5 AN OFF-SITE LIQUIDITY SUPERVISION TOOL

By
Štefan Rychtárik*
Franco Stragiotti†

1 INTRODUCTION

Monitoring liquidity in credit institutions has been a rising matter of debate among regulators since the beginning of the liquidity crunch in August 2007, in particular with respect to the banking sector, where several authors focused on macro stress testing exercises (Van den End 2008, Boss and Altera 2007). Nevertheless, the literature on frameworks adopted by central banks and financial regulators for monitoring liquidity risk of single banks is scarce. In this context, a paper published by the Bank of Japan [2009] tackles the issue of liquidity monitoring in the banking sector. In this analysis, the central bank point of view, the complexity of measuring liquidity risk, and as a consequence, the difficulties embedded in monitoring the process, are highlighted. The assessment of liquidity risk based on indicators (with a dynamic, forward-looking perspective) has been proposed by the Financial Services Authority (FSA) [2009] through its consultation papers on strengthening liquidity standards. The FSA also proposes a set of metrics for liquidity risk monitoring. In these consultation papers, several issues arise regarding comparability across different banks as well as problems related to the intrinsic value of such liquidity metrics when they are extrapolated from their economic and financial context.

Recent market developments have also reminded us of the complex nature of liquidity risk. Based on this experience, this study contributes to the existing literature as it considers liquidity risk from a different perspective, namely as a relative problem.[1] Indeed, our framework does not define a threshold below which a bank would be considered as illiquid. Our assessments are always relative, since they result from comparisons. In this context, we believe that, in order to evaluate the liquidity position of a bank, it is reasonable to compare its liquidity drivers (defined by our ratios) regarding two aspects. On one hand, the liquidity ratios of a bank are compared to the liquidity ratios of similar banks. On the other hand, these ratios are compared to the liquidity ratios of the bank itself over time. In other words, we focus on two principal dimensions in our analysis: (i) the definition and evaluation of the liquidity position of a selected bank across a sub sample of similar banks previously identified through a matrix-based approach and, (ii) the definition and evaluation of the liquidity position of a selected bank by comparing it to its own past liquidity position. This latter dimension integrates a scenario-based set of weighted indicators combined with a set of market and macroeconomic data for each bank located in Luxembourg. The outcome of this process is a scoring-based system which allows us to evaluate the relative degree of liquidity risk of each bank at a certain point in time and helps us to understand the nature of liquidity risk by decomposing it into individual risk factors.

As highlighted by the FSA [2009], comparability across banks implies the use of standardized metrics. These metrics would trigger a biased assessment of their liquidity profile when applied to a heterogeneous population of banks in terms of the sources of liquidity risk each one faces. Similar ratios may imply different liquidity risk levels across diverse business lines. This is true for the Luxembourg banking sector, which is characterized by a large number of subsidiaries and branches of foreign banking groups which often focus on several niche businesses (e.g. custody, private banking and covered bond issuance). A set of indicators identified as relevant for each business activity was defined partly on the basis of Rychtárik Š. [2009]. Moreover, the peculiarity of the Luxembourg banking sector requires the inclusion in the scoring process of a set of ratios assessing the liquidity and (to a certain extent) the financial

* National Bank of Slovakia
† BCL – Prudential Surveillance Department

1 This approach is decribed in detail in the BCL Working paper No. 43

situation of the banking group as well as the economic situation of the country of origin of the local entity. This allows for a more comprehensive and more realistic assessment of the local entity's liquidity position. As regards the choice of the macro variables, we integrate the results of several studies. The definition of a subset of variables which are significant for the assessment of the liquidity profile of each bank originates from several analyses.

2 METHODOLOGY

This study is based on a panel of 145 banks (all banks located in Luxembourg at the time the study was conducted) and a database with financial market and economic indicators from 2003q1 to 2009q3 and on- and off-balance sheet data from 2005q5 to 2009q3. The methodology consists of a foundation and two core pillars:

- The foundation consists of a risk factor matrix that allocates a set of liquidity risk factors with respective weights to each bank based on its business

- The first pillar evaluates the liquidity position of a selected bank vis-à-vis that of similar banks ("peers"). Thus, it attributes a "peer score" to each bank, based on the selected set of liquidity risk factors. This score is calculated on the basis of each bank's on- and off- balance sheet data compared to the other banks' for different time periods

- The second pillar assesses the current liquidity position of a selected bank over time vis-à-vis its own historical data. It defines a "time score" for each bank, which integrates both a micro- and a macro-component.

