned} \Delta LAS_{it} = & a_i + (\rho_1 - 1)(LAS_{it-1} - \delta_1 ETA_{it-1} - \delta_2 NIM_{it-1} - \delta_3 ROA_{it-1} - \delta_4 INR_{it-1} \\ & - \delta_5 DCR_{it-1} - \delta_6 INF_{it-1} - \delta_7 GDP_{it-1} - \delta_8 OIA_{it-1} - \delta_9 \log TAS_{it-1} - \delta_{10} LLR_{it-1}) \quad (1) \\ & + \beta_1 \Delta ETA_{it} + \beta_2 \Delta NIM_{it} + \beta_3 \Delta ROA_{it} + \beta_4 \Delta INR_{it} + \beta_5 \Delta DCR_{it} + \beta_6 \Delta INF_{it} \\ & + \beta_7 \Delta GDP_{it} + \beta_8 \Delta OIA_{it} + \beta_9 \log TAS_{it} + \beta_{10} LLR_{it} + \xi_{it}, \end{aligned}$$

where: a_i denotes the intercept decomposed into $i = 84$ objects – banks (for new 12 members of the EU without Croatia) and 367 (for old 15 members of the EU), LAS_{it} – Liquid Assets / Deposits & ST Funding of a given bank i in the period t , ETA_{it} – Equity / Total Assets of a given bank i in the period t , NIM_{it} – Net Interest Margin of a given bank i in the period t , ROA_{it} – Return on Average Assets of a given bank i in the period t , INR_{it} – Interbank Ratio of a given bank i in the period t , DCR_{it} – Domestic credit provided by banking sector (% of GDP) in the country in which resides bank i in the period t , INF_{it} – Inflation, consumer prices (annual %) in the country in which resides bank i in the period t , GDP_{it} – Gross Domestic Product (annual change %) in the country in which resides bank i in the period t , OIA_{it} – Overnight Index Average in the country in which resides bank i in the period t , TAS_{it} – Total Assets (in thousands of USD) of a given bank i in the period t , LLR_{it} – Loan Loss Reserve / Gross Loans of a given bank i in the period t .

The variables: INF , GDP , OIA , DCR are responsible for the impact of the macro environment to the phenomenon being researched. The Gretl programme was used to estimate the model. The weighted least-squares method was used. In the first model, the test statistics $F(15, 414) = 22.111$

⁸ Testing for stationarity of panel data requires a sufficiently long time series. In the present case, the possible application was merely the Kao Residual Cointegration Test (Kao 1999), which pointed to the existence of a cointegration vector.

with the value $p < 0.0001$ (new members) and $F(16, 1931) = 284.278$ with the value $p < 0.0001$ (old members) confirms the validity of the estimation of the panel model with fixed effects (Suchecky 2010). The final results are presented in Table 2.

Table 2
The values of structural parameter assessments in LAS models

Variable	Parameter	Old members		New members	
		Parameter estimate	p-value	Parameter estimate	p-value
constant	α	0.00001	<0.00001	32 493.65115	0.00144
<i>LAS</i>	$\rho-1$	-0.11890	<0.00001	-0.20003	<0.00001
<i>ETA</i>	δ_1	3.02118	<0.00001	-	-
<i>NIM</i>	δ_2	-3.85545	0.00129	-1.02593	0.1071
<i>ROA</i>	δ_3	-3.63520	0.02849	4.66996	0.00002
<i>INR</i>	δ_4	0.22418	<0.00001	0.05750	<0.00001
<i>DCR</i>	δ_5	0.20910	<0.00001	-0.26275	0.00254
<i>INF</i>	δ_6	3.27593	0.00735	-	-
<i>GDP</i>	δ_7	-1.57239	0.00776	-0.73488	0.06999
<i>OIA</i>	δ_8	35.11737	0.00016	-	-
<i>TAS</i>	δ_9	2.29328	0.00007	-1.44610	0.09619
Δ <i>ETA</i>	β_1	1.05826	<0.00001	-0.65297	0.00016
Δ <i>NIM</i>	β_2	-0.93429	0.00295	-	-
Δ <i>ROA</i>	β_3	0.46596	0.01716	0.04541	0.00606
Δ <i>INR</i>	β_4	0.06373	<0.00001	0.02040	<0.00001
Δ <i>DCR</i>	β_5	-0.10396	<0.00001	-0.51417	<0.00001
Δ <i>GDP</i>	β_7	-	-	-0.16665	0.00166
Δ <i>OIA</i>	β_8	-	-	-0.00589	0.0001
Δ <i>TAS</i>	β_9	-	-	4.94945	0.00093
Δ <i>LLR</i>	β_{10}	38.82610	0.00002	28.49430	0.07738

