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Determinants of Polish Co-operative Banks' Financial Liquidity in the Post-Crisis Perspective*

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Abstract

The paper aims to identify financial liquidity determinants of cooperative banks in Poland in the period of 2008 until 2017. Our research paper reviews pre-crisis and post-crisis regulations in the area of financial liquidity of banks and discusses the research results regarding liquidity determinants of banks that are available in the literature. In order to analyze the liquidity determinants of cooperative banks, we collected panel data of 350 cooperative banks operating in Poland. The results showed that the level of cooperative banks' short-term financial liquidity depends on the level of banking market concentration, credit policy, solvency ratios, revenue structure, and quality of credit exposures. However, long-term financial liquidity is affected by GDP dynamics (for large banks), banking market concentration, interest rates, profitability, and cost efficiency. Additionally, long- term liquidity- for small and medium-sized banks – depends also on capital adequacy ratio and NPL ratio.

1. Introduction

Liquidity risk is inseparably connected with the bank's function as financial intermediary, which transforms liquid liabilities (deposits) into illiquid receivables (loans) (Diamond and Dybvig, 1983). Some studies indicate that the role of banks in creating liquidity contributes to economic growth. Moreover, financial crisis did not eliminate this effect (Fidrmuc et al., 2015).

Before the financial crisis of 2007-2009, the liquidity risk was the most often considered as the risk of minor importance (Matz and Neu, 2007). The interest in the subject results mainly from treating this risk category as an independent variable affecting the banks' profitability (it was estimated, among others, examining volume of the margin generated by banks) (Wójcik-Mazur and Szajt, 2015). However, more attention was paid to the serious effects of liquidity risk after crisis 2007 (Jenkinson, 2008). Many studies show that liquidity shocks constitute one of the most important determinants of the decline bank lending activity (Kapounek, 2017).

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Many banks, both in the world and in Poland, encountered difficulties in the area of liquidity risk measurement and management, despite their satisfactory capital position.

With the accompanied risks, such as market risk and financial risk, those problems have contributed to the emergence of systemic phenomena. Crisis escalation caused rapid increase in interest rates on the interbank market, shorter deadlines for interbank transactions and reduction of limits for exposures to individual entities. All that led to an increase in financing costs, difficulties in managing liquidity and risk hedging (Kil, 2017).

The appearance of new, global regulations in the area of financial liquidity[1] (BIS, 2008; Moore, 2009) and liquidity risk is an additional effect of the crisis[2]. Significant changes to the Basel Committee on Banking Supervision regulations were introduced by implementing Basel III solutions. Their impact on the banking sector and the economy is widely discussed in the literature (e.g. Fidrmuc, Lind 2020). The most important changes consisted of implementation quantitative standards in the area of short- and long-term liquidity of banks, i.e. the Liquidity Coverage Requirement (LCR) and the Net Stable Funding Requirement (NSFR).

In Poland, first rules regarding liquidity risk were introduced by the Polish Financial Supervision Authority (KNF). They were binding liquidity standards for all banks and were based on supervisory liquidity measures. Construction of these measures depends on the size of the bank. Also Basel Committee on Banking Supervision introduced quantitative standards in the field of short- and long-term liquidity of banks (BIS, 2008)[3]. Polish liquidity regulations incorporate the principle of proportionality, including a distinction of requirements for small, medium and large banks. Cooperative banks in Poland were mostly covered by regulations concerning small- and medium-sized entities due to the relatively small average scale of operations.

Cooperative banks are special type of credit institutions that are subject to both banking and cooperative law. They are financial institutions that perform social activities apart from economic functions. Cooperative banks constitute also major element of Polish banking sector. At the end of 2017, 553 cooperative banks operated in Poland. 551 of them were a member of two associations: *Bank Polskiej*

[1] There are various definitions of financial liquidity in the literature. In particular, the definition of the Basel Committee for the International Settlements Supervisory Committee should be noted. It indicates that the bank's liquidity is its ability to finance asset growth and meet obligations that become due, without accepting unacceptable losses (BIS, 2008). In some definitions, attention is put only to the assets of financial institutions, defining liquidity as the ability of a financial institution to convert assets into cash without any obstacles (Moore, 2009).

[2] There were supervisory regulations regarding liquidity in the pre-crisis period (up to 2008), and they were usually in the form of national regulations, e.g. supervisory liquidity standards in Poland - discussed further in the third part of our article.

[3] Besides national liquidity standards, Basel Committee on Banking Supervision developed liquidity management principles in the bank and control principles of this process in 2008. Those rules emphasis the need for banks to develop an individual liquidity management system. It should be tailored to their specificity, and comprise a set of indicators, which constitute early warning measures and tools for identifying vulnerabilities in the liquidity risk management system.

Spółdzielczości (BPS SA) or *Spółdzielcza Grupa Bankowa* (SGB-Bank). Two cooperative banks operated unassociated. Those numbers represented almost 90% of the total number of banks, that operate in Poland. Cooperative banks have a relatively small share in the Polish banking sector (they possess less than 10% of banking assets, loans and deposits from the non-financial institutions). Cooperative banks in Poland are not organizationally and financially well connected. Banks within the same association are neither required to issue consolidated financial statements nor guarantee each other's obligations. The role of the affiliating bank is generally limited to clearing activities. The scope of operations of individual cooperative banks often overlaps, thereby pushing them to compete in their local markets (Kozłowski, 2018). Despite the small market share, cooperative banks in Poland play a significant stabilizing role. This was particularly evident through the maintenance of lending activity during the 2007-2009 crisis (Kil and Miklaszewska, 2017).

The literature presents many research results, which justify the implementation of supervisory liquidity standards (Flotyński, 2017). Previous researches on this subject proved that well balanced funding positions of bank (a higher value of long-term deposits and a smaller liquidity gap) realistically make the risk of bank bankruptcy lower (Bologna, 2016), as well as increases bank's stability (Diamond and Kashyap, 2016). The results have additionally drawn attention to the fact that introduction of the LCR and NSFR standards before crisis 2008, would have resulted in lower level of liquidity among the euro area banks (in detail concerning 32 and 110 billion euros, respectively in the case of LCR and NSFR) (Hoerova et al., 2018).