These scores can be further analysed bank by bank as they change over time. They can also be decomposed to identify the main liquidity risk factors for every bank. Moreover, the framework can be used as a tool in general banking sector analysis, e.g. for financial stability purposes.

Different types of banking activities are often related to different sources of liquidity risk. Therefore, the analysis or the quantification of liquidity risk needs to be tailored to the set of local banking activities. Previous research at the Central Bank of Luxembourg (BCL) [Stragiotti, F., 2009] showed that Luxembourg's banking sector is characterized by a rather high level of specialization. Several banks are active in a few highly specific activities, such as custodian or depository banks or covered bond issuance banks. The average number of activities is often characterized by more than two business activities per bank. This implies that banks may not be merely classified by allocating a bank to one business activity. Similarly, even if there are some typical combinations of business lines (e.g. private banking and fiduciary deposits, custody and asset management), to cluster banks located in Luxembourg into several "peer" groups would necessarily result in an oversimplification of reality. To avoid it, the methodology presented in this paper uses a matrix of weighted liquidity risk factors translated into indicators and mapped to every bank in the sample.

For this purpose we have selected and defined 14 on- and off- balance sheet risk factors and 7 market risk factors. We believe that these 21 risk factors cover, altogether, even though with a different degree of importance, a large spectrum of the potential sources of liquidity stress relevant for the banks active in Luxembourg.

2.1 Balance sheet risk factors

Since the nature of liquidity risk depends importantly on the type of business conducted by the bank, it is necessary to identify the main banking activities located in Luxembourg. For that purpose, we used several sources of information. The main ones were: (i) regulatory reporting data (also treated by a principal component analysis); (ii) annual reports of the banks; (iii) questionnaires[2]; (iv) meetings with banks; (v) on-site visits and; (vi) other sources such The Luxembourg Bankers' Association.[3] We identified 14 risk liquidity factors that can be defined by on- and off-balance sheet data (Table 1).

Table 1 :
Balance sheet risk factors

Risk factor	Type of trigger	Description
Freeze of interbank market	Macro	Banks are not willing to lend to each other, which leads to a substantial decrease of interbank positions, both long and short.
Capital markets shock	Macro	Fall in debt security prices, which results in a decrease in the value of liquid assets.
Retail run in Luxembourg	Idiosyncratic	Withdrawal of household deposits triggered by rumours.
Private run	Idiosyncratic	Withdrawal of private deposits triggered by rumours.
Corporate run	Idiosyncratic	Withdrawal of corporate deposits triggered by rumours.
Withdrawals by funds	Idiosyncratic	Withdrawal of investment fund deposits triggered by banks' rating downgrade, or as a result of fund redemptions
Issuance problems	Macro/ Idiosyncratic	Problems to raise funding by new debt issuance triggered either by unfavourable market conditions or banks' rating downgrade.
Custodian operational issues	Idiosyncratic	Due to operational issues in settlement the bank runs into overnight liquidity shortage.
Committed credit lines	Idiosyncratic	Generous loans commitments given during favourable market conditions are drawn down by the counterparties.
Foreign exposures	Macro	Credit risk problems in foreign country/ currency exposures result in a liquidity problem.
Fiduciary deposits	Legislative	Due to changes in regulation, fiduciary deposits become more volatile.
Off-shore centres	Legislative	Due to stricter regulation of off-shore centres, some of the flows become more volatile.
Eurosystem refinancing	Idiosyncratic	Conditions for accessing Eurosystem liquidity become stricter (e.g. stricter collateral criteria and larger haircuts)
Group liquidity	Group idiosyncratic	Netting of the liquidity position with banks from the parent banking group

2.2 Market risk factors

The market risk factors are included in our framework for three main reasons. First, according to the Principles for Sound Liquidity Risk Management and Supervision (BIS 2008), supervisors should also use the market information in the process of liquidity risk assessment.[4]

Second, the host character of the Luxembourg banking sector implies a rather high dependence of the local entities on the overall situation of the parent banking group[5]. Therefore the plain on- and off-balance sheet data reported by these local entities in the large majority of cases do not contain enough information to obtain a complete picture of their liquidity position. Given that we do not have direct access to internal documents, reports or other information as regards the liquidity position of the parent banking group, we deemed it appropriate to include among the liquidity ratios a set of indicators which could be a proxy for the liquidity profile of the parent company.

