ISSN 1429-2939

4(65) 2016

BEZPIECZNY BANK

BEZPIECZNY BANK

4(65) 2016

BFG

BANK GUARANTEE FUND

SAFE BANK is a journal published by the Bank Guarantee Fund since 1997. It is devoted to issues of financial stability, with a particular emphasis on the banking system.

All articles published in “SAFE BANK” are reviewed.

All articles present the opinions of the authors and should not be construed to be an official position of BFG.

PUBLISHER:
Bank Guarantee Fund
ul. Ks. Ignacego Jana Skorupki 4
00-546 Warszawa

SECRETARY:
Ewa Teleżyńska, Małgorzata Polak
Telephone: 22 583 08 78, 22 583 05 74
e-mail: ewa.telezynska@bfg.pl; malgorzata.polak@bfg.pl

www.bfg.pl

DOM WYDAWNICZY ELIPSA

Typesetting and printing by:
Dom Wydawniczy ELIPSA
ul. Inflancka 15/198, 00-189 Warszawa
tel./fax 22 635 03 01, 22 635 17 85
e-mail: elipsa@elipsa.pl, www.elipsa.pl

Bezpieczny Bank
4(65)/2016

Małgorzata Olszak[*]
Iwona Kowalska[**]

DETERMINANTS OF LEVERAGE AND LIQUIDITY AND BANK SIZE – CROSS-COUNTRY STUDY

1. INTRODUCTION

In the current debate on macroprudential policy, the excessive procyclicality of leverage and liquidity risk in the banking sector have gained a lot of attention. In this respect, both practitioners and academics are looking for solutions that may be helpful in constraining the excessive procyclicality of banking activities, in particular those that could tame the leverage and maturity mismatch between assets and liabilities. In spite of this focus on leverage and liquidity risk in international standard setters' fora (Basel III, CRR/CRDIV) and the related academic literature, relatively little is known about the drivers of leverage and funding risk for individual banks; in particular in a cross-country context. Our study aims to bridge this gap by looking at bank specific and macroeconomic drivers of leverage and funding liquidity risk. We also attempt to identify whether bank size determines the sensitivity of leverage and funding liquidity risk to the business cycle, in particular during crises. Our study is related to three streams in the literature. The first focuses on the determinants of bank risk. This literature focuses on mainly on the drivers of equity risk measures (i.e. systematic risk proxied by beta coefficient; idiosyncratic risk;

[*] Małgorzata Olszak is working at Faculty of Management of the University of Warsaw.
[**] Iwona Kowalska is working at Faculty of Management of the University of Warsaw.

total risk, i.e. bank equity return standard deviation; interest rate risk, i.e. interest rate beta[1]) and credit risk (measured as loan loss provisions divided by total assets). In a recent paper Haq and Heaney[2] find mixed evidence on the relation between bank specific factors and bank risk measures in 15 European countries. Although their study analyses the drivers of bank specific risk measures, it does not consider determinants of leverage and liquidity risk.

The second stream in the literature stresses the link between leverage and liquidity in the banking sector. Studies in this stream focus on the role of liquidity in asset pricing[3], and on the role of leverage and liquidity in amplification of financial shocks through balance sheets[4]. These studies show that there is some link between leverage and liquidity in investment banks[5], and that market liquidity and funding liquidity are affected by the build-up of leverage in financial sector[6]. However, none of these studies looks for potential determinants of leverage and liquidity.

The third stream in the literature focuses on the role of macroprudential policy instruments for leverage and liquidity risk[7]. This literature stresses the need to curb the excessive procyclicality of leverage and liquidity, in particular in large banking organisations. However, in its concentration on the impact of macroprudential policy instruments on leverage and liquidity risk (measured in a specific way, as a real asset growth), this literature does not analyse the relative importance of bank specific and macroeconomic factors on leverage and liquidity risk.

Our study contributes relative to the literature in several important respects. First, we identify factors that affect the leverage and liquidity risk of banks. This strategy gives us the opportunity to show which banks' specific and macroeconomic factors are relatively more vital for solvency and liquidity risk formation. Second, as we focus on banks that differ in size (large, medium and small), we are able to identify what is the role of bank size in the link between leverage and liquidity funding risk. Third, we look at the relationship between leverage and liquidity, and ask whether bank leverage is affected by liquidity risk and vice versa, and show the diversity of association between leverage and liquidity risk and vice versa. In particular, following the gaps in previous research and considering the theoretical background, we test several hypotheses. First, increases in leverage (and thus solvency risk) for large banks are associated with increases in liquidity risk for these banks. Second, increases in liquidity risk for large banks are associated with

1 See Kane and Unal (1988); Flannery and James (1984) and Haq and Heaney (2012).
2 Haq and Heaney (2012).
3 Adrian and Shin (2010).
4 *Ibidem*; Acharya and Viswanathan (2010).
5 Adrian and Shin (2010).
6 Acharya and Viswanathan (2010).
7 Lim et al. (2011); Cerutti et al. (2015); Claessens et al. (2014).

increases in leverage (and thus solvency risk) for these banks. Third, during a non-crisis period the business cycle does not affect bank leverage in an economically significant way. Fourth, large banks' leverage is procyclical during a crisis period. Fifth, during a non-crisis period liquidity risk is procyclical. Sixth, during a crisis period liquidity risk is countercyclical. And finally, during a crisis period the liquidity risk of large banks is more countercyclical than the liquidity risk of medium and small banks. We examine the determinants of banks' leverage and liquidity for 383 banks across 67 countries for the period 2000–2011. To estimate the models we apply the two-step dynamic GMM Blundell and Bond[8] estimator, with Windmejer's correction. The findings show that increases in previous period funding liquidity risk are associated with increases in leverage in the full sample and in large banks, but not in other banks. With reference to the impact of macroeconomic conditions on the leverage of banks we find mixed results. On the one hand, during a non-crisis period the large business cycle is not a significant driver of leverage. On the other hand, during a crisis period seems to be procyclical in the case of large banks. With reference to the impact of leverage on liquidity risk we find that large banks with high solvency risk also have high funding liquidity risk. As for the impact of the business cycle on liquidity risk, we are able to confirm the view that liquidity risk is procyclical during a non-crisis period. By contrast, during a crisis period this liquidity risk is countercyclical, because the worsening economic environment is related to increasing liquidity risk (consistent with the potential for panic and bank runs during crisis periods). This counter-cyclicality is particularly strong in large banks, which suffer the most from the limited access to interbank funding during a crisis period.

The rest of the paper is organised as follows. Section 2 provides an overview of the literature. Section 3 describes the methodology applied in the study and data used in this paper. Section 4 includes our empirical results, and a review of robustness tests conducted to analyse the sensitivity of the results. Section 5 concludes.

2. LITERATURE REVIEW

Our study is related to three streams in the literature focusing generally on bank risk-taking. The first stream focuses on the drivers of bank risk. One recent study investigates bank capital, charter value, off-balance sheet activities, dividend payout ratio and size as determinants of bank equity risk (systematic risk, total risk, interest rate risk and idiosyncratic risk) and credit risk[9]. Their paper uses

---

8 Blundell and Bond (1998).
9 Haq and Heaney (2012).

information for 117 financial institutions across 15 European countries over the period 1996–2010, and finds evidence of a convex (U-shaped) relationship between bank capital and bank systematic risk and credit risk. They also find mixed evidence on the relationship between charter value and our measures of bank risk. This paper also shows that large banks reflect a higher total risk and lower credit risk. Considering the importance of bank size to the level of bank risk, we ask how bank size affects the sensitivity of leverage and liquidity risk to bank-specific and macroeconomic determinants.

The second stream is represented by studies from Adrian and Shin[10] and Acharya and Viswanathan[11]. In an explorative study, Adrian and Shin analyse the activities of several large investment banks, and argue that aggregate liquidity can be understood as the rate of growth of the aggregate financial sector balance sheet. Considering the fact that fair value accounting has been increasingly popular with banks[12], when asset prices increase, financial intermediaries' balance sheets generally become stronger, and without adjusting asset holdings, their leverage tends to be too low (as was the case in investment banks in the period before the crisis of 2007/8, but also in the case of commercial banks). The financial intermediaries then hold surplus capital, and in the search for yield, they will attempt to find ways in which they can employ their surplus capital. As Adrian and Shin suggest, for such surplus capacity to be utilised, the intermediaries must expand their balance sheets. On the liability side, they take on more short-term debt. On the asset side, they search for potential borrowers. According to Adrian and Shin, aggregate liquidity is intimately tied to how hard the financial intermediaries look for borrowers. Another paper in this stream by Acharya and Viswanathan[13] is theoretical, and presents a model of the financial sector in which short-term or rollover debt is an optimal contracting response to risk-shifting or asset-substitution problems. Their analysis helps in understanding the deleveraging of the financial sector during crises, including the crisis of 2007–09. In particular, they show that the extent of the funding liquidity problem and related deleveraging or fire sales faced by each financial firm are determined by the extent of its own short-term debt, the adversity of the asset shock, the specificity of assets to borrowers relative to lenders, and the extent of short-term debt of potential buyers of assets, i.e., other financial firms. Following those two papers we ask to what extent is bank leverage affected by liquidity and bank liquidity by leverage. Looking at the results of an explorative study by the Bank of England[14], which

---

10 Adrian and Shin (2010).
11 Acharya and Viswanathan (2010).
12 CGFS (2009).
13 Acharya and Viswanathan (2010).
14 Bank of England (2009).

shows that large banks' leverage and liquidity risk may be positively related, we hypothesise that:

Hypothesis 1a: Increases in leverage (and thus solvency risk) of large banks are associated with increases in liquidity risk of these banks;

Hypothesis 1b: Increases in liquidity risk of large banks are associated with increases in leverage (and thus solvency risk) of these banks.