The aim of this article is to present an empirical analysis of the liquidity[4] determinants of cooperative banks in Poland between 2008-2017. This article operates under inclusion of macroeconomic factors such as gross domestic product, interest rates, concentration of the market and microeconomic characteristics of the bank such as return on assets (ROA), size of the bank, share of deposits, structure of sources of financial profit, capital adequacy ratio (CAR). This analysis provides conclusions on the relationship between banks' liquidity and macroeconomic and microeconomic characteristics. The newly gathered results may provide information that can have implications for management of banks. More accurately concerning the impact on individual factors that allow the maintenance of an adequate liquidity. This shall be at least in line with the minimum supervisory standards.

2. Methodology and Data

The following studies have been conducted with the goal to assess determinants of cooperative banks' financial liquidity. Unit data were obtained from BPS S.A. Association, the Cooperative Banks' Financial Audit Association (ZRBS), Center for Banking and Information Law and the financial statements of banks. The

[4] Supervisory liquidity ratios (M1, M2, M4), presented by the Polish Financial Supervision Authority, were used in this study.

research period covered the years 2008-2017 and was conditioned by the availability of reporting data.

As of December 2017, 350 cooperative banks have been operating under the BPS Association SA. These credit institutions were included in the scope of the research. No mergers and acquisitions took place during the time span of 2008 – 2017 in these particular banks. At the end of 2017, banks covered by the analysis accounted for 60.8% of the number of cooperative banks operating in Poland, and the value of their assets constituted 59.2% of the assets of the cooperative banking sector[5].

The analyzed credit institutions were divided into two groups: large cooperative banks and medium and small cooperative banks. Large cooperative banks possess assets over PLN 200 million (108 entities), while the value of medium and small bank assets does not exceed PLN 200 million (242 entities). This division was dictated by the scale of operations as of December 31, 2017 and this distinction was conditioned also by the national liquidity regulations.

In order to perform the analysis, the type and scope of the available data have to be taken in consideration (micro-panel data, resulting from the combination of time series observations for cross-sectional units - banks). The dynamic panel model was employed- Generalized Method of Moment- commonly referred to as GMM, in the GMM-SYS version (Blundell and Bond, 1998). GMM models are considered to be useful in financial research, particular in studies regarding banking (Andreß, Golsch and Schmidt-Catran, 2013). One of the advantages of this method is the deviation from the standard assumption of strict exogeneity of regressors. It enables taking into account the lagged values of the dependent variable, what is infeasible in the case of statistical panel models (with fixed effects and individual random effects) (Kozłowski, 2016). Methods, which are based on GMM, are therefore particularly useful for models including endogenous or predetermined explanatory variables (Dańska-Borsiak, 2009). Moreover, small research sample (2,148 observations[6]) constitutes also a factor, which conditions the use of the GMM-SYS model (Bond, 2002). The GMM-SYS estimator can produce more reliable and accurate results in similar cases (Baltagi, 2005). Statistical inference within the scope of significance of the model's parameters has been carried out based on the 1-step estimate. 2-step method could lead to erroneous conclusions, especially in the case of heteroscedasticity of the random component (Blundell and Bond 1998). For diagnostic purposes, the Sargan test for the 2-step method was used (Hansen test), as well as Arellano-Bond autocorrelation tests for first differences: AR (1) and AR (2).

The final shape of the estimated dynamic models of regression is given by the equation:

$$FL_{it} = const + a_1 FL_{it-1} + a_2 MACRO.VAR_{i(t,\,t-1)} + a_3 MICRO.VAR_{i,t} + v_{it} \qquad (1)$$

[5] Due to the lack of permission of SGB-Bank SA for providing individual data, it was not possible to include other entities in the analyses.

[6] Three cooperative banks were removed from the analyses because of missing data.

where: FL - measure of financial liquidity; MACRO.VAR - the vector of values of macroeconomic variables in period t or t-1; MICRO.VAR - a vector of control variables characterizing the specific operation of a particular cooperative bank in the period t; v_{it} -the random component, which is the sum of the individual, unchanged in time effect and the pure random error ε.

All control variables were applied in the model, because they can be endogenous. What is also important, only one lag of each endogenous variable was used in the GMM estimations. Time effects are included as exogenous instruments. National regulatory liquidity standards serve as measurement of banks' financial liquidity. Information about those measurements contains Table 1.

Table 1 Characteristics of Explained Variables Used in the Panel Survey

Explained variable	*Description*	*Data source*
M1	The share of the main and additional liquidity reserves in total assets; banks with a balance sheet total of up to PLN 200 million. Short-term liquidity gap - banks with total sum of balance sheet above PLN 200 million.	Data from BPS S.A., ZRBS for cooperative banks
M2	The coverage ratio of illiquid assets with own funds; banks with a balance sheet total of up to PLN 200 million. Short-term liquidity ratio - banks with total sum of balance sheet above PLN 200 million.	Data from BPS S.A., ZRBS for cooperative banks
M4	The coverage ratio of illiquid assets and assets with limited liquidity with own funds and stable external funds; banks with a balance sheet total above PLN 200 million	Data from BPS S.A., ZRBS for cooperative banks

Notes: Indicators and their construction are discussed in Chapter 4. Measurement of liquidity risk in banks in the light of domestic and international supervisory regulations.

Source: Own presentation.

A review of the literature and previous studies on this matter formed the basis to selection of explanatory variables. Correlation matrix (Table A1 in the Appendix 1) identifies a set of variables characterized by a strong correlation. For instance, GDP dynamics remained strongly correlated with the inflation rate in the region. ROA was strongly correlated with ROE, SIR was correlated with LIR and solvency ratio remained strongly correlated with CAR (equity/assets). Therefore, a number of modeling attempts have been made by replacing strongly correlated variables and by taking into account the Akaike Information Criterion. The basic model with the best fit was chosen[7].

[7] Selected variables that proved to be irrelevant in all created models (e.g. the share of non-financial sector deposits in total sources of financing - DEP_A and GDP per capita for the administrative districts of Poland, in which the bank has a dominant or sole activity - GDP_PC) were completely excluded from the analyses. Other variables characterized by a significant correlation were used to test model stability (robustness check) - see point 5.4.