Source: authors' own research

Based on the studies conducted in the area of the identification of liquidity risk determinants, where this risk is measured as the relation of liquid assets to deposits and short-term funding for banks operating in countries of so-called Old Union and in the new members, we can indicate certain differences and similarities. The estimation reveals the existence of the long-term negative relation between the level of the generated margin and the liquidity risk ratio. For the members of the Old Union it is also negative in the shorter term. The negative relation between the margin level and the risk ratio is consistent with the expected relation and is the result of the fact that liquid assets generate lower incomes in terms of lending

activity. However, in reference to the impact of total assets profitability ratio on the liquidity risk level, it should be noted that for the “Old Union” members the relation is negative in the long term. The opposite (positive and statistically significant) features are adopted by those relations for banks operating in countries that are so-called new members. It is somewhat surprising that the relation between the ROA ratio and the liquidity risk is positive in so-called new members (at similar regularity is mentioned by Kosmidou et al. (2005)). It seems this is caused by the high rate of return on liquid assets in those countries that result in the increasing share of liquid assets in the total balance sheet total accompanied by the increase of net profit, which is proportionally higher than the balance sheet total increase. In the end this indicates a positive relation.

The evaluation in the group of internal determinants affecting the level of credit risk focused on the credit risk ratio. It should be noticed that for both groups of countries being evaluated, the credit risk measure demonstrates a positive relation in relation to the share of liquid assets in total deposits. This relationship illustrates the cyclical nature of liquidity risk. Banks in facing the growing credit risk level increase the share of liquid assets in the short term. Similar dependencies can be observed between the share of equity in total assets and liquidity risk. When the liquidity level rises, the share of equity also rises, which is another significant argument for the cyclical nature of liquidity risk. This relationship is not observed in the members of the New Union. The cyclical nature of liquidity risk is also confirmed by the negative relation of GDP growth for liquidity level, observed both in Old and New Union members. In addition it should be noted that in the case of countries being new members of the EU, this relationship is also valid in the shorter term. This negative relation proves that in times of economic growth the level of liquid assets significantly decreases in favour of lending activity. These studies are consistent with the work of Aspach et al. (2005), who find that the UK banks’ liquidity buffers are negatively related to real GDP growth and the policy rate.

The group of macroeconomic indicators being subject of the estimation process included the inflation level. According to our studies, the increase of inflation level affects the increase of liquidity level. This phenomenon is a result of liquid assets increasing faster than the volume of the lending portfolio, as the increase in interest rates caused by inflation encourages banks to invest in illiquid assets, with a higher interest rate. Opposite to the expected, the relation between the volume of domestic credit provided by the banking sector to GDP is positive. This dependency can be observed in a

situation where the decrease of the GDP ratio is accompanied by holding a constant level of domestic credit provided by the banking sector.

A different influence in terms of the effect of α ; size on the liquidity risk level in the presented two groups of countries should also be emphasized. In the countries of the “Old Union”, the positive relation indicates that banks maintain a higher level of liquidity. Such conclusions were reached by Rauch et al. (2009) and Berger and Bouwman (2009), who claimed that smaller banks that concentrate on intermediation and transformation activities have a smaller amount of liquidity. However, an inverse relationship was observed in the banks included in the group of countries that are new members of the European Union, whereas in the short-term the relation is consistent with the direction characteristic for the old EU countries.

The engagement of banks in the interbank market is characterized by the positive relation to liquidity measure, both for Old and New Union members. This means that banks increase the interbank market engagement level, and at the same time with the allocation of capital, increase the level of liquid assets (a positive relation both long- and short-term). It should also be noted that a positive relation was observed between the actual increase in the O/N deposits interest rate in the unsecured market of interbank deposits and the increase in the liquidity level in the banks operating in countries of the “Old Union”. On the other hand, in countries belonging to the group of the “New Union”, the increase of this rate is not identical with the total increase of liquid assets. Therefore it seems that the increase in O/N interest rates in the interbank markets of New Union does not lift the liquidity level in the short term, which may suggest that banks conduct a long-term strategy in the area of liquid assets portfolio construction, where the objective does not have to be the maximization of profit. Nevertheless, such conclusions require further, more detailed studies.