Finally, the economic literature stresses the existence of several factors that act as predictors of financial crises which could potentially hit the banking sector.[6] In this context, the integration of the risk factors in our

2 See Stragiotti [2009]

3 For more information on this organization, please visit: www.abbl.lu

4 Principle 15: Supervisors should supplement their regular assessments of a bank's liquidity risk management framework and liquidity positions by monitoring a combination of internal reports, prudential reports and market information.

5 These specific characteristics of each local banking sector should be taken into consideration according to, e.g. Kaminsky and Reinhardt [1999] and Hermosillo [1999].

6 For a review of early warning indicators in banking crises, see Gaytán and Johnson [2002].

framework is a first step in the process of formulating a more precise linkage between these variables and their role as early warning indicators. These are indeed the "canary in the mine" that signal an increased probability of occurrence of a stress situation in a specific banking group/country. Based on the literature and data availability, we have defined four main categories of indicators of market risk: financial markets, interbank market, macroeconomic conditions and currency issues.

Like the balance sheet part of our framework, the market risk factors need to be translated into indicators; we use three levels of specificity. While the first two indicators (namely Euribor/ Eurepo spread and Luxembourg consumer confidence indicator) are applied to all the banks; the next three indicators (economic sentiment, stock exchange index and special drawing rights) are common for banks whose mother company is located in the same country. The final two indicators (stock price and stock price volatility) relate to the parent banking group. The set of market risk factors is translated into a set of market variables, which could be classified according to the following matrix (Table 2). The table displays the components of market risk factors, their coverage (market-wide, country specific and idiosyncratic) and their type (financial vs. macroeconomic).

Table 2 :
Market risk indicators

	Financial markets	Macroeconomic
Common indicator across the sample	– EURIBOR-EUREPO spread	– Consumer confidence indicator of Luxembourg
Common for banking groups from the same country	– Reference stock exchange index	– Economic sentiment indicator (ESI) of the country of origin – Foreign exchange rate (SDR) of the country of origin
Idiosyncratic (bank-specific)	– Stock price – Stock price volatility	n/a

2.3 Risk factor weights determination

After the risk factors are selected and translated into risk indicators, we need to determine the relative importance of these risk factors to every bank for every period.

The balance sheet risk factor weight $(w_i^{b,t})$ is a normalised intermediate risk weight that sums up to 1, and depends on how many risk factors are relevant for each individual bank. Intermediate risk weights are a function of the relative share of the risk parameters over the liquid assets and the volatility of these parameters over time. As a general rule, the higher the importance and the volatility of a risk parameter, the higher the balance sheet risk factor weight associated with it. This allows us to integrate the effect of changes in banking activity into the balance sheet of the banks over time.

Unlike balance sheet risk factor weights, the market risk factor weights $(w_j^{b,t})$ do not depend on the relative balance sheet importance and volatility of the risk parameter, but on the number of market risk factors. As some of the banks are not listed and no stock price data are available, not all of the banks have the same number of market risk factors. As a result, the market risk factor weights are calculated as a function of the number of market risk indicators available for each bank in different periods. The weights are equal to either 1/7, if all indicators are available, or to 1/5, if the bank is not listed and thus the stock price and its volatility are not available.[7]

7 The market factor weights can be further calibrated according to characteristics of the local banking sector.

3 CALCULATION OF THE SCORES

The objective of the first pillar is to provide a relative score from 1 (the best) to 9 (the worst) for every bank at a moment in time. This score is a weighted average of the position of a bank's risk indicator in the distribution of risk indicators calculated for all relevant banks. The peer score is based exclusively on the data from regulatory reporting, i. e. the on-balance sheet and off-balance sheet data of the Luxembourg entities. There is no reference to the parent banking group risk profile, to financial markets or to macroeconomic developments. Thus, the only risk factors considered in this calculation are the 14 balance sheet risk factors (see Table 1).