Table 2 includes the description of the variables that were employed in the study, as well as the information on previous publications. The previous studies confirm the banks' financial liquidity determinants.

Table 2 Characteristics of Independent Variables Used in Panel Study

Variable	*Description*	*Data source*	*Previous research*
		Macroeconomic / regional characteristics	
HHI	Herfindahl-Hirschman Index for Poland - a measure of concentration of the banking sector (no access to data on concentration measurement in administrative districts of Poland)	EBC – Consolidated Banking Data: https://www.ecb.europa.eu/stats/supervisory_prudential_statistics/consolidated_banking_data/html/index.en.html (available: 16/06/2018)	Lei and Song (2013) Horvath et al. (2016) Berger and Bouwman (2009)
ΔGDP	GDP growth rate in annualized terms for the administrative districts of Poland, in which the bank has a dominant or sole activity - a measure of the rate of economic growth	GUS Local Data Bank - Regional accounts: https://bdl.stat.gov.pl/BDL/dane/podgrup/temat (available: 17/12/2018)	Aspachs et al. (2005) Chen and Phuong (2013) Vodova (2012) Dinger (2009) Bhati et al. (2015) Choon et al. (2013) Moussa (2015)
SIR	Three-month short-term interest rate on the interbank market - a measure of the financing cost in the interbank market	ECB: http://sdw.ecb.europa.eu/browse.do?node=9691124 (available: 17/12/2018)	Lucchetta (2007) Moore (2010) Vodova (2013)
		Microeconomic characteristics	
LG_A	The logarithm of bank's total assets in fixed prices from 2004 - a measure of the size of bank	Own calculations based on data from BPS S.A., ZRBS, CPBiI, Orbis	Bonfim and Kim (2012) Bonner et al. (2013) Alger and Alger (1999) Dinger (2009) Choon et al. (2013) Kashyap et al. (2002) Singhn and Sharma (2016)
ROA	Average return on assets - a measure of profitability	Data from BPS S.A., ZRBS, CPBiI, Orbis	Vodova (2013) Lartey et al. (2013) Singhn and Sharma (2016)
C_I	Cost-to-income ratio - measure of cost effectiveness	Data from BPS S.A., ZRBS, CPBiI, Orbis	Bonfm and Kim (2014)
L_A	Share of loans in total assets - a measure of bank's credit exposure	Data from BPS S.A., ZRBS, CPBiI, Orbis	Cucinelli (2013) Bonfm and Kim (2014) Lucchetta (2007)
NIBP_TP	Relation of bank's profit from non-interest-bearing activities to bank's total profit - characteristics of bank's business model	Own calculations based on data from BPS S.A., ZRBS, CPBiI, Orbis	Lucchetta (2007)
NPL	Share of impaired loans in bank's total loan portfolio	Data from BPS S.A., ZRBS, CPBiI, Orbis	
TCR	Total Capital Ratio- bank's stability measure based on bank's solvency in a broad sense	Data from BPS S.A., ZRBS, CPBiI, Orbis	Singhn and Sharma (2016) Vodova (2012) Vodova (2013) Tseganesh (2012)

Source: Own presentation.

3. Literature Review

Literature emphasizes that the bank's liquidity is the result of micro- and macroeconomic factors. Microeconomic factors include bank-specific liquidity determinants, that are partially or fully controlled by the bank's management. While macroeconomic factors are external factors, over which the bank's management has no control (Singh and Sharma 2016, Bonner et al., 2015).

Studies regarding impact of the bank's size on banks financial liquidity have shown diverse results. A positive relationship (with 99% significance) between the size of the bank and its liquidity was confirmed by D. Bonfim and M. Kim and V. Dinger in research on five hundred largest banks in Europe and South America in the pre-crisis period (2002-2009) (Bonfim and Kim, 2012; Dinger 2009). Choon, Hooi, Murthi, Yi and Shven presented different results. They confirmed significant negative relationship between the bank's size and its liquidity (Choon et al., 2013). Additionally, Horváth et al., who examined the relationship between the size of the bank's capital and financial liquidity, verified that small banks with high value of capital were characterized by lower liquidity, while large banks with excessive value of capital had greater liquidity (Horváth et al., 2014).

Another studies on this subject include a group of 686 banks, that operate in the OIC countries between 1989-2008. Authors confirmed the negative impact of capital ratio, share of foreign owners, credit risk, inflation rate, and restrictive monetary policy on banks' liquidity. However, the efficiency, bank size, scale of off-balance sheet items, market capitalization and concentration showed a positive impact on banks' liquidity (Al-Harbi, 2017).

Many studies, regarding stability of supervisory liquidity standards (LCR and NSFR), confirm that the bank's profile, its size, asset quality and capitalization are perceived as important determinants of banks' liquidity. Furthermore, bank's liquidity determinants also include: bank's business profile, size, asset quality and capitalization as major determinants of their financial liquidity (Cucinelli, 2013).

After the financial crisis of 2008, particular attention has been paid to the relationship between liquidity and the profitability, and between liquidity and solvency of banks. Temporary liquidity deficit on the interbank market constitute additional cost of living for bank and make continuation of the bank's operations more difficult. It was especially visible in 2008 through so-called deposit wars. In this time deposit rates significantly exceeded those from lending activities (Niedziółka, 2015).

The literature also emphasizes the negative impact of changes in post-crisis liquidity regulation on the profitability of the bank's operations. On the one hand, this results from the need to ensure a high value of A_{HQL} assets (which are characterized by relatively lower profitability in relation to loans), on the other hand, from higher cost which arises from the need to finance operations using long-term deposits and debt securities. At the same time, in order to maintain their current level of profitability, banks must improve rate of return on other assets. This will further cause an increase in risk (especially in the area of credit risk) and consequently also

in capital requirements. Deterioration of the bank's solvency may be noticeable as result of those actions (Marcinkowska et al., 2014).