The third stream in the literature focuses on the role of macroprudential policy instruments for leverage and liquidity risk[15]. This literature underlines the necessity to affect the excessive procyclicality of leverage and liquidity, in particular in large banking organisations. However, in its concentration on the impact of macroprudential policy instruments on leverage ratio and liquidity risk (measured in a specific way, as a real asset growth), this literature does not analyse the relative importance of bank-specific and macroeconomic factors on leverage and liquidity risk. In particular, this literature omits the role of bank size for the sensitivity of leverage and liquidity to their drivers. Previous research shows that bank size may have an impact on bank risk and therefore affect the sensitivity of bank risk to the business cycle[16]. Large banks may have better chances for diversification, and could therefore better reduce overall risk exposure as compared to smaller banks that do not have much opportunity to diversify their loan portfolio[17]. Government protection of larger banks could also result in large banks becoming "too big to fail" or "too interconnected to fail"[18], in particular financial conglomerates operating in a few sectors of the financial market (e.g. banking, insurance and other financial products), and as the economic theory predicts, such banks undertake too many risky investments[19]. Large banks could also be more sensitive to general market movements than small banks focusing on traditional loan extension activity, which may lead to a positive relationship between bank size and systemic risk[20]. From an EU context, the problem of bank size has been accounted for in the analysis of factors determining bank risk[21]. In 15 EMU countries the relationship between banking sector systemic risk (proxied by bank equity market beta) and bank size has been found to be positive[22]. But can we state the same about the relationship between leverage and liquidity risk and the business cycle during non-crisis and

15 Lim et al. (2011); Cerutti et al. (2015); Claessens et al. (2014).
16 Olszak et al. (2016).
17 Konishi and Yasuda (2004); Stiroh (2006).
18 Schooner and Taylor (2010); Stiglitz (2010); De Haan and Poghosyan (2012).
19 See also Freixas et al. (2007).
20 Anderson and Fraser (2000); Haq and Heaney (2012).
21 Haq and Heaney (2012).
22 *Ibidem*.

crisis periods? As for the role of the business cycle on leverage during a non-crisis period we may predict two types of links. On the one hand, due to the fact that in such periods banks' profits are increasing, the stock value of equity is increasing and additionally, access to external finance is relatively easy[23], macroeconomic conditions may have an insignificant impact on leverage. However, during crisis periods, when access to external finance is limited, banks may feel constrained by the macroeconomic environment, and thus their leverage may become procyclical, i.e. banks will deleverage when the economy is in the bust. Following this, we hypothesise that:

Hypothesis 2: During a non-crisis period the business cycle does not affect bank leverage in an economically significant way.

However, due to the fact that large banks tend to be affected more by external market movements and have a generally more fragile business model, which creates more systemic risk[24], their leverage may be more sensitive to business cycle movements, in particular during a crisis period. We therefore expect that:

Hypothesis 2a: Large banks' leverage is procyclical during a crisis period.

As for the impact of the business cycle on liquidity risk during non-crisis period, we expect that independent of bank size, liquidity risk is procyclical, i.e. when macroeconomic conditions improve, banks take on more liquidity risk. This is due to high liquidity on the wholesale interbank market and on other markets where banks operate (including the real estate market, which is highly liquid during non-crisis periods and is financed by banks). We therefore hypothesise that:

Hypothesis 3: During a non-crisis period liquidity risk is procyclical.

The crisis period may, however, change this procyclical pattern of liquidity risk, due to the drying up of liquidity during such period, in particular, in the interbank market (as was the case during the last financial crisis[25]). Thus even if macroeconomic conditions improve, banks reduce their exposure to liquidity risk during the crisis period. On the other hand, when the economy is going down, banks' liquidity risk is increasing, due to the fact that bank deposits are prone to panics and runs. We thus expect that:

---

23 Myers and Mayluf (1984).
24 Laeven et al. (2014).
25 See e.g. Schooner and Taylor (2010).

Hypothesis 3a: During a crisis period liquidity risk is countercyclical.

Large banks are more vulnerable to access to external finance[26]. Therefore we expect the liquidity risk of large banks to be more countercyclical during crisis period than the liquidity risk of other banks. We thus hypothesise that:

Hypothesis 3b: During a crisis period the liquidity risk of large banks is more countercyclical than the liquidity risk of medium and small banks.

3. RESEARCH METHODOLOGY AND DATA DESCRIPTION

3.1. Research methodology

To measure the leverage of a bank, we apply the ratio of total assets divided by equity capital, as suggested by the BOE[27]. As the BOE[28] shows, such a ratio among major UK banks tended to increase in economic booms (i.e. the balance sheets of banks grew quicker than their capital, necessary to cover unexpected losses). To quantify the liquidity risk, we include a simple loans-to-deposits ratio. This ratio is one of recommended indicators of liquidity risk in a macroprudential policy context[29]. It may be helpful in identification of the structural and cyclical dimension of systemic risk resulting from maturity mismatch (i.e. the funding risk). This ratio is a promising leading indicator of systemic liquidity risk and seems to have some signalling power regarding the build-up of this risk[30].

To compute the sensitivity of individual banks' leverage and funding risk to bank-specific and macroeconomic factors, and to crisis periods, we estimate two separate equations, of which equation 1 [EQ1] is our model of determinants of leverage, and equation 2 [EQ2] is our model of determinants of liquidity.

Model of determinants of leverage [EQ1]

$$Leverage_{i,t} = \alpha_0 + \alpha_1 Leverage_{i,t-1} + \alpha_2 Liquidity_{i,t-1} + \alpha_3 Loans/TA_{i,t-1} + \alpha_4 \Delta Loans_{i,t-1} + \\ + \alpha_5 DEPOSITS/TA_{i,t-1} + \alpha_6 QLP_{i,t-1} + \alpha_7 SIZE_{i,t-1} + \alpha_8 GDPG_{j,t} + \alpha_9 \Delta UNEMPL_{j,t} + \\ + \alpha_{10} CRISIS + \alpha_{11} CRISIS * GDPG_{j,t} + \vartheta_i + \varepsilon_{i,t}$$

26 Laeven et al. (2014).
27 (2009), p. 14 and Adrian and Shin (2010).
28 BOE (2009).
29 ESRB (2014, p. 121.
30 See CGFS (2012), p. 10; ESRB (2014), p. 16.

Model of determinants of liquidity [EQ2]

$$Liquidity_{i,t} = \alpha_0 + \alpha_1 Liquidity_{i,t-1} + \alpha_2 Leverage_{i,t-1} + \alpha_3 Loans/TA_{i,t-1} + \alpha_4 \Delta Loans_{i,t-1} + \alpha_5 DEPBANKS/TA_{i,t-1} + \alpha_6 QLP_{i,t-1} + \alpha_7 SIZE_{i,t-1} + \alpha_8 GDPG_{j,t} + \alpha_9 \Delta Uempl_{j,t} + \alpha_{10} CRISIS + \alpha_{11} CRISIS * GDPG_{j,t} + \vartheta_i + \varepsilon_{i,t}$$

where:
- i – the number of the bank;
- j – the number of country;
- t – the number of observation for the i-th bank or j-th country;
- *Leverage* – total assets divided by equity capital;
- *Liquidity* – Loans of nonfinancial sector to deposits of nonfinancial sector (i.e. loans-to-deposits ratio, LTD); this ratio is a proxy for maturity mismatch of the bank's balance sheet; it measures funding liquidity risk;
- *Loans/TA* – loans to total assets; is our measure of credit risk;
- Δ*Loan* – real annual loans growth rate; measures sensitivity of solvency and Liquidity risk to changes in bank lending activity;
- *Deposits/TA* – deposits from nonfinancial customers divided by total assets;
- *DEPBANKS/TA* – deposits from banks divided by total assets;
- *QLP* –quality of the lending portfolio; it equals loan loss provisions divided by average loans;
- size – logarithm of assets;
- *GDPG* – real GDP per capita growth. A positive coefficient suggests procyclicality of leverage or liquidity risk, respectively, during a non-crisis period. A negative coefficient would imply economic insignificance of the business cycle to levels of leverage and liquidity risk during a non-crisis period;
- Δ*Unempl* – annual change in unemployment rate;
- *CRISIS* – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise;
- *CRISIS * GDPG* – interaction term between CRISIS and GDPG, this informs the sensitivity of leverage or liquidity risk to GDPG during crises; a positive coefficient in equation 1 suggests procyclicality of leverage'; a positive coefficient on Crisis*GDPG in equation 2 implies counter-cyclicality of LTD.