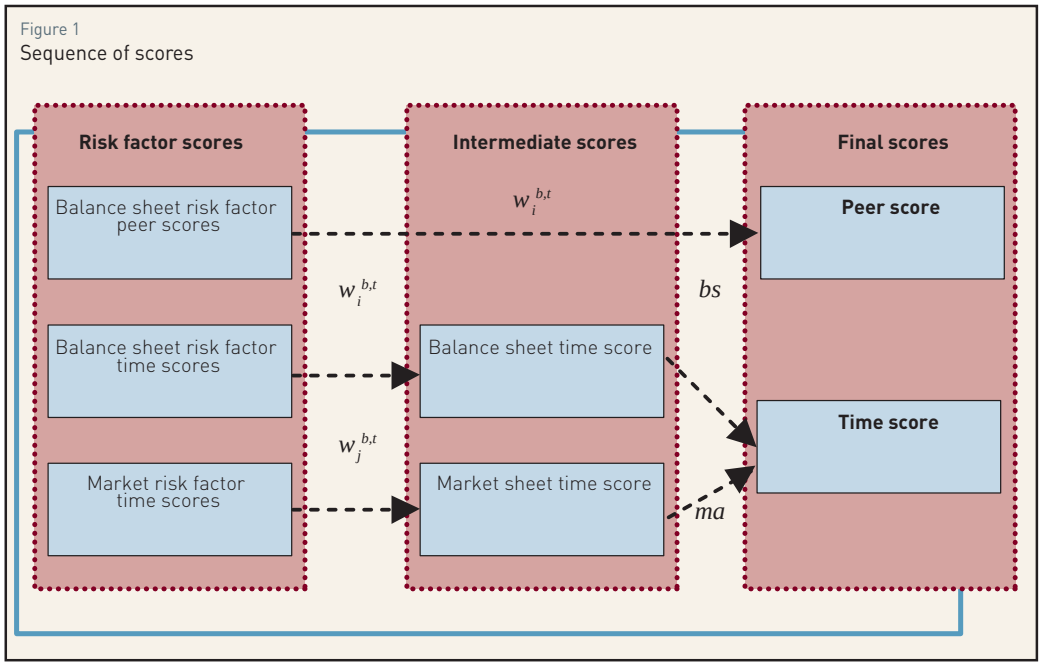
A distribution of every balance sheet risk indicator is calculated taking into consideration only those banks for which that indicator is relevant. Based on the relative position of the bank's risk indicator in the distribution, a score is assigned. This is done separately for each of the 14 balance sheet risk factors. A bank receives a balance sheet risk factor peer score, unless its corresponding weight is below a threshold, which, in our case, is equal to 0.1. According to the position of the risk indicator in the different percentiles of the distribution, this risk balance sheet factor peer score can span from 1 to 9. The final peer score is an average of the balance sheet risk factor peer scores obtained for different risk factors weighted by their relative importance and volatility (Figure 1).

As a result, the peer score depends only on a bank's relative liquidity position within the banking sector as measured by the balance sheet risk factors, and does not reflect possible shifts in the liquidity position of the banking sector as a whole. In other words, the peer score only provides us with information about an individual bank's liquidity position relative to its peers. It does not capture trends in the banks in the sample. This is, instead, captured by the second pillar, namely the time score.

The objective of the second pillar is to provide a score relative to the bank's previous experience (the time score). In this exercise, we do not compare the banks among themselves but we confront the bank with its past liquidity positions. For the time score, we have added 7 external market variables to take into consideration developments in financial markets, the situation of the parent banking group and the general macroeconomic outlook for the relevant countries (Table 2). The introduction of these 7 external variables reduces the degree of interdependence between the peer score and the time score. As a result, the difference between the two pillars lies not only in the different methodology followed (peer comparison vs. comparison over time), but also in the variables considered. As in the first pillar, every bank gets a score which spans from 1 (the best) to 9 (the worst) at a precise moment in time. In general, the time score depends on the positions of a bank's risk indicators in the distribution of the respective risk indicators calculated for previous periods. This is done separately for balance sheet and market components to calculate risk factor specific scores within both components. As a result, two intermediate scores are assigned to every bank, i.e. the balance sheet time score and the market time score. The final time score is a weighted average of the intermediary scores (Figure 1).

As a result, at every moment in time, each bank is characterised by two scores. On the one hand, we can see the bank's liquidity position described by reporting data, which depends primarily on comparisons among different banks in the Luxembourg banking sector. On the other hand, we can observe a dynamic picture where every bank is analysed in terms of its own vulnerability on standard balance sheet scenarios under dynamic macroeconomic conditions and contingent on the general soundness of its parent banking group.