There are a few studies on the liquidity of banks, that operates in Poland. Most of them include only commercial banks and the pre-crisis period or the beginning of the crisis. Vodova (2013) carried out studies regarding commercial banks in Poland in 2001-2010. She showed that banks' liquidity was strongly dependent on the general economic situation and it deteriorated because of the financial crisis, economic slowdown and increase in unemployment rate. Vodova based her research on balance sheet liquidity ratios (liquid assets/total assets, liquid assets/deposits, loans/total assets, loans/deposits). The liquidity of Polish commercial banks was also adversely affected by increase in the interest margin and higher profitability of the bank. She also proved that liquidity decreases along with the size of the bank. The growth in capital adequacy, inflation rate, share of non-performing loans and level of interbank market interest rates in the analyzed period had a positive impact on the liquidity of commercial banks in Poland (Vodova, 2012; Vodova 2013).

Analyses devoted to liquidity determinants in the countries of Central and Eastern Europe comprise a separate group of studies. Polish banks play an important role in those analyzes. Roman and Sargu (2015) showed on the sample of 15 polish commercial banks that their liquidity was significantly dependent on the profitability of equity. The reasons for this were high expectations of shareholders regarding rates of return on investing capital (Roman and Sargu, 2015). Additionally, Patora (2013) in his research on financial liquidity determinants confirmed that there is a statistically significant relationship between bank's liquidity and changes in profitability, alternative cost, capitalization, market power or an unemployment rate. This study covered 21 largest banks from five Central and Eastern European countries, including Poland.

4. Measurement of Liquidity Risk in Banks in the Light of Domestic and International Supervisory Regulations

According to art. 8 of the Banking Act, banks are obliged to maintain payment liquidity adjusted to its size and type of business, in a manner, that ensures the meeting of all financial commitments in accordance with due dates (Banking Act, 1997).

To assess the liquidity risk, banks usually use ratios assigned to the following groups: firstly, measures of inflows and outflows mismatch in a given period. Secondly, bank's balance sheet structure resistance measures for liquidity tensions. Thirdly, measures describing the liquidity of assets. Fourthly risk measures related to the structure of the bank's financing sources. Fifthly, sensitivity measures describing the liquidity risk, and lastly measures that associate liquidity risk with other categories of risk.

The literature emphasizes the importance of regulatory instruments to reduce liquidity risk. The required reserve ratio (macroprudential instrument) and

loans/deposits ratio (micro-prudential tool) are considered as the classic supervisory liquidity measurements (Olszak and Świtała, 2018).

One of the first regulation in Poland, in the area of liquidity risk, was liquidity standards issued by the Polish Financial Supervision Authority (KNF, 2008). According to the regulation, banks' assets and liabilities are divided into various categories in line with their liquidity or stability. The bank's assets are divided into four basic categories, as follows: basic liquidity reserve (blr), additional liquidity reserve (alr), assets with limited liquidity (all), and illiquid assets (ia).

Blr includes: cash, receivables and other assets, which are possible to obtain within 7 days. Alr encompasses receivables and other assets, which are possible to obtain within 7 to 30 days. All comprises assets resulting from banking activities outside the wholesale financial market, and ia are assets not resulting from banking activities.

Banks' liabilities are divided into: core capital (cc), stable foreign funds (sff), and unstable foreign funds (uff).

CC is decreased by the amount of the capital requirements for market risk, the capital requirement for settlement risk and counterparty risk. Sff are funds, that the bank classifies as stable sources of financing, in particular a stable part of the deposit base. Sff encompasses also own securities, not included yet in own funds, other liabilities with maturity over 1 year, which the bank intends to maintain and other liabilities resulting from banking activities, whose acquisition and maintenance plan is approved by the Supervisory Board.

Based on the aforementioned categories, the Polish Financial Supervision Authority created supervisory short- and long-term liquidity standards - see Table 3.

Table 3 National Supervisory Liquidity Standards for Banks

Liquidity type	***The value of assets up to PLN 200 million.***	***The value of assets over PLN 200 million.***
short-term liquidity	(blr + alr) / assets ≥ 0,2 (M1)	(blr + alr) – uff ≥ 0 (M1) (blr + alr) / uff ≥ 1 (M2)
long-term liquidity	cc / ia ≥ 1 (M2)	cc / ia ≥ 1 (M3) (cc + sff) / (ia + all) ≥1 (M4)

Notes: (blr + alr) - uff - short-term liquidity gap (M1); (blr + alr) / uff - short-term liquidity ratio (M2); cc / ia – the coverage ratio of illiquid assets with core funds (M3); (cc + sff) / (ia + all) – coverage ratio of illiquid assets and assets with limited liquidity by own funds and stable external funds (M4).

Source: Own presentation.

According to art. 94 of the macro-prudential supervision over the financial system and crisis management in the financial system act, banks are required to comply with national liquidity standards, which are applicable until the bank reaches 100% of the LCR ratio. National long-term liquidity standards remain in effect until full implementation of the NSFR regulations.

Polish supervisory standards were similar to the indicators proposed in the Basel III and the CRDIV/CRR regulatory package. However, there are minor

differences between the LCR ratio and the Polish short-term liquidity measure. LCR does not take into account the received credit lines in its structure, wheras it is less restrictive, when we take into account the category of "wholesale" inflows. The long-term liquidity ratio, that is proposed in Basel III, is more restrictive than the Polish current long-term liquidity ratio (Lepczyński, 2013).

According to art. 138 of the Banking Law Act, the Polish Financial Supervision Authority has the power to impose an additional liquidity requirement on the bank. Firstly, this may occur, if the bank does not comply with supervisory liquidity standards due to the deteriorating liquidity situation of the bank. Secondly, it is possible, when extreme liquidity conditions occur, and the bank maintains an inappropriate level or improper liquidity surplus structure. Thirdly, if the bank has an inadequate structure and inadequate long-term financing stability (this cause a high level of liquidity risk in the bank's operations and its business model. And fourthly, in the event of obstacles to the flow of liquidity between entities in the group.

Due to the introduction of LCR requirements, the establishment of two institutions were promoted in Poland. These two protection systems are: IPS-SGB institutional protection scheme (it associates 196 banks) and IPS – BPS institutional protection scheme (it associates 292 entities). These protection schemes were established for two reasons. Firstly, cooperative banks could not classify deposits, that are hold in affiliating banks, as liquid assets. Secondly, affiliating banks can not consider deposits from cooperative banks as a stable source of financing.