Our econometric model involves explanatory variables, in particular bank-specific variables, which may be endogenous and this may result in estimation bias. In order to limit this possible estimation bias we consider the system of generalised method of moments (GMM) developed by Blundell & Bond[31] with Windmejer's[32] finite sample correction. We control for the potential endogeneity of bank-specific variables in the two-step system GMM estimation procedure, by the inclusion of

31 Blundell & Bond (1998).
32 Windmejer's (2005).

up to two lags of explanatory variables as instruments. The UNEMPL, as well as the country and the time dummy variables are the only variables considered exogenous. The GMM estimator is efficient and consistent if the models are not subject to serial correlation of order two and the instruments are not proliferated. Therefore, we apply the test verifying the hypothesis of absence of second-order serial correlation in the first difference residuals AR(2). We also use the Hansen's J statistic for overidentifying restrictions, which tests the overall validity of the instrument tests[33].

3.2. Data description

We use pooled cross-section and time series data of individual banks' balance sheet items and profit and loss accounts from 67 countries and country-specific macroeconomic indicators for these countries, over a period from 2000 to 2011. The balance sheet and profit and loss account data are taken from consolidated financials available in the Bankscope database, whereas the macroeconomic data were accessed from the Worldbank and the IMF web pages. We exclude from our sample outlier banks by eliminating the extreme bank-specific observations when a given variable adopts extreme values. Additionally, in order to conduct the analysis only the data for which there were a minimum of 5 successive values of dependent variable from the period 2000 to 2011 was used (in effect the number of banks included in the study is 1105 from 67 countries[34], and the number of observations eventually amounted to approximately 10974).

As for the influence of bank size, we divide banks into three subsamples: large, medium and small (in each country separately: 30% of banks with the largest assets constitute our largest banks' sample and 40% of banks with the smallest assets constitute the smallest banks' sample; 30% of banks with assets that are in between are included in the medium-sized banks subsample). In this step we test the impact of different methods of division on the estimated results. We divide our banks according to the average-value-of-assets method[35]. In this method we

---

33 See Roodman (2009), for more details.

34 All countries included in the research: Australia, Austria, Belgium, Bulgaria, Canada, China Rep., Colombia, Croatia, Cyprus, Czech Rep., Denmark, Ecuador, Salvador, Estonia, Finland, France, Germany, Ghana, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea Rep., Latvia, Lithuania, Luxemburg, Malaysia, Malta, Mexico, Morocco, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Panama, Peru, Philippines, Poland, Portugal, Romania, Russia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Tunisia, Turkey, Uganda, Ukraine, UK, USA.

35 Beck and Levine (2002).

firstcalculate the average assets of a bank over the whole period of 2000–2011, and then apply this average value at the next stage of division.

In table 1 and 2 we present descriptive statistics for our sample and subsamples and correlation matrices.

Table 1. Summary descriptive statistics

	Mean	Median	Min	Max	Std. Dev.	# banks	#observ
	full sample						
Leverage	14.40	12.54	1.00	97.60	9.05	1105	10794
Liquidity	65.81	68.65	0.10	199.14	23.19	1090	10114
Loans/TA	54.89	58.61	0.07	99.92	19.92	1101	10758
ΔLoans	14.24	6.67	–53.13	884.39	37.34	1022	9478
Deposits/TA	76.19	81.07	0.13	98.97	16.81	1102	10779
Depbanks/TA	12.37	6.80	0.00	96.22	15.24	1044	9002
QLP	1.22	0.66	–18.78	19.46	2.04	1084	9722
size	6.75	6.76	3.26	9.49	0.94	1105	10853
GDPG	2.51	2.20	–16.59	30.34	3.69	1105	13260
ΔUnempl	–0.04	–0.10	–5.40	9.70	1.20	1105	13260
	large						
Leverage	16.18	12.92	1.54	97.60	9.73	383	3887
Liquidity	65.16	66.67	0.23	179.75	20.48	380	3797
Loans/TA	55.18	55.92	0.19	93.24	17.69	381	3896
ΔLoans	12.63	7.62	–53.13	794.79	32.62	365	3578
Deposits/TA	74.14	79.51	0.16	96.83	15.72	382	3901
Depbanks/TA	11.82	8.10	0.00	95.44	12.18	363	3384
QLP	1.15	0.67	–10.07	17.04	1.72	380	3711
size	7.42	6.98	5.07	9.49	0.83	383	3912
GDPG	2.47	2.35	–16.59	30.34	3.63	383	4596
ΔUnempl	–0.02	–0.10	–5.40	9.70	1.21	383	4596

	Mean	Median	Min	Max	Std. Dev.	# banks	#observ
	medium						
Leverage	14.46	12.84	1.00	94.20	8.59	399	3914
Liquidity	67.43	68.26	0.23	199.14	22.94	397	3730
Loans/TA	56.58	58.58	0.16	99.92	19.33	399	3927
ΔLoans	14.83	7.36	–49.43	579.24	33.63	365	3420
Deposits/TA	78.08	82.30	0.28	98.97	16.49	399	3924
Depbanks/TA	11.83	6.88	0.00	96.22	15.67	385	3340
QLP	1.22	0.69	–18.78	19.26	2.07	394	3564
size	6.69	6.69	4.22	8.25	0.65	399	3938
GDPG	2.60	2.41	–16.59	30.34	3.74	399	4788
ΔUnempl	–0.06	–0.10	–5.40	9.70	1.17	399	4788
	small						
Leverage	12.00	11.55	1.00	63.71	8.14	323	2993
Liquidity	64.44	67.84	0.10	194.92	26.86	313	2587
Loans/TA	52.25	56.38	0.07	98.49	22.99	321	2935
ΔLoans	15.75	7.20	–51.36	884.39	47.22	292	2480
Deposits/TA	76.38	81.73	0.13	97.60	18.26	321	2954
Depbanks/TA	13.97	7.43	0.00	89.40	18.26	296	2278
QLP	1.34	0.71	–15.87	19.46	2.40	310	2447
size	5.96	6.28	3.26	7.42	0.70	323	3003
GDPG	2.46	2.40	–16.59	30.34	3.70	323	3876
ΔUnempl	–0.05	–0.10	–5.40	9.70	1.22	323	3876

Notes: Leverage – total assets divided by equity capital; Liquidity – loans to deposits (LTD ratio); Loans/TA – loans to total assets; DLoans – annual loans growth real; Deposits/TA – deposits of nonfinancial sector divided by total assets; Depbanks/TA – deposits of banks divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; DUnempl – annual change in unemployment rate; # denotes number of banks and observations (denoted as observ).

Table 2. Correlation matrices

	Leverage	Liquidity	Loans/TA	ΔLoans	Deposits/TA	Depbanks/TA	QLP	size	GDPG	ΔUNEMPL
full sample										
Leverage	1									
Liquidity	–0.124***	1								
Loans/TA	0.038***	0.926***	1							
ΔLoans	–0.087***	0.005	–0.014	1						
Deposits/TA	0.153***	–0.036***	0.157***	–0.035***	1					
Depbanks/TA	0.088***	–0.027**	–0.018*	0.048***	–0.009	1				
QLP	–0.151***	0.013	–0.040***	0.024**	–0.076***	0.030***	1			
size	0.507***	0.006	0.112***	–0.131***	0.032***	–0.040***	–0.156***	1		
GDPG	–0.128***	–0.020**	–0.040***	0.241***	0.005	–0.048***	–0.122***	–0.126***	1	
ΔUnempl	0.032***	0.014	0.025**	–0.150***	0.001	0.026**	0.155***	0.047***	–0.572***	1
large										
Leverage	1.000									
Liquidity	–0.273***	1.000								
Loans/TA	–0.196***	0.957***	1.000							
ΔLoans	–0.065***	0.048***	0.045***	1.000						
Deposits/TA	–0.241***	0.010	0.098***	0.017	1.000					

Depbanks/ TA	0.218***	–0.030*	–0.024	0.060***	–0.039**	1.000				
QLP	–0.185***	–0.034**	–0.072***	–0.005	0.024	0.030*	1.000			
size	0.495***	–0.148***	–0.121***	–0.114***	–0.267***	0.051***	–0.179***	1.000		
GDPG	–0.128***	–0.025	–0.030*	0.251***	0.103***	–0.081***	–0.1736***	–0.154***	1.000	
ΔUnempl	0.017	0.0324**	0.043***	–0.178***	–0.017	0.053***	0.202***	0.053***	–0.579***	1
medium										
Leverage	1.000									
Liquidity	–0.096***	1.000								
Loans/TA	0.078***	0.912***	1.000							
ΔLoans	–0.108***	0.030*	–0.012	1.000						
Deposits/TA	0.310***	–0.130***	0.098***	–0.052***	1.000					
Depbanks/ TA	0.108***	–0.049***	–0.019	0.068***	0.007	1.000				
QLP	–0.146***	0.064***	–0.008	0.025	–0.121***	0.040**	1.000			
size	0.464***	0.088***	0.216***	–0.199***	0.220***	–0.045***	–0.190***	1.000		
GDPG	–0.131***	–0.029*	–0.058***	0.272***	–0.033**	–0.040**	–0.08***	–0.185***	1.000	
ΔUnempl	0.059***	0.0113	0.026	–0.163***	0.020	0.037**	0.13***	0.062***	–0.573***	1
s**mal**l										
Leverage	1.000									
Liquidity	0.014	1.000								
Loans/TA	0.240***	0.915	1.000							
ΔLoans	–0.084***	–0.052	–0.059***	1.000						
Deposits/TA	0.539***	0.013	0.273***	–0.082	1.000					