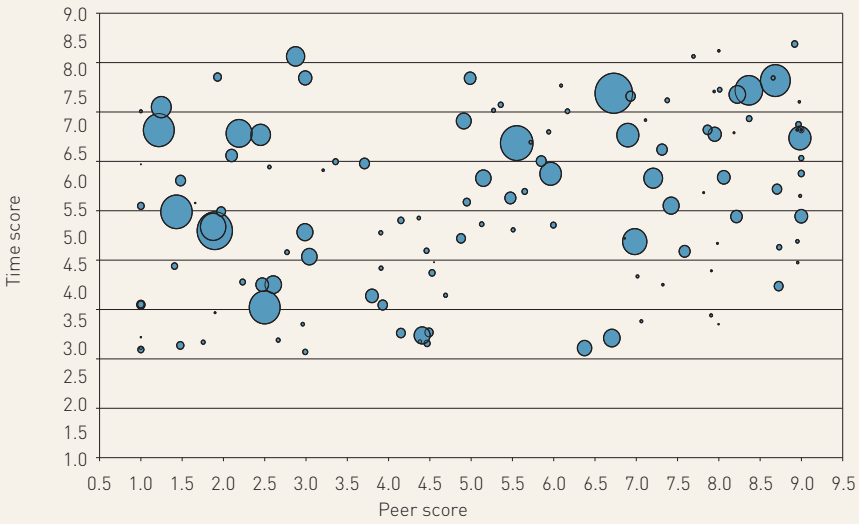
Figure 1
Sequence of scores



4 RESULTS

This section demonstrates how results could be analysed and what conclusions could be drawn from the monitoring framework. These results can be applied both in the process of supervision of individual banks and in general banking sector liquidity risk analysis for supervisory or financial stability purposes.

Figure 2
Example of a liquidity matrix (September 2009)



The size of the bubble represents the size of the balance sheet.
Source: BCL, authors' calculations

4.1 Liquidity matrix

In every time period, the liquidity situation of banks can be displayed in a liquidity matrix that shows both the peer scores and the time scores (Figure 2). If such analysis is done for time t_0, the supervisors are able to spot the outliers, to better focus their attention, and to allocate analytical resources more efficiently. The liquidity matrix also contains a third dimension of information, which is the size of individual banks represented by the size of the bubbles.

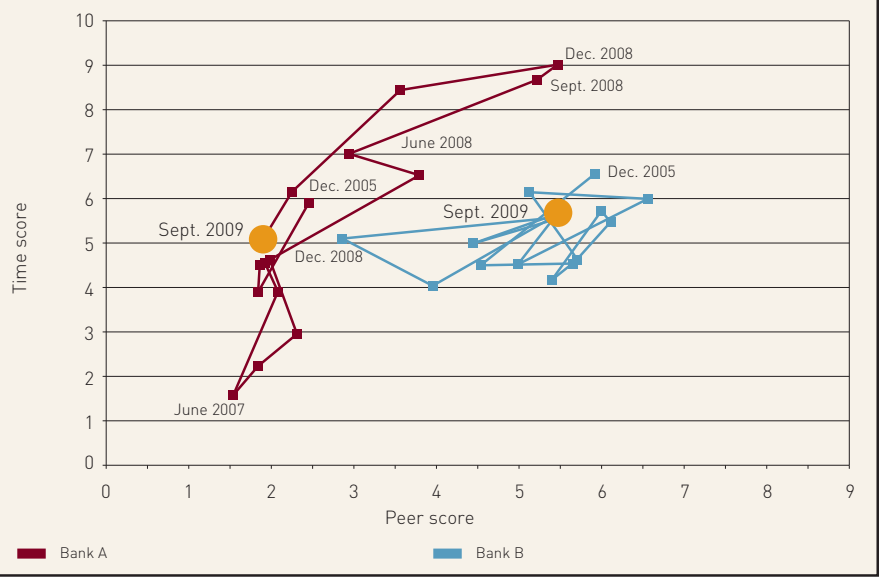
As the size of a bank could be correlated with its systemic importance, such information can be useful in the field of financial stability as well.

To give a practical example, the results for September 2009 displayed on Figure 2 could be analysed in the following way. Although the bigger banks are spread all over the matrix, the first band of peer score (1-2) is dominated by banks with relatively greater market share. In other words, except for a few big banks, the peer liquidity positions of Luxembourg entities do not generally depend on size. From a time point of view, no bank fell into the best time score band. In general, this means that Luxembourg entities are in a relatively more difficult liquidity position than their historical benchmark provided by four years of data. The biggest banks dominate the score bands from 4 to 8. From a supervisory point of view, therefore, attention should be focused on the banks in the upper right hand corner to analyse and understand the reason behind their relative liquidity positions.

4.2 Evolution of the scores over time

The liquidity matrix can be analysed by studying the liquidity position of a bank over time. On Figure 3 we can observe the trajectory of the positions of two of the banks in the liquidity matrix.

Figure 3
Examples of changes of two banks' position in the liquidity matrix



The bubbles represent the last available observation.
Source: BCL, authors' calculations