According to the Polish Financial Supervision Authority, national liquidity standards are satisfactorily held by banks in Poland. The share of entities not complying with the regulations of the Polish Financial Supervision Authority did not exceed 0.2% in 2013-2017 (KNF, 2018a). The good situation concerning liquidity of Polish cooperative banks is confirmed by the levels of liquidity ratios. At the end of 2017, the LCR level for IPS BPS was 196%, and 264 % for IPS SGB . All cooperative banks that remain outside the institutional protection schemes or do not have permission to apply to the group standard have met individual LCR standards (KNF, 2018b).

5. Results

5.1 Liquidity Situation in the Analyzed Group

The values of the liquidity ratios M1, M2 and M4 vary slightly in the analyzed years (see Fig. 1 at the end). The average level of liquidity ratios significantly exceeded values required by the Polish Financial Supervision Authority in the analyzed period.

However, the analyzed group (banks associated in BPS) is characterized by large variation in the level of liquidity between various individual banks (Table 4). The lowest and the highest levels of M1 were recorded in 2014 - respectively 0.06 and 0.74. The lowest level of M2 was found in 2017 - -0.45 (the bank in recovery process), while the highest value in 2011 - 15,59. Regarding M4 indicator, the lowest value was recorded in 2009 - 0.51, and the highest in 2017 - 3.34.

Table 4 The Values of Cooperative Banks' Liquidity Ratios Between 2008-2017 (Cooperative Banks Associated in BPS)

YEAR	M1 – SMALL AND MEDIUM COOPERATIVE BANKS				M2 – SMALL AND MEDIUM COOPERATIVE BANKS				M4 – BIG COOPERATIVE BANKS			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
2008	0.343	0.098	0.180	0.730	3.429	2.068	1.020	10.89	1.221	0.213	0.970	2.040
2009	0.311	0.085	0.160	0.710	3.630	2.226	1.030	12.93	1.165	0.193	0.510	1.870
2010	0.314	0.081	0.190	0.710	3.733	2.330	1.010	13.05	1.259	0.228	1.030	2.080
2011	0.320	0.083	0.200	0.700	3.645	2.231	0.980	15.59	1.276	0.243	1.050	2.170
2012	0.319	0.080	0.200	0.640	3.409	1.865	0.990	11.19	1.266	0.196	1.020	1.880
2013	0.345	0.086	0.200	0.630	3.577	1.942	0.970	12.59	1.300	0.241	1.010	2.310
2014	0.382	0.109	0.060	0.740	3.522	1.951	0.980	12.27	1.303	0.231	1.020	2.290
2015	0.372	0.102	0.200	0.700	3.644	1.936	1.010	10.17	1.329	0.254	1.060	2.700
2016	0.408	0.104	0.200	0.730	3.346	1.744	0.810	10.30	1.463	0.316	1.110	2.980
2017	0.396	0.103	0.220	0.710	3.401	1.790	-0.45	10.16	1.545	0.342	1.170	3.340

Source: Own study based on data from BPS S.A. association.

5.2 Determinants of Financial Liquidity of Cooperative Banks in the Analyzed Group

Based on the methodology presented in section 2, we carried out panel studies, the results of which are presented in Table 5.

The results confirm that the value of financial liquidity ratios of cooperative banks in Poland in the next period is strongly dependent on the levels of these variables in the previous period.

The macroeconomic indicators showed positive relation between GDP growth for the region and long-term liquidity for large cooperative banks. The negative impact of HHI concentration index on the value of short-term liquidity ratio (M1) was confirmed for the group of small- and medium-sized banks. The opposite impact direction of the HHI index relates to the long-term liquidity for all groups of the analyzed credit institutions.

Similarly, negative relation between market short-term interest rates and the long-term liquidity indicators has been proved for small- and medium-sized cooperative banks (M2 ratio) and for large banks (M4 ratio). This indicates that the Central Bank may improve the liquidity of cooperative banks, by easing its monetary policy. This could be done through the long-term interest rate channel.

Table 5 Determinants of Polish Cooperative Banks' Financial Liquidity Between 2008-2017

Explained variable	*Financial Liquidity*		
	M1 small and medium cooperative banks	***M2 small and medium cooperative banks***	***M4 big cooperative banks***
Lagged value of dependent variable (-1)	0.192***	0.895***	0.829***
	(0.050)	(0.054)	(0.100)
const	0.484***	1.324	1.109***
	(0.151)	(1.588)	(0.391)
HHI	2.443***	-37.054***	-8.097***
	(0.939)	(8.299)	(2.616)
ΔGDP (-1)	-0.001	0.009	0.005**
	(0.001)	(0.010)	(0.002)
SIR	-0.005	-0.164***	-0.005***
	(0.004)	(0.037)	(0.002)
LG_A	-0.008*	0.037	0.006*
	(0.005)	(0.057)	(0.003)
C_I	-0.000	-0.007*	-0.002***
	(0.000)	(0.005)	(0.001)
ROA	-0.005	0.202***	0.018**
	(0.005)	(0.070)	(0.005)
L_A	-0.003***	0.001	-0.004***
	(0.001)	(0.002)	(0.001)
NIBP_TP	-0.001***	0.001	0.001
	(0.000)	(0.001)	(0.001)
TCR	0.001*	0.014***	0.000
	(0.000)	(0.006)	(0.003)
NPL	0.002***	-0.007*	0.001
	(0.000)	(0.004)	(0.001)
Number of observations	1913	2148	509
Number of banks	240	240	107
Number of instruments	47	56	56
Test AR (1)	-9.299 [0.000]	-5.781 [0.000]	-3.145 [0.001]
Test AR (2)	1.122 [0.262]	1.209 [0.227]	1.491 [0.136]
Hansen test	159.884 [0.126]	499.815 [0.164]	111.088 [0.157]
Wald test	661.345 [0.000]	5703.41 [0.000]	1599.3 [0.000]

Notes: AR (1) – 1st order autocorrelation test. AR (2) – 2nd order autocorrelation test. Robust standard errors in parentheses and p-values in brackets. Time effects are included but not reported. System GMM (1 lag used as instrument).Variables M1, M2, M4 as defined in Table 4.