	Leverage	Liquidity	Loans/TA	ΔLoans	Deposits/TA	Depbanks/ TA	QLP	size	GDPG	ΔUNEMPL
Depbanks/ TA	–0.040*	0.005	0.004	0.013	–0.004	1.000				
QLP	–0.111***	0.000	–0.043**	0.043	–0.139***	0.012	1.000			
size	0.607***	0.116	0.265***	–0.127	0.435***	–0.038*	–0.150***	1.000		
GDPG	–0.134***	–0.006	–0.034*	0.211	–0.064***	–0.027	–0.123***	–0.146***	1.000	
ΔUnempl	0.012	–0.0027	0.0038	–0.116	0.003	–0.010	0.142***	0.031*	–0.565***	1

Notes: Leverage – total assets divided by equity capital; Liquidity – loans to deposits (LTD ratio); Loans/TA – loans to total assets; ΔLoans – annual loans growth real; Deposits/TA – deposits of nonfinancial sector divided by total assets; Depbanks/TA – deposits of banks divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; ΔUnempl – annual change in unemployment rate; ***, **, * denote significance at the 1%, 5% and 10% rates, respectively.

4. RESULTS

We present the main results in Section 4.1 and sensitivity analyses in Section 4.2.

4.1. Main results

Due to the fact that our sample includes a large number of banks operating in the United States, in this section we present the main results for leverage and liquidity risk separately in tables including US banks (denoted with letter a) and in tables excluding Japanese banks (denoted with letter b).

Tables 3a and 3b show the coefficients obtained with the model of determinants of leverage (EQ1). Specification 1 is our baseline model analysing determinants of leverage in the full sample and specifications 2–4 show the effects of bank size on the sensitivity of leverage to its determinants. Funding liquidity ratio (LTD) enters specifications 1 and 2 positively and significantly. This indicates that increases in previous period funding liquidity risk are associated with increases in leverage in the full sample and in large banks. Such effect is not found in medium and small banks, whose leverage is not statistically significantly affected by LTD ratio. We thus find empirical support for our prediction expressed in hypothesis 1a, that increases in leverage (and thus solvency risk) of large banks are associated with increases in liquidity risk of these banks.

The lagged loans to total assets ratio enters the full sample and large banks sample negatively and statistically significantly. Such a result implies that large banks decrease leverage in response to increases in credit risk. However, lagged credit risk does not seem to affect the leverage of medium and small banks. As for the impact of real loans growth we find that it does not affect bank leverage (all coefficients are statistically insignificant).

The results reported in Tables 3a and 3b are mixed with regard to the association between leverage and the nonfinancial sector deposits to assets ratio (see columns 2 and 3). On the one hand, greater access to stable retail deposits is related to lower leverage in large banks. In contrast, medium banks tend to increase their leverage in response to better access to nonfinancial sector deposits.

A negative regression coefficient on QLP (and statistically significant in the full sample and marginally significant in large banks) implies that banks decrease their leverage in response to the deprecated quality of the loans portfolio in the previous year. As can be inferred from the table (see specification 2), this effect is definitely strongest in the sample of large banks.

The size enters all specifications positively and statistically significantly, implying that large banks have higher leverage. As can be seen from the table, this effect is very strong in the case of large and small banks (see columns 2 and 4).

With reference to the impact of macroeconomic conditions on the leverage of banks we find support for hypothesis 2, which predicts that during non-crisis periods the business cycle does not affect bank leverage in an economically significant way. In particular, the coefficient on GDPG enters all specifications negatively and significantly in Table 3a, and insignificantly in Table 3b. However, the unemployment rate enters these specifications negatively and statistically significantly in all estimations, suggesting procyclicality of leverage, with leverage of large banks the most procyclical.

We note from column 2 of Tables 3a and 3b that the relationship between leverage and the business cycle during a crisis is positive and statistically significant (see Table 3b) in the case of large banks. This positive relationship suggests that when economic conditions worsen, large banks tend to decrease their leverage. Such a result implies procyclicality of leverage for large banks. Such a result supports the view expressed in hypothesis 2a, that large banks' leverage is procyclical during a crisis period. In the remaining samples of banks, we do not find a statistically significant impact of the business cycle on leverage in crisis times.

Table 3a. Determinants of leverage and bank size

Dependent variable: Leverage	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
Leverage (-1)	0.930 (52.32)	0.000	0.889 (29.19)	0.000	0.869 (26.77)	0.000	0.798 (18.48)	0.000
Liquidity	0.082 (4.02)	0.000	0.094 (2.73)	0.006	0.005 (0.29)	0.773	0.008 (0.51)	0.610
Loans/TA	–0.070 (–3.16)	0.002	–0.091 (–2.47)	0.013	0.006 (0.26)	0.792	0.025 (1.36)	0.173
ΔLoans	–0.002 (–0.98)	0.325	0.000 (0.06)	0.953	0.001 (0.34)	0.732	0.000 (0.05)	0.958
Deposits/TA	0.011 (1.37)	0.169	–0.021 (–1.77)	0.077	0.017 (2.19)	0.029	0.008 (0.7)	0.483
QLP	–0.095 (–2.18)	0.029	–0.094 (–1.45)	0.147	–0.037 (–0.6)	0.548	–0.035 (–0.51)	0.611
size	0.211 (1.6)	0.109	0.665 (3.5)	0.000	0.331 (1.69)	0.092	0.971 (3.21)	0.001

Dependent variable: Leverage	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	coef (t val)	p val	coef (t val)	p val	coef (t val)	p val	coef (t val)	p val
GDPG	–0.054 (–1.69)	0.091	–0.073 (–1.78)	0.075	–0.073 (–1.98)	0.048	–0.115 (–2.04)	0.042
ΔUnempl	–0.556 (–4.54)	0.000	–0.461 (–2.5)	0.013	–0.467 (–2.28)	0.023	–0.308 (–1.47)	0.143
Crisis	0.287 (1.59)	0.112	–0.221 (–0.87)	0.385	0.072 (0.25)	0.801	0.018 (0.06)	0.956
Crisis*GDPG	–0.047 (–0.94)	0.348	0.104 (1.53)	0.125	–0.116 (–1.15)	0.251	–0.058 (–0.65)	0.514
cons	–2.836 (–2.47)	0.014	–2.484 (–1.46)	0.145	–2.239 (–1.61)	0.107	–5.463 (–2.99)	0.003
AR(1)	–6.04	0.000	–3.95	0.000	–4.54	0.000	–3.51	0.000
AR(2)	2.4	0.016	2.16	0.031	0.53	0.598	1.12	0.262
Sargan (p val)		0.000		0.000		0.000		0.000
Hansen (p val)		0.000		0.091		0.015		0.396
# observ	7 961		3 265		2 896		1 800	
# banks	994		362		357		275	

Notes: This table presents full sample estimation of equation 1 [EQ1]. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmejer's (2005) finite sample correction for the period of 2000–2011 for panel data with lagged dependent variable. In each regression, dependent variable is Leverage – total assets divided by equity capital. As explanatory variables we include: Leverage (-1) – lagged dependent variable; Liquidity – loans to deposits (LTD ratio); Loans/TA – loans to total assets; ΔLoans – annual loans growth real; Deposits/TA – deposits of nonfinancial sector divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; ΔUNEMPL – annual change in unemployment rate; Crisis – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise; Crisis * GDPG – interaction between Crisis and GDPG; # denotes "number of", observ denotes observations, cons denotes intercept; t-statistics are given in brackets.

Table 3b. Determinants of leverage and bank size – banks operating in Japan are excluded

Dependent variable: Leverage	full sample	p-ist	large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
Leverage (-1)	0.926 (50.23)	0.000	0.901 (30.26)	0.000	0.880 (29.35)	0.000	0.784 (21.21)	0.000
Liquidity	0.079 (3.81)	0.000	0.088 (2.49)	0.013	0.000 (–0.01)	0.993	0.006 (0.41)	0.683
Loans/TA	–0.067 (–2.990)	0.003	–0.082 (–2.14)	0.032	0.012 (0.65)	0.513	0.017 (0.94)	0.349
ΔLoans	–0.002 (–1.040)	0.298	0.000 (0.07)	0.943	0.001 (0.18)	0.854	0.001 (0.53)	0.596
Deposits/TA	–0.004 (–0.45)	0.653	–0.024 (–1.66)	0.096	0.010 (0.86)	0.389	0.001 (0.10)	0.918
QLP	–0.116 (–2.61)	0.009	–0.119 (–1.910	0.056	0.000 (0.00)	0.998	–0.041 (–0.63)	0.530
size	0.109 (0.87)	0.383	0.551 (2.81)	0.005	0.239 (1.29)	0.196	0.603 (2.17)	0.030
GDPG	–0.012 (–0.37)	0.713	–0.037 (–0.990	0.324	–0.044 (–1.00)	0.318	–0.061 (–1.15)	0.250
ΔUnempl	–0.362 (–2.83)	0.005	–0.375 (–1.91)	0.057	–0.452 (–1.99)	0.047	0.077 (0.45)	0.656
Crisis	0.041 (0.21)	0.834	–0.263 (–1.02)	0.310	–0.012 (–0.03)	0.975	–0.447 (–1.23)	0.217
Crisis*GDPG	0.025 (0.48)	0.629	0.140 (1.96)	0.050	–0.062 (–0.52)	0.605	0.106 (1.11)	0.265
cons	–0.883 (–0.73)	0.466	–1.817 (–0.94)	0.346	–1.365 (–0.73)	0.463	–2.202 (–1.17)	0.243
AR(1)	–5.64	0.000	–3.84	0.000	–3.95	0.000	–2.94	0.003
AR(2)	2.56	0.010	2.13	0.033	0.73	0.464	1.84	0.066
Sargan (p val)	930.81	0.000	646.17	0.000	628.79	0.000	401.23	0.000