The second model is created for a dependent variable which relates to loans to total assets for individual banks. The components of independent variables are the same as for the former model.

$$\begin{aligned} \Delta NLC_{it} = & a_i + (\rho_1 - 1)(NLC_{it-1} - \delta_1 ETA_{it-1} - \delta_2 NIM_{it-1} - \delta_3 ROA_{it-1} \\ & - \delta_4 INR_{it-1} - \delta_5 DCR_{it-1} - \delta_6 INF_{it-1} - \delta_7 GDP_{it-1} - \delta_8 OIA_{it-1} - \delta_9 \log TAS_{it-1} \\ & - \delta_{10} LLR_{it-1}) + \beta_1 \Delta ETA_{it} + \beta_2 \Delta NIM_{it} + \beta_3 \Delta ROA_{it} + \beta_4 \Delta INR_{it} \\ & + \beta_5 \Delta DCR_{it} + \beta_6 \Delta INF_{it} + \beta_7 \Delta GDP_{it} + \beta_8 \Delta OIA_{it} + \beta_9 \log TAS_{it} + \beta_{10} LLR_{it} + \xi_{it}, \end{aligned} \quad (2)$$

where: NLC_{it} – Net Loans / Customer & ST Funding of a given bank i activity country in the period t , the other like in the model in Las models.

In this model, the test statistics $F(7, 496) = 27,528$ with the value $p < 0,0001$ (new members) and $F(16, 2125) = 70,157$ with the value $p < 0,0001$ (old members) confirm the validity of the estimation of the panel model with fixed effects. The low value of the index error correction (all the models) indicates that the tested systems can achieve an equilibrium point only in the distant future.

Table 3

The values of structural parameter assessments in NLC models

Variable	Parameter	Old members		New members	
		Parameter estimate	p-value	Parameter estimate	p-value
constant	α	37.70226	<0.00001	0.00414	0.01596
<i>NLC</i>	ρ_{I-1}	-0.09412	<0.00001	-0.06979	<0.00001
<i>ETA</i>	δ_1	-1.48406	<0.00001	-	-
<i>NIM</i>	δ_2	4.03756	0.00311	-	-
<i>ROA</i>	δ_3	-0.10622	0.08864	-	-
<i>INR</i>	δ_4	-0.06244	<0.00001	-	-
<i>DCR</i>	δ_5	0.19509	0.00003	1.49013	0.00010
<i>INF</i>	δ_6	4.92559	0.02148	5.58336	0.01358
<i>GDP</i>	δ_7	7.15632	<0.00001	15.48628	<0.00001
<i>LLR</i>	δ_{10}	-188.95917	0.00165	-	-
Δ ETA	β_1	10.22700	<0.00001	-	-
Δ NIM	β_2	-	-	0.91223	0.05636
Δ ROA	β_3	-0.00800	0.05619	-	-
Δ INR	β_4	-0.00890	<0.00001	-	-
Δ DCR	β_5	0.15364	<0.00001	0.29978	0.00003
Δ GDP	β_7	0.46530	<0.00001	0.87021	<0.00001
Δ TAS	β_9	-10.17800	<0.00001	-	-
Δ LLR	β_{10}	-33.50530	0.00058	-	-

Source: authors' own research

The conducted estimation (Table 3), that adopted the measure for liquidity risk (identifying the relation between net loans and total deposits) as dependent variable, indicates the opposite relations for two groups of banks (for the Old and New Union). In the case of banks operating in the group of “Old” members, there can be observed a positive, long-term relation between liquidity risk and interest rate margin ratio. This is caused in particular by the strong impact of the lending activity intensification on the margin increase. A positive but short-term relation is also characteristic for banks in “New” members, and at the same time, it is statistically

insignificant in the longer term. Such directions of relation may be the result of the fact that the greater increase of lending activity in relation to acquired deposits generates a significant growth of the margin in the short term, while in the long term, due to the dynamics of lending activity, requires additional sources of financing, and therefore increases the interest costs. The increase in those costs is relatively smaller than the value of incomes generated by the lending activity, as it does not lower the margin, but only makes this relation statistically insignificant. Also the estimated negative relation (both in the short and long-term) between liquidity risk and total assets return rate, adopting statistical significance for the Old EU, should also be emphasized. Such a direction of dependencies suggests that financing the increasing lending activity requires the search for additional financing sources, with costs higher than traditional deposits. As a result, the increase in the balance sheet total is proportionally higher than the profit increase which reduces the total assets profitability.