Source: Own estimation.

Among the microeconomic factors, special attention should be paid to the relationship between the size of the bank and its financial liquidity. The results of the study confirmed the negative impact of the bank's size on its short-term financial liquidity (M1 indicator) in the group of small- and medium-sized cooperative banks. These results remain consistent with the conclusions from surveys on US banks. DeYoung and Jang (2016) proved that small banks could faster adopt required liquidity level than banks classified as systemically important. At the same time, they also confirmed that the long-term liquidity ratios of large cooperative banks are characterized by the highest values of the M4 indicator.

In addition, the significant impact of bank profitability (measured by ROA) on the M2 indicator is noticeable. However, the relationship between M2 indicator and cost effectiveness (C / I indicator) is negative. Above that, substantial negative impact of cost-effectiveness on the long-term liquidity of Polish large cooperative banks can also be observed. These results confirmed fact, that higher profitability of bank cannot always be connected with reductions in liquidity (e.g. by purchasing illiquid assets). On the contrary, better financial results can contribute to improved liquidity.

The obtained results also showed that short-term and long-term financial stability of small and medium cooperative banks is also affected by solvency level. This relation has positive character, therefore bank, that posses higher total capital ratio, have also higher value liquidity ratios (M1 and M2 ratios).

Moreover, there is a negative significant impact of the ratio of loans to the non-financial sector in total assets on short-term liquidity of small and medium cooperative banks, and positive impact on long-term liquidity (M2 for small and medium-sized entities and M4 for big cooperative banks). Therefore, the supervisors' concerns are justified that the new post-crisis liquidity regulations may discourage banks from lending to the non-financial sector.

Regarding the NIBP_TP indicator, only its positive impact on the level of short-term financial liquidity (M1) of small and medium cooperative banks in Poland was confirmed. In the case of long-term liquidity ratios, the negative impact of credit quality on banks liquidity is intuitively obvious (better credit quality should improve the bank's ability to pay its liabilities in a timely manner). Regarding short-term liquidity, the impact is positive and therefore surprising. A possible explanation of this phenomenon could be the fact, that cooperative banks with poorer credit exposure, tend to minimize the loan portfolio. At the same time, having a significant deposit base, they use those funds to invest in financial instruments with a high liquidity, but lower income rate.

5.3 Additional Robustness Analyses

Impact of the 2007 crisis on the financial results of banks, and numerous interventions of the National Bank of Poland aimed at maintaining the liquidity of the banking system (in the form of fine-tuning operations in the years 2008–2010), contributed to the decision to extend previous analyzes. Analyzes regarding the

model stability were added to the study (excluding the period 2008-2010, i.e. only in the post-crisis period). The results of the analyzes are presented in Table 6.

Table 6 Liquidity Determinants Polish Cooperative Banks (Only Post-Crisis Period)

	Financial Liquidity		
Explained variable	***M1 small and medium cooperative banks***	***M2 small and medium cooperative banks***	***M4 big cooperative banks***
Lagged value of dependent variable (-1)	0.105***	0.828***	0.920***
	(0.024)	(0.073)	(0.096)
const	0.628***	1.206	0.564***
	(0.177)	(1.662)	(0.186)
HHI	2.200**	−32.616***	−5.260**
	(1.060)	(8.196)	(2.592)
ΔGDP (-1)	−0.001	−0.014	0.007**
	(0.001)	(0.012)	(0.003)
SIR	−0.005	−0.128***	−0.039***
	(0.004)	(0.038)	(0.011)
LG_A	−0.012*	0.042	0.015*
	(0.006)	(0.061)	(0.008)
C_I	−0.000	-0.010**	−0.002***
	(0.000)	(0.004)	(0.001)
ROA	0.009*	0.264***	0.028***
	(0.004)	(0.069)	(0.010)
L_A	−0.003***	0.001	−0.003**
	(0.000)	(0.002)	(0.001)
NIBP_TP	−0.001***	−0.008	0.002
	(0.000)	(0.006)	(0.002)
TCR	0.001*	0.017**	−0.001
	(0.001)	(0.007)	(0.004)
NPL	0.002***	−0.008*	−0.001
	(0.001)	(0.006)	(0.002)
Number of observations	1210	1445	507`
Number of banks	240	240	107
Number of instruments	24	56	56
AR (1)	-7.564 [0.000]	-6.919 [0.000]	-3.005 [0.003]
AR (2)	1.447 [0.164]	1.097 [0.361]	1.011 [0.294]
Hansen test	70.678 [0.149]	272.63 [0.138]	45.136 [0.257]
Wald test	565.801 [0.000]	2144.79 [0.000]	1005.36 [0.000]

Notes: AR (1) – 1st order autocorrelation test. AR (2) – 2nd order autocorrelation test. Robust standard errors in parentheses and p-values in brackets. Time effects are included but not reported. System GMM (1 lag used as instrument). Variables M1. M2. M4 as defined in Table 4.

Source: Own presentation.

The obtained results show that there was no significant impact of the crisis 2008-2009 on the determinants of financial liquidity in the case of Polish cooperative banks. The results presented by this model remain qualitatively consistent with the results of the base model (Table 5). This confirms the fact that the liquidity of Polish cooperative banks, thanks to their nature (location, strong deposit base, independence from the impact of the interbank market), remained almost insensitive to the effects of the latest financial crisis (observed in Poland in 2008-2010).

Finally, to examine the stability of the original model, the authors also attempted to estimate various modifications of the model. For this purpose alternative variables, which showed a strong correlation with other exogenous variables, were used. Instead of the ROA variable, the ROE variable was adopted alternatively, the short-term interest rate (SIR) was replaced by the long-term rate (LIR), and the total capital ratio (TCR) was replaced by the equity / asset ratio (CAR). The characteristics of the variables are presented in Table 7.