Dependent variable: Leverage	full sample	p-ist	large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
Hansen (p val)	410.39	0.000	271.42	0.168	271.77	0.115	230.36	0.644
# observ	6,891		3,021		2,398		1,472	
# banks	883		338		307		238	

Notes: This table presents full sample estimation of equation 1 [EQ1]. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmejer's (2005) finite sample correction for the period of 2000–2011 for panel data with lagged dependent variable. In each regression, dependent variable is Leverage – total assets divided by equity capital. As explanatory variables we include: Leverage (-1) – lagged dependent variable; Liquidity – loans to deposits (LTD ratio); Loans/TA – loans to total assets; ΔLoans – annual loans growth real; Deposits/TA – deposits of nonfinancial sector divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; ΔUNEMPL – annual change in unemployment rate; Crisis – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise; Crisis * GDPG – interaction between Crisis and GDPG; # denotes "number of", observ denotes observations, cons denotes intercept; t-statistics are given in brackets.

Tables 4a (all banks from 65 countries) and 4b (with exclusion of the US banks) show the estimations of equation 2 [EQ2], where we regress a series of explanatory variables on liquidity risk (i.e. LTD ratio). With reference to the impact leverage on LTD we find mixed results. Leverage enters with a positive (but insignificant) coefficient only in the case of small banks in Table 4a and with marginally statistically significant and positive coefficient in the case of large banks in Table 4b (see column 2). Such a result for large banks implies increases in solvency risk results in increases in funding liquidity risk. We thus find support for the view expressed in hypothesis 1b, that *increases in liquidity risk for large banks are associated with increases in leverage (and thus solvency risk) for these banks*. In contrast, a negative coefficient (but insignificant) on leverage in medium banks suggests that in response to increases in solvency risk, banks tended to decrease liquidity risk. Traditional bank lending activity and credit risk (as proxied by the loans to total assets ratio), do not significantly affect banks' LTD. However, increases in previous years' bank lending lead to increases of funding liquidity risk in the large banks sample, because the regression coefficient on ÄLoans enters the specification in column 2 positively and statistically significantly.

With reference to the impact of access to interbank market financing our findings are mixed. On the one hand, better access to the wholesale markets financing (interbank deposits) results in decreased funding liquidity risk in the case of large banks (see column 2). Such a result may imply that large banks with better access to interbank funding extend fewer loans and invest more in other financial instruments. In contrast, the effect of Depbanks/TA on LTD of medium banks is positive, implying that better access to financing by other banks induces medium banks to take on higher levels of liquidity risk. The access to interbank funding does not significantly affect the funding liquidity risk of small banks.

A negative regression coefficient on QLP implies that banks decrease their liquidity funding risk in response to deprecated quality of the loans portfolio in the previous year. As can be inferred from the table (see specification 3), this effect is definitely strongest in the sample of medium banks.

We note from the results in Tables 4a and 4b that the role of size on LTD is diversified and seems to be related to the size category of banks. A negative and statistically significant coefficient on size in large banks (see specification 2) implies that large banks tend to decrease their liquidity funding risk, as their assets get higher. In contrast, size enters specifications 3 and 4 positively (and significantly) suggesting that medium and small banks with higher assets are more exposed to liquidity risk.

As for the impact of the business cycle (proxied by the real growth in GDP per capita, GDPG and change in unemployment rate) our findings lend empirical support to the view expressed in hypothesis 3; that d*uring a non-crisis period liquidity risk is procyclical*. GDPG enters all specifications positively and ÄUnempl negatively – implying procyclicality of LTD, because LTD tends to increase in good economic conditions and decrease in unfavourable times. There is, however, a visible diversity of impact of the business cycle on LTD – which seems to be related to the bank size category. Generally, medium and small banks' LTD seems to be procyclical in a significant way relative to large banks' LTD. This procyclical pattern of liquidity risk is confirmed in Table 4b, when we exclude US banks.

Additionally, we find that during a crisis period GDPG exerts a negative impact on LTD in all subsamples of banks. Such a result implies that even when economic conditions improve in some countries during a crisis, banks tend to decrease their LTD relative to boom periods. This may be an effect of banks' attempts to decrease liquidity funding risk. Thus our findings support the view expressed in hypothesis 3a, predicting that during a crisis period liquidity risk is countercyclical. The counter-cyclicality hypothesis is particularly evident in the sample of large banks, because the negative coefficient on Crisis*GDPG is the strongest in the subsample of these banks, both in Table 4a and 4b. As can be inferred from Tables 4a and 4b, the association between LTD and Crisis*GDPG is –2.072 (Table 4a) and –0,727 (Table 4b) for large banks, -0.401 (Table 4a) and –0.289 (Table 4b) for medium banks, and –0.592 (Table 4a) and -0.534 (Table 4b). Such results thus provide evidence of greater sensitivity to liquidity risk for large banks to the business cycle during non-crisis periods and are consistent with the view expressed in hypothesis 3b, that during a crisis period the liquidity risk for large banks is more countercyclical than the liquidity risk for medium and small banks. In particular, these results imply that even improvements in GPDG do not stimulate large banks to increase their exposure to liquidity risk (maturity mismatch). In effect, the counter-cyclicality of liquidity risk for large banks may result in weaker access to the bank financing necessary to stimulate investments in the real economy. This may have further negative consequences for the real economy, generating an extended period of sluggish economic growth.

Table 4a. Determinants of Liquidity (LTD) and bank size

Dependent variable: Liquidity	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
Liquidity (-1)	0.756 (9.7)	0.000	1.418 (4.1)	0.000	0.908 (7.51)	0.000	0.786 (7.00)	0.000
Leverage	–0.015 (–0.36)	0.718	–0.174 (–0.24)	0.813	–0.052 (–0.81)	0.420	0.062 (0.64)	0.520
Loans/TA	0.076 (0.89)	0.376	0.000 (0.00)	0.000	–0.071 (–0.49)	0.624	0.040 (0.29)	0.768
ΔLoans	0.006 (0.93)	0.352	0.001 (0.01)	0.989	0.007 (0.86)	0.391	–0.001 (–0.08)	0.935
Depbanks/TA	0.009 (0.37)	0.711	–0.318 (–1.44)	0.149	0.044 (2.18)	0.029	–0.019 (–0.65)	0.514
QLP	–0.303 (–2.42)	0.015	0.771 (0.62)	0.537	–0.443 (–2.73)	0.006	–0.085 (–0.41)	0.680
size	0.422 (0.92)	0.360	10.420 (0.88)	0.379	1.297 (1.83)	0.068	1.946 (1.90)	0.057
GDPG	0.440 (4.67)	0.000	0.278 (0.73)	0.467	0.389 (3.02)	0.003	0.647 (3.16)	0.002
ΔUnempl	–1.313 (–3.48)	0.001	–8.433 (–0.97)	0.334	–0.863 (–2.05)	0.040	–0.962 (–1.65)	0.098
Crisis	2.209 (4.74)	0.000	5.153 (1.61)	0.107	1.529 (2.7)	0.007	1.857 (1.88)	0.061
Crisis*GDPG	–0.627 (–4.66)	0.000	–2.072 (–0.5)	0.620	–0.401 (–2.44)	0.015	–0.592 (–2.28)	0.023

Dependent variable: Liquidity	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
cons	8.388 (2.73)	0.006	–95.204 (–0.98)	0.326	1.522 (0.29)	0.773	–2.193 (–0.36)	0.717
AR(1)	–11.94	0.000	–2.31	0.021	–6.99	0.000	–6.3	0.000
AR(2)	–0.44	0.660	–0.5	0.615	–0.47	0.641	0.06	0.951
Sargan (p val)		0.000		0.000		0.000		0.000
Hansen (p val)		0.000		0.000		0.065		0.923
# observ	6 508		2 771		2 402		1 335	
# banks	885		337		328		220	

Notes: This table presents full sample estimation of equation 2 [EQ2]. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmejer's (2005) finite sample correction for the period of 2000–2011 for panel data with lagged dependent variable. In each regression, dependent variable is Liquidity – total loans divided by deposits (LTD ratio). As explanatory variables we include: Liquidity (-1) – lagged dependent variable; Leverage – assets to equity capital ratio; Loans/TA – loans to total assets; ΔLoans – annual loans growth real; Depbanks/TA – deposits of banks divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; ΔUNEMPL – annual change in unemployment rate; Crisis – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise; Crisis* GDPG – interaction between Crisis and GDPG; # denotes "number of"; observ denotes observations, cons denotes intercept; t-statistics are given in brackets.