When analyzing the determinants of liquidity risk one should also notice the existing negative relation of credit risk in relation to the indicated liquidity predictor. In the group of banks operating in the area of the old EU this dependency occurs both in the long and short term, while it is statistically insignificant in the group of the “new EU” countries. This means that in the countries of the old EU, liquidity risk adopts a cyclical nature. The strong increase of lending activity in relation to the volume of acquired deposits is accompanied by the decrease in credit risk. This may be the result of the fact, that the high dynamics of lending activity increase is accompanied by a relatively lower increase in the reserves value, which leads to the decrease in the overall level of credit risk. This relation confirms the dependency between GDP growth and liquidity risk. Such a relation is positive both for banks operating in new and old EU. This phenomenon is also confirmed by the increase of domestic credit in relation to GDP. The estimated positive relation, both in the short-term and long-term approach, is present in both groups of banks. Definitely different from the expected relation is the analyzed relationship between the inflation level and liquidity risk ratio, both in the countries of the old and the new EU. Such a direction of the relationship can be justified by the fact that the inflation increase is likely to be connected with the GDP growth and as a result does not affect significantly the interest rates progression, and thus does not limit the expansion of lending activity.

Among the components of co-creating liquidity risk determinants an important factor being subject to evaluation is the level of financial leverage.

The relationship between leverage ratio and liquidity risk in the long term is negative and statistically significant only for banks belonging to the old EU countries. This means that the increased progression of lending activity is accompanied by an increase in the balance sheet total, which with maintaining a constant level of equity by banks causes a decrease in the leverage ratio. This phenomenon does not occur in the short term, as indicated by the estimated positive relation. The analyses show that the increase in the interbank market engagement focused on allocating capital reduces liquidity risk both in the short and long term. This relation is characteristic only for banks operating in the old EU countries. The relationship between the bank size and the liquidity risk level should also be emphasized. In this configuration, the short-term positive relation indicates that with the growth of the bank, the level of liquidity risk decreases.

CONCLUSIONS

The study shows that the determinants of liquidity risk characteristic for banks operating in countries of the so-called old EU are slightly different from those for banks operating in the countries of the so-called new EU. Furthermore, the relationship between micro- and macro-economic determinants are also dependent on the liquidity predictor. However, you can determine a group of internal determinants that affect the level of liquidity risk regardless the form of liquidity risk measure and the country of operation. These determinants include the efficiency ratio estimated as the value of the margin, the level of credit risk, and the interbank market engagement. Macroeconomic determinants affect with different strength and direction the level of liquidity risk. A significant difference in terms of relation being diagnosed accounted for the impact of the weighted average interest rates for O/N deposits of unsecured interbank deposits market on liquidity risk.

The performed estimation indicates that the interbank market interest rate in the old EU countries clearly have an impact on the level of liquidity. The positive relation between the actual increase in the interest rate for O/N deposit transactions in the unsecured interbank deposit market and the increase in the level of liquidity in the banks operating in the old EU means that the increase in interest rates encouraged banks to increase money market engagement. On the other hand, in countries belonging to the group of the new EU the increase in this rate is not identical to the total increase in liquid assets.

In countries belonging to the so-called new Union a relation between short-term fluctuations in the interbank market interest rate and the level of liquidity held by individual banks was not confirmed. Therefore, it seems that the increase in the O/N interest rates in the interbank markets of the new EU countries does not increase the liquidity level in the short term, which may mean that banks conduct a long-term strategy for the liquid assets portfolio construction, which does not aim at short-term profit maximization. However, the verification of this conclusion requires further study.

The diagnosed relationship between the short-term interbank market interest rate and the level of liquidity of individual banks may be important for the authorities responsible for the implementation of monetary policy, because central banks implementing monetary policy in terms of price stability and inflation target use a comprehensive package of monetary policy instruments. Central banks therefore affect the level and structure of interest rates as well as include in their operational goals short-term market interest rates on a defined target level favourable to attain its strategic goals. It seems, therefore, that indicating a relation between the interbank market interest rate and the level of liquidity held by commercial banks or lack of it, is crucial in terms of monetary policy implementation.

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