Table 7 Characteristics of Additional Independent Variables Used in Panel Study

Variable	*Description*	*Data source*
	Macroeconomic characteristic	
LIR	Interest rate for long-term treasury debt securities - a measure of the country's risk and the long-term cost of capital	ECB: http://sdw.ecb.europa.eu/browse.do?node=9691124 (available: 17/12/2018)
	Microeconomic characteristics	
ROE	Average return on equity - a measure of profitability	Own calculations based on data from BPS S.A., ZRBS, CPBiI, Orbis
CAR	The logarithm of the bank's total assets in fixed prices from 2004 - a measure of bank size	Own calculations based on data from BPS S.A., ZRBS, CPBiI, Orbis

Source: Own presentation.

At the same time, the dummy variable C (Crisis) was introduced into the model, which takes the values 1 in 2008-2010 and 0 in the remaining period covered by the analysis. The results of the estimation are presented in Table 8.

The conclusion from the modification of the model is as follows: after having introduced new variables to the model, there was no change in the interpretation of previous results. Other results remain qualitatively the same, which confirms our conclusions - see Table 7.

Table 8 Estimation Results with Selected Alternative Variables

Explained variable	*M1*				*M2*				*M4*			
	(1)	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*
Lagged value of dependent variable (-1)	0.204***	0.203***	0.204***	0.212***	0.870***	0.869***	0.869***	0.867***	0.870***	0.864***	0.874***	0.829***
	(0.048)	(0.049)	(0.049)	(0.050)	(0.062)	(0.057)	(0.062)	(0.058)	(0.098)	(0.100)	(0.099)	(0.101)
const	0.499***	0.301**	0.506***	0.661***	−1.690	0.226	−1.709	−0.626	0.815***	0.539*	0.824***	1.243***
	(0.150)	(0.139)	(0.150)	(0.152)	(1.478)	(1.326)	(1.468)	(1.494)	(0.247)	(0.314)	(0.246)	(0.314)
HHI	4.401***	4.063***	4.350***	2.864***	−9.316**	−22.95**	−8.322**	−16.70**	−3.867**	−3.475**	3.995*	−6.977***
	(0.974)	(0.960)	(0.975)	(1.030)	(3.575)	(9.595)	(4.564)	(8.634)	(1.368)	(1.488)	(2.376)	(2.501)
ΔGDP (-1)	−0.000	−0.001	-0.000	0.000	−0.015*	−0.017	−0.014*	−0.003	−0.000	−0.000	−0.000	0.004*
	(0.000)	(0.001)	(0.001)	(0.001)	(0.008)	(0.007)	(0.008)	(0.009)	(0.002)	(0.002)	(0.002)	(0.002)
SIR				−0.007*				−0.111***				−0.045***
				(0.004)				(0.037)				(0.010)
LIR	0.001	0.001	0.001		−0.073**	−0.098**	0.073**		−0.029***	−0.027***	−0.028***	
	(0.003)	(0.003)	(0.003)		(0.034)	(0.042)	(0.034)		(0.011)	(0.010)	(0.010)	
LG_A	−0.015**	−0.007	−0.016**	−0.018***	0.127**	0.061	0.127**	0.093	0.010	0.019	0.010	0.000
	(0.006)	(0.006)	(0.007)	(0.007)	(0.059)	(0.052)	(0.059)	(0.060)	(0.010)	(0.012)	(0.010)	(0.011)
C_I	-0.000	-0.000	−0.000	−0.000	0.005*	0.005	0.006*	0.005	−0.003***	−0.002***	−0.003***	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.005)	(0.003)	(0.005)	(0.001)	(0.001)	(0.000)	(0.001)
ROE	-0.001	0.000		−0.000	0.018**	0.018**		0.0193***	0.002**	0.002*		0.001*
	(0.001)	(0.001)		(0.001)	(0.008)	(0.008)		(0.007)	(0.001)	(0.001)		(0.001)
ROA			−0.006				0.163**				0.027**	
			(0.004)				(0.071)				(0.011)	
L_A	-0.003***	-0.003***	-0.003***	−0.003***	−0.004*	0.003	−0.004*	−0.003*	−0.004***	−0.004***	−0.004***	−0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
NIBP_TP	-0.001**	-0.001**	-0.001**	−0.001**	−0.005	−0.003	−0.005	−0.005	0.000	0.001	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	(0.005)	(0.005)	(0.005)	(0.001)	(0.001)	(0.001)	(0.001)

Table 8 Estimation Results with Selected Alternative Variables - Continued

Explained variable	*M1*				*M2*				*M4*			
	(1)	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*
TCR		0.001*				0.023***				−0.000		
		(0.001)				(0.007)				(0.003)		
CAR	0.000		5.306	−0.000	0.045**		0.035*	0.044**	−0.006		−0.004	−0.006
	(0.001)		(0.001)	(0.001)	(0.019)		(0.019)	(0.018)	(0.004)		(0.003)	(0.004)
NPL	0.002***	0.002***	0.001***	0.002***	−0.009**	−0.008**	−0.007*	−0.008**	0.002	0.002	0.001	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.003)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)
C	0.002	0.002	0.002	−0.000	0.355***	0.338***	0.349***	0.266***	0.064*	0.062**	0.064*	0.025
	(0.005)	(0.005)	(0.005)	(0.005)	(0.077)	(0.075)	(0.077)	(0.088)	(0.026)	(0.027)	(0.025)	(0.022)
Number of observations	1913	1913	1913	1913	2148	2148	2148	2148	507	507	507	507
Number of banks	240	240	240	240	240	240	240	240	107	107	107	107
Number of instruments	47	47	47	47	56	56	56	56	56	56	56	56
AR (1)	-9.349	-9.323	-9.248	-9.320	-6.025	-5.897	-5.994	-5.883	-3.109	-3.183	-3.110	-3.062
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]	[0.001]	[0.002]	[0.001]
AR (2)	1.002	0.903	1.012	1.193	1.750	1.721	1.759	1.517	1.398	1.392	1.386	1.453
	[0.405]	[0.486]	[0.403]	[0.283]	[0.112]	[0.099]	[0.107]	[0.099]	[0.162]	[0.164]	[0.166]	[0.146]
Sargan test (two-step)	165.464	161.407	164.581	162.276	467.351	464.461	465.193	450.795	130.139	131.467	129.725	106.004
	[0.217]	[0.243]	[0.212]	[0.224]	[0.223]	[0.143]	[0.204]	[0.171]	[0.232]	[0.290]	[0.204]	[0.387]
Wald test	680.6	703.2	682.8	674.9	4219.8	4387.1	4344.6	4781.9	1726.3	1595.7	1727.9	1561.2
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: AR (1) – 1st order autocorrelation test. AR (2) – 2nd order autocorrelation test. Robust standard errors in parentheses and p-values in brackets. Time effects are included but not reported. System GMM (1 lag used as instrument).Variables M1. M2. M4 as defined in Table 4.