Table 4b. Determinants of Liquidity (LTD) and bank size – banks operating in the US are excluded

Dependent variable: Liquidity	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
Liquidity (-1)	0.761 (7.95)	0.000	0.910 (14.36)	0.000	0.890 (6.45)	0.000	0.802 (6.81)	0.000
Leverage	0.008 (0.17)	0.868	0.045 (1.530	0.126	–0.051 (–0.78)	0.433	0.097 (0.85)	0.395
Loans/TA	0.079 (0.70)	0.487	–0.042 (–0.57)	0.570	–0.049 (–0.29)	0.770	0.032 (0.220	0.825

Dependent variable: Liquidity	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
ΔLoans	0.006 (0.92)	0.359	0.012 (1.67)	0.094	0.007 (0.84)	0.403	–0.001 (–0.13)	0.897
Depbanks/TA	0.004 (0.16)	0.869	–0.041 (–1.88)	0.060	0.043 (1.55)	0.121	–0.025 (–0.80)	0.425
QLP	–0.279 (–2.13)	0.033	–0.367 (–3.05)	0.002	–0.421 (–2.37)	0.018	–0.034 (–0.16)	0.869
size	0.460 (0.96)	0.339	–1.008 (–3.02)	0.003	1.282 (2.91)	0.004	2.198 (2.16)	0.031
GDPG	0.473 (4.51)	0.000	0.503 (5.37)	0.000	0.401 (3.08)	0.002	0.591 (2.81)	0.005
ΔUnempl	–1.173 (–2.94)	0.003	–1.380 (–3.56)	0.000	–0.655 (–1.39)	0.165	–1.060 (–1.76)	0.079
Crisis	2.314 (3.64)	0.000	3.337 (6.64)	0.000	1.365 (1.76)	0.079	1.520 (1.25)	0.210
Crisis*GDPG	–0.560 (–3.62)	0.000	–0.727 (–5.16)	0.000	–0.289 (–1.54)	0.124	–0.534 (–1.94)	0.052
cons	7.212 (2.36)	0.018	14.032 (5.21)	0.000	1.524 (0.44)	0.659	–4.325 (–0.72)	0.469
AR(1)	–11.79	0.000	–7.52	0.000	–6.85	0.000	–6.27	0.000
AR(2)	–0.43	0.671	–0.1	0.918	–0.5	0.619	0.07	0.944
Sargan (p val)	5025.56	0.000	2059.67	0.000	1815.26	0.000	1140.41	0.000
Hansen (p val)	502.24	0.000	274.09	0.132	254.46	0.294	185.08	0.987
# observ	5,779		2,536		2,055		1,188	
# banks	785		313		280		192	

Notes: This table presents full sample estimation of equation 2 [EQ2]. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmejer's (2005) finite sample correction for the period of 2000–2011 for panel data with lagged dependent variable. In each regression, dependent variable is Liquidity – total loans divided by deposits (LTD ratio). As explanatory variables we include: Liquidity (-1) – lagged dependent variable; Leverage – assets to equity capital ratio; Loans/TA – loans to total assets; ΔLoans – annual loans growth real; Depbanks/TA – deposits of banks divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; ΔUNEMPL – annual change in unemployment rate; Crisis – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise; Crisis* GDPG – interaction between Crisis and GDPG; # denotes "number of"; observ denotes observations, cons denotes intercept; t-statistics are given in brackets.

4.2. Robustness checks

To build more confidence in our main findings, we employ several robustness checks. In particular, we control for the impact concentration of our sample in one and three research countries with the largest number of banks and observations. Thus in this section we exclude a further two countries, in which we find the number of banks to be the greatest. These countries include the Russian Federation and the United States. We also look at the role of the number of instruments in the 2-step GMM model, due to the fact that the excessively large number of instruments validates the Hansen test[36]. To test the sensitivity of our results, we collapse the number of lags of endogenous variables to 1. The results for the effect of a reduced number of countries are presented in Table 5 (for the determinants of leverage) and in Table 6 (for the determinants of liquidity risk). As can be inferred from these tables, our main findings are further supported. In particular, with reference to hypotheses 1a and 1b, we still find the association between solvency and liquidity risk to be positive, implying interdependence between these two types of risks. Our conclusions on the impact of the business cycle on leverage are further supported. As can be seen from Table 5, the association between leverage and GDPG is negative (and statistically insignificant), implying the economic insignificance of the business cycle to leverage levels during non-crisis periods (and thus confirming the view expressed in hypothesis 2). The positive link between leverage and GDPG during crisis periods in large banks (see the coefficient on Crisis*GDPG in column 2 in Table 5), suggests procyclicality of leverage during a crisis period (supporting hypothesis 2a). As for the impact of the business cycle on liquidity risk, we still find that liquidity risk is procyclical during non-crisis periods (see coefficients on GDPG in Table 6) – consistent with the prediction expressed in hypothesis 3. We also find further support to hypothesis 3a, that liquidity risk is countercyclical, and to hypothesis 3b, that this counter-cyclicality of liquidity risk is particularly evident in the subsample of large banks.

Table 5. Determinants of leverage – sensitivity of results to exclusion of three countries with the largest number of observations

Dependent variable: Leverage	full sample		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
Leverage (-1)	0.916 (48.00)	0.000	0.888 (27.97)	0.000	0.904 (43.06)	0.000	0.779 (20.18)	0.000
Liquidity	0.061 (2.68)	0.007	0.094 (2.86)	0.004	0.003 (0.20)	0.838	0.003 (0.19)	0.845

36 See Roodman (2009).

Dependent variable: Leverage	full sample		large 2		medium 3		small 4	
Explanatory variables:	coef (t val)	p val	coef (t val)	p val	coef (t val)	p val	coef (t val)	p val
Loans/TA	–0.047 (–1.88)	0.060	–0.090 (–2.48)	0.013	0.010 (0.70)	0.482	0.019 (1.01)	0.310
ΔLoans	–0.002 (–0.71)	0.476	0.000 (–0.10)	0.924	–0.002 (–0.53)	0.598	0.003 (1.07)	0.287
Deposits/TA	–0.002 (–0.18)	0.858	–0.022 (–1.46)	0.144	0.014 (0.90)	0.368	0.005 (0.44)	0.663
QLP	–0.136 (–2.48)	0.013	–0.108 (–1.47)	0.143	–0.085 (–1.13)	0.258	–0.023 (–0.30)	0.762
size	0.061 (0.45)	0.651	0.575 (2.78)	0.006	–0.087)	0.563	0.619 (1.95)	0.051
GDPG	–0.041 (–1.19)	0.236	–0.063 (–1.55)	0.122	–0.045 (–0.91)	0.364	–0.076 (–1.35)	0.178
ΔUnempl	–0.339 (–2.47)	0.013	–0.470 (–2.31)	0.021	–0.417 (–1.68)	0.092	0.045 (0.26)	0.795
Crisis	–0.054 (–0.26)	0.798	–0.386 (–1.28)	0.200	0.158 (0.41)	0.685	–0.373 (–1.00)	0.316
Crisis*GDPG	0.048 (0.79)	0.427	0.142 (1.73)	0.084	–0.093 (–0.72)	0.473	0.094 (0.81)	0.416
cons	–0.392 (–0.30)	0.768	–1.763 (–0.86)	0.392	0.174 (0.08)	0.933	–2.445 (–1.17)	0.242
AR(1)	–5.52	0.000	–3.74	0.000	–3.87	0.000	–2.87	0.004
AR(2)	2.56	0.010	2.1	0.035	0.69	0.493	1.82	0.069
Sargan (p val)	827.08	0.000	588.16	0.000	511.26	0.000	395	0.000
Hansen (p val)	398.96	0.000	250.33	0.447	251.2	0.345	210.06	0.896
# observ	6,017		2,510		2,144		1,363	
# banks	771		279		271		221	

Notes: This table presents full sample estimation of equation 1 [EQ1]. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmejer's (2005) finite sample correction for the period of 2000–2011 for panel data with lagged dependent variable. In each regression, dependent variable is Leverage – total assets divided by equity capital. As explanatory variables we include: Leverage (-1) – lagged dependent variable; Liquidity – loans to deposits (LTD ratio); Loans/TA – loans to total assets; ΔLoans – annual loans growth real; Deposits/TA – deposits of nonfinancial sector divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; ΔUNEMPL – annual change in unemployment rate; Crisis – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise; Crisis * GDPG – interaction between Crisis and GDPG; # denotes "number of", observ denotes observations, cons denotes intercept; t-statistics are given in brackets.

Table 6. Determinants of liquidity – sensitivity of results to exclusion of three countries with the largest number of observations

Dependent variable: Liquidity	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
Liquidity (-1)	0.873 (7.15)	0.000	0.940 (14.86)	0.000	1.038 (6.25)	0.000	0.819 (7.31)	0.000
Leverage	0.018 (0.36)	0.720	0.051 (1.66)	0.096	–0.053 (–0.78)	0.436	0.094 (0.89)	0.372
Loans/TA	–0.025 (–0.17)	0.867	–0.061 (–0.81)	0.421	–0.197 (–0.97)	0.334	0.023 (0.16)	0.870
ΔLoans	0.008 (1.09)	0.274	0.011 (1.37)	0.172	0.014 (1.68)	0.093	–0.003 (–0.26)	0.791
Depbanks/TA	–0.006 (–0.25)	0.803	–0.028 (–1.33)	0.185	0.053 (1.79)	0.073	–0.038 (–1.21)	0.228
QLP	–0.284 (–2.23)	0.026	–0.438 (–3.21)	0.001	–0.432 (–2.45)	0.014	–0.018 (–0.09)	0.928
size	0.211 (0.44)	0.656	–1.245 (–3.33)	0.001	1.319 (1.77)	0.077	1.986 (1.97)	0.049
GDPG	0.504 (4.02)	0.000	0.526 (5.32)	0.000	0.475 (2.94)	0.003	0.572 (2.33)	0.020
ΔUnempl	–1.200 (–3.34)	0.001	–1.157 (–2.93)	0.003	–0.760 (–1.85)	0.064	–1.027 (–1.77)	0.077
Crisis	2.661 (3.76)	0.000	3.219 (5.99)	0.000	1.830 (2.32)	0.020	1.356 (1.08)	0.279
Crisis*GDPG	–0.621 (–3.37)	0.001	–0.621 (–4.24)	0.000	–0.497 (–2.32)	0.020	–0.492 (–1.60)	0.110
cons	7.098 (2.23)	0.026	14.744 (5.03)	0.000	–0.710 (–0.14)	0.888	–3.379 (–0.57)	0.571
AR(1)	–11.28	0.000	–7.53	0.000	–6.43	0.000	–6.04	0.000
AR(2)	–0.87	0.382	–0.20	0.839	–0.40	0.689	–0.59	0.554
Sargan (p val)	4638.26	0.000	1989.67	0.000	1660.03	0.000	1074.08	0.000

Dependent variable: Liquidity	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
Hansen (p val)	467.25	0.000	258.4	0.296	242.86	0.454	169.35	0.999
# observation	5,375		2,369		1,893		1,113	
# banks	701		270		252		179	

Notes: This table presents full sample estimation of equation 2 [EQ2]. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmejer's (2005) finite sample correction for the period of 2000–2011 for panel data with lagged dependent variable. In each regression, dependent variable is Liquidity – total loans divided by deposits (LTD ratio). As explanatory variables we include: Liquidity (-1) – lagged dependent variable; Leverage – assets to equity capital ratio; Loans/TA – loans to total assets; ΔLoans – annual loans growth real; Depbanks/TA – deposits of banks divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; ΔUNEMPL – annual change in unemployment rate; Crisis – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise; Crisis* GDPG – interaction between Crisis and GDPG; # denotes "number of"; observ denotes observations, _cons denotes intercept; t-statistics are given in brackets.

As can be inferred from Tables 7 and 8, our specifications of equation 1 [EQ1] and equation 2 [EQ2] do not differ significantly from the baseline results presented in Tables 2 and 3. What's more, our sensitivity analysis increased the economic and statistical importance of our baseline results.

Table 7. Robustness – leverage (reduced number of instruments, number of lags of endogenous variables collapsed to 1)

Dependent variable: Leverage	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
Leverage (-1)	0.942 (53.72)	0.000	0.927 (33.5)	0.000	0.911 (34.42)	0.000	0.805 (20.02)	0.000
Liquidity	0.083 (3.18)	0.001	0.128 (3.14)	0.002	0.012 (0.35)	0.729	0.011 (0.74)	0.459
Loans/TA	–0.071 (–2.55)	0.011	–0.132 (–3.03)	0.002	–0.007 (–0.16)	0.870	0.023 (1.13)	0.260

Dependent variable: Leverage	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**	**coef (t val)**	**p val**
ΔLoans	–0.005 (–2.05)	0.040	0.000 (0.04)	0.971	0.001 (0.23)	0.815	–0.002 (–0.59)	0.552
Deposits/TA	0.003 (0.28)	0.779	–0.019 (–1.97)	0.049	0.009 (0.61)	0.541	–0.002 (–0.18)	0.858
QLP	–0.097 (–1.89)	0.058	–0.085 (–1.27)	0.203	–0.109 (–1.42)	0.154	–0.026 (–0.40)	0.687
size	0.217 (1.58)	0.114	0.472 (2.28)	0.023	0.126 (0.75)	0.451	0.948 (3.3)	0.001
GDPG	–0.052 (–1.52)	0.129	–0.058 (–1.25)	0.211	–0.040 (–0.89)	0.371	–0.134 (–2.46)	0.014
ΔUnempl	–0.535 (–4.01)	0.000	–0.276 (–1.45)	0.148	–0.522 (–2.39)	0.017	–0.405 (–1.87)	0.061
Crisis	0.244 (1.33)	0.184	–0.257 (–0.96)	0.335	0.293 (1.24)	0.216	–0.004 (–0.01)	0.990
Crisis*GDPG	–0.038 (–0.78)	0.437	0.134 (1.80)	0.072	–0.132 (–1.82)	0.068	–0.075 (–0.86)	0.388
cons	–2.271 (–1.75)	0.080	–1.772 (–1.06)	0.291	–0.738 (–0.38)	0.707	–4.650 (–3.09)	0.002
AR(1)	–6.03	0.000	–3.95	0.000	–4.51	0.000	–3.51	0.000
AR(2)	2.38	0.017	2.17	0.030	0.52	0.604	1.13	0.258
Sargan (p val)		0.000		0.000		0.000		0.000
Hansen (p val)		0.000		0.005		0.001		0.090
# observation	7 961		3 265		2 896		1 800	
# banks	994		362		357		275	

Notes: This table presents full sample estimation of equation 1 [EQ1]. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmejer's (2005) finite sample correction for the period of 2000–2011 for panel data with lagged dependent variable. In each regression, dependent variable is Leverage – total assets divided by equity capital. As explanatory variables we include: Leverage (-1) – lagged dependent variable; Liquidity – loans to deposits (LTD ratio); Loans/TA – loans to total assets; ΔLoans – annual loans growth real; Deposits/TA – deposits of nonfinancial sector divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; ΔUNEMPL – annual change in unemployment rate; Crisis – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise; Crisis * GDPG – interaction between Crisis and GDPG; # denotes "number of", observ denotes observations, _cons denotes intercept; t-statistics are given in brackets.

Table 8. Robustness – liquidity (reduced number of instruments, number of lags of endogenous variables collapsed to 1)

Dependent variable: Liquidity	full sample 1		large 2		medium 3		small 4	
Explanatory variables:	coef (t val)	p val	coef (t val)	p val	coef (t val)	p val	coef (t val)	p val
Liquidity (-1)	0.740 (8.49)	0.000	0.977 (13.36)	0.000	0.916 (8.44)	0.000	0.807 (7.71)	0.000
Leverage	–0.013 (–0.29)	0.770	0.063 (1.92)	0.054	–0.052 (–0.77)	0.441	0.105 (0.93)	0.351
Loans/TA	0.095 (1.00)	0.316	–0.113 (–1.3)	0.192	–0.079 (–0.59)	0.555	–0.001 (–0.01)	0.991
ΔLoans	0.009 (1.15)	0.249	0.008 (1.04)	0.297	0.005 (0.57)	0.571	0.001 (0.06)	0.954
Depbanks/TA	0.016 (0.57)	0.565	–0.056 (–2.22)	0.026	0.049 (2.48)	0.013	–0.034 (–0.99)	0.323
QLP	–0.395 (–2.57)	0.010	–0.447 (–3.41)	0.001	–0.571 (–3.17)	0.002	–0.111 (–0.47)	0.636
size	0.248 (0.49)	0.623	–1.217 (–3.47)	0.001	1.102 (1.66)	0.098	1.615 (1.87)	0.061
GDPG	0.426 (4.11)	0.000	0.528 (5.37)	0.000	0.359 (3.49)	0.000	0.695 (3.10)	0.002
ΔUnempl	–1.326 (–3.05)	0.002	–1.604 (–3.78)	0.000	–1.193 (–2.51)	0.012	–1.035 (–1.56)	0.118
Crisis	2.221 (4.27)	0.000	3.657 (6.75)	0.000	1.477 (2.66)	0.008	2.196 (2.09)	0.036
Crisis*GDPG	–0.575 (–3.97)	0.000	–0.864 (–5.82)	0.000	–0.396 (–2.47)	0.013	–0.734 (–2.72)	0.006
cons	9.585 (2.77)	0.006	15.104 (5.32)	0.000	3.159 (0.91)	0.363	0.288 (0.07)	0.948
AR(1)	–11.55	0.000	–7.59	0.000	–7.11	0.000	–6.28	0.000
AR(2)	–0.31	0.756	–0.14	0.889	–0.44	0.662	0.01	0.995
Sargan (p val)		0.000		0.000		0.000		0.000
Hansen (p val)		0.000		0.001		0.012		0.451
# observation	6 508		2 771		2 402		1 335	
# banks	885		337		328		220	

Notes: This table presents full sample estimation of equation 2 [EQ2]. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmejer's (2005) finite sample correction for the period of 2000–2011 for panel data with lagged dependent variable. In each regression, dependent variable is Liquidity – total loans divided by deposits (LTD ratio). As explanatory variables we include: Liquidity (-1) – lagged dependent variable; Leverage – assets to equity capital ratio; Loans/TA – loans to total assets; ΔLoans – annual loans growth real; Depbanks/TA – deposits of banks divided by total assets; QLP – is quality of lending portfolio, it equals loan loss provisions divided by average loans; size – logarithm of assets; GDPG – real GDP per capita growth; ΔUNEMPL – annual change in unemployment rate; Crisis – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise; Crisis* GDPG – interaction between Crisis and GDPG; # denotes "number of"; observ denotes observations, _cons denotes intercept; t-statistics are given in brackets.