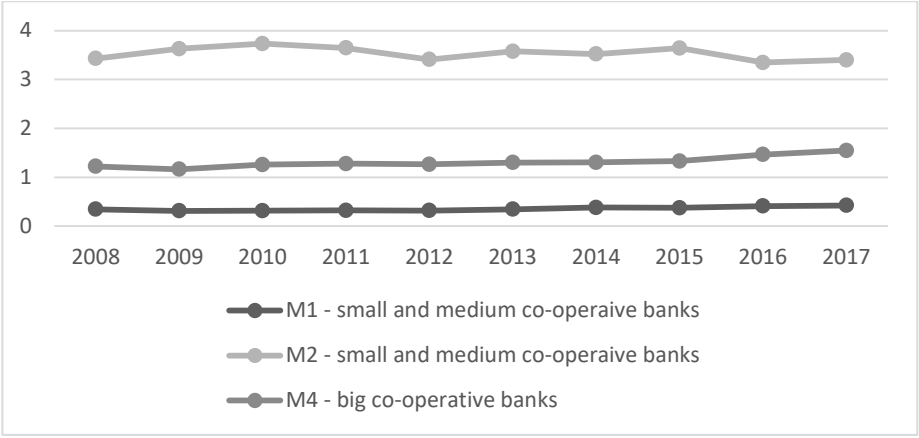
Source: Own calculations

6. Discussion and Conclusions

We review post-crisis liquidity developments of credit institutions and present the results on cooperative banks' liquidity determinants. The research confirmed satisfactory liquidity situation of cooperative banks in Poland, both in the area of short-term and long-term liquidity. Having applied panel research (which include 350 cooperative banks operating in Poland and affiliated to BPS SA), it has been shown that the level of short-term financial liquidity depends on the level of banking market concentration, credit policy, solvency ratios, revenue structure, and quality of credit exposures. Additionally, the study confirmed that long-term financial liquidity is affected by GDP dynamics (for large banks), banking market concentration, interest rates, profitability, and cost efficiency. Long-term financial liquidity of small- and medium-sized banks is also affected by capital adequacy ratio and NPL ratio. The results of the research are in line with previous analyses from other countries. These and previous studies may constitute major conclusions for monetary and supervisory policy. In the current economic situation caused by the coronavirus, cooperative banks in Poland may also face extraordinary difficulties in the area of liquidity management. Unlike the previous crisis (which concerned mainly the lack of interbank confidence), the current disturbances may be caused by the crisis of social relations on which cooperative banking is based.

APPENDIX

Figure A1 Average Values of Liquidity Ratios in The Analyzed Group of Cooperative Banks in 2008-2017



Source: Own presentation.

Table A1 Cross-Correlation Matrix

	M1	*M2*	*M4*	*ROE*	*NPL*	*NIBP_TP*	*DEP_A*	*K_A*	*C_I*	*CAR*	*ROA*	*L_A*	*TCR*	*HHI*	*CPI*	*GDP_PC*	*ΔGDP (-1)*	*SIR*	*LIR*
LIR	-0.28***	0.02	-0.24***	0.58***	-0.16***	-0.01	-0.57***	0.2***	-0.26***	0.01***	0.57***	-0.21***	-0.17***	-0.62***	0.95***	-0.35***	0.67***	0.89***	
SIR	-0.23***	0.00	-0.24***	0.63***	-0.15***	-0.09***	-0.55***	0.19***	-0.28***	0.04**	0.6***	-0.21***	-0.16***	-0.66***	0.94***	-0.33***	0.69***		
ΔGDP (-1)	-0.17***	-0.01	-0.15***	0.49***	-0.15***	0.05*	-0.43***	0.19***	-0.2***	-0.03	0.46***	-0.15***	-0.11***	-0.61***	0.71***	-0.21***			
GDP_PC	0.09***	-0.06***	-0.06	-0.27***	0.17***	0.07***	0.21***	-0.05***	0.13***	-0.05***	-0.29***	0.16***	0.01*	0.3***	-0.33***				
CPI	-0.27***	0.00***	-0.22***	0.59***	-0.14***	-0.06***	-0.56***	0.19***	-0.28***	0.00	0.57***	-0.19***	-0.17***	-0.61***					
HHI	0.29***	-0.01***	0.22***	-0.53***	0.11***	0.05*	0.59***	-0.17***	0.25***	-0.03***	-0.54***	0.19***	0.18***						
TCR	0.4***	0.55***	0.49***	-0.28***	-0.15***	-0.04	-0.26***	-0.47***	-0.09***	0.87***	0.16***	-0.57***							
L_A	-0.16***	-0.4***	-0.11	0.10**	0.31***	-0.01***	0.42***	0.15***	-0.06***	-0.68***	-0.3***								
ROA	-0.16***	0.35***	-0.19***	0.88***	-0.37***	-0.26***	-0.52***	0.21***	-0.62***	0.34***									
CAR	0.13***	0.55***	0.15*	-0.22***	-0.17***	-0.11***	-0.44***	-0.1***	-0.18***										
C_I	0.09***	-0.4***	-0.16***	-0.48***	0.02	0.43***	0.25***	-0.21***											
K_A	-0.52***	-0.1***	-0.73***	0.25***	0.00	-0.21***	-0.14***												
DEP_A	0.13***	-0.27***	0.29***	-0.28***	0.12***	0.09***													
NIBP_TP	0.02	-0.28***	0.08*	-0.17***	0.00														
NPL	0.10***	-0.15***	0.06	-0.27***															
ROE	-0.23***	0.01	-0.24***																
M4	X	X																	
M2	0.18***																		
M1																			

Notes: *** significance at the level of 1%, ** significance at the level of 5%, *significance at the level of 10%.

Source: Own calculations.

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