6. CONCLUSIONS

We examine the determinants of leverage and liquidity of banks for 383 banks across 67 countries over the period 2000–2011. To resolve this problem we applied a 2-step GMM robust estimator to a sample of over 60 countries in the years 2000–2011. Our findings show that increases in previous period funding liquidity risk are associated with increases in leverage in the full sample and in large banks, but not in other banks. What's more, large banks' liquidity risk tends to increase with increasing leverage. Thus we find support for the view that leverage and liquidity risk are interrelated.

With reference to the impact of macroeconomic conditions on the leverage of banks we find results that are economically important. In particular we find support for the view that leverage is not affected significantly by the business cycle during non-crisis periods – consistent with the view that the business cycle does not have economic meaning for leverage level during a non-crisis period. On the other hand, during a crisis period the leverage of large banks is statistically significantly and positively associated with the real growth of domestic product per capita, but only in the subsample of large banks, implying procyclicality of leverage for these banks. As for the impact of the business cycle on liquidity we find support for the prediction that liquidity risk is procyclical during non-crisis periods, i.e. it tends to increase when the economy is booming. In contrast during a crisis period, liquidity risk seems to be countercyclical (i.e. negatively related to real GDP per capita growth). Such a result implies that even when economic conditions improve in some countries during crisis, banks tend to decrease their liquidity risk relative to boom periods. This may be an effect of banks' attempts to decrease liquidity funding risk and thus may result in increased procyclicality of bank lending. There is, however, a visible diversity of impact of the business cycle on liquidity during a crisis period – which seems to be related to bank size category. Generally, medium and small banks' liquidity risk seems to be less countercyclical than the liquidity risk for large banks

Our study contributes relative to the literature in several important respects. First, we identify factors that affect the leverage and liquidity risk of banks. This strategy gives us the opportunity to show which banks' specific and macroeconomic factors are relatively more vital for solvency and liquidity risk formation. Second, we focus on banks that differ in their size (large, medium and small), we are able to identify what is the role of bank size in the link between leverage and liquidity funding risk. Third, we look at the relationship between leverage and liquidity, and ask whether bank leverage is affected by liquidity risk and vice versa, and show the diversity of association between leverage and liquidity risk and vice versa. Our study is important for the current debate on macroprudential policy, and in particular its implementation in the financial sector. As our results show that the association between leverage and liquidity funding risk (and vice versa) is statistically significant and positive in large banks, we are able to confirm the view that macroprudential policy instruments which affect leverage of those banks will also have the potential to stimulate liquidity funding risk (and vice versa) of large banks.

Acknowledgements

The authors gratefully acknowledge that this study has been financed by the Faculty of Management of the University of Warsaw from funds delivered by the Ministry of Science and Higher Education to increase the research potential of the Faculty. The Authors would like to thank an anonymous referee for fruitful comments and suggestions which helped improve the quality of this paper.

Abstract

This paper aims to identify the role of bank size for the sensitivity of leverage and liquidity funding risk to their determinants (both bank-specific and macroeconomic). Applying the two-step robust GMM estimator to individual bank data from over 60 countries covering the period 2000–2011 our study shows that increases in previous period funding liquidity risk are associated with increases in leverage in the full sample and in large banks, but not in other banks. The liquidity of large banks tends also to increase with leverage levels. With reference to the impact of macroeconomic conditions on leverage of banks we find that leverage of large banks is the most procyclical during a crisis period. Liquidity risk is procyclical during non-crisis periods. However, during a crisis period this liquidity risk is countercyclical, consistent with the view that even slight improvements in

macroeconomic environment do not stimulate banks to increase their exposure to this risk. Such effect is particularly strong in the case of large banks. Generally, such counter-cyclicality of liquidity risk of large banks may result in weaker access to the bank financing necessary to stimulate investments in the real economy during a crisis period. This may have further negative consequences for the real economy, generating an extended period of sluggish economic growth.

Key words: leverage, liquidity, funding risk, business cycle, bank size

References

Acharya V.V., Viswanathan S., (2010) Leverage, Moral Hazard and Liquidity. NBER Working Paper Np. 15837.

Adrian T., Shin H.S. (2010) Liquidity and Leverage. Staff Report No. 328. Federal Reserve Bank of New York.

Bank of England (2009) The role of macroprudential policy. A Discussion Paper. Bank of England: November 2009.

Beck T., Demirgüç-Kunt A., Levine R. (1999) A New Database on Financial Development and Structure. World Bank Policy Research Working Paper No. 2146.

Beck T., Demirgüç-Kunt A., Levine R. (2009) Financial Institutions and Markets across Countries and over Time. Data and Analysis. Policy Research Working Paper 4943, World Bank.

Beck T., Levine R. (2002) Industry growth and capital allocation: does having a market- or bank-based system matter? *Journal of Financial Economics* 64: 147–180.

Blundell R., Bond S. (1998) Initial conditions and moment restrictions in dynamic panel data model. *J Econom* 87: 115–143.

Cerutti E., Claessens S., Laeven L. (2015) The Use and Effectiveness of Macroprudential Policies: New Evidence. IMF Working Paper IMF/15/61.

Claessens S., Ghosh S.R., Mihet R. (2014) Macro-Prudential Policies to Mitigate Financial System Vulnerabilities. IMF Working Paper WP/14/155.

Committee on the Global Financial System CGFS. (2012) Operationalising the selection and application of macroprudential instruments. *CGFS Papers* No 48. Bank for International Settlements, 2012.

Committee on the Global Financial System CGFS. (2009) The role of valuation and leverage in procyclicality. *CGFS papers* No. 33.

De Haan J., Poghosyan T. (2012) ‘Bank size, market concentration and bank earnings volatility in the US’, *Journal of International Financial Markets, Institutions, and Money* 22: 35–54.European Systemic Risk Board (ESRB), (2014a) The ESRB Handbook on Operationalising Macro-Prudential Policy in the Banking Sector.

European Systemic Risk Board (ESRB), (2014b) Flagship Report on Macro-Prudential Policy in the Banking Sector.

Flannery M.J., James C.M. (1984) The effect of interest rate changes on the common stock returns of financial institutions. *Journal of Finance* 39(4): 1141–1153.

Freixas X., Loranth G., Morrison A.D. (2007), 'Regulating financial conglomerates', *Journal of Financial Intermediation* 16: 479–514.

Haq M., Heaney R., (2012) Factors determining European bank risk. *Journal of Internatianal Financial Markets, Institutions and Money* 22: 696–718.

Kane E.J., Unal H. (1988) Change in market assessment of deposit-institution riskiness. *Journal of Financial Services Research* 1(3): 207–229.

Konishi M., Yasuda Y., (2004) Factors affecting bank risk taking: evidence from Japan. *Journal of Banking and Finance* 28: 117–232.

Laeven L., Ratnovski L., Tong, H., 2014. Bank Size and Systemic Risk, Staff Discussion Notes 14/4, IMF, Washington, D.C.

Lim C., Columba F., Costa A., Kongsamut P., Otani A., Saiyid M., Wezel T., Wu X., 2011. Macroprudential Policy: What Instruments and How to Use Them? Lessons from Country Experiences. *IMF Working Paper* 11/238.

Myers S., Majluf N., 1984. Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics* 13: 187–221

Olszak M., Pipień M. (2014) Cross country linkages as determinants of procyclicality of loan loss provisions. *European Journal of Finance*.

Olszak M., Pipień M., Kowalska I., Roszkowska S. (2016) What drives heterogeneity of cyclicality of loan loss provisions in the EU? *Journal of Financial Services Research*, http://link.springer.com/article/10.1007/s10693-015-0238-6?wt_mc=internal.event.1.SEM.ArticleAuthorOnlineFirst

Repullo R. (2004) Capital requirements, market power, and risk-taking in banking. *Journal of Financial Intermediation* 13: 156–182.

Roodman D. (2009) Practitioners Corner: A Note on the Theme of Too Many Instruments. *Oxford Bull Econ Stat* 71: 135–158.

Schooner H.M., Taylor M.W. (2010) Global Bank Regulation. Principles and Policies. Elsevier, Academic Press.

Stiglitz JE (2010) Freefall. America, Free Markets, and the Sinking of the World Economy. New York, Norton.

Stiroh K.J. (2006) New evidence on the determinants of bank risk. *Journal of Financial Services Research* 30: 464–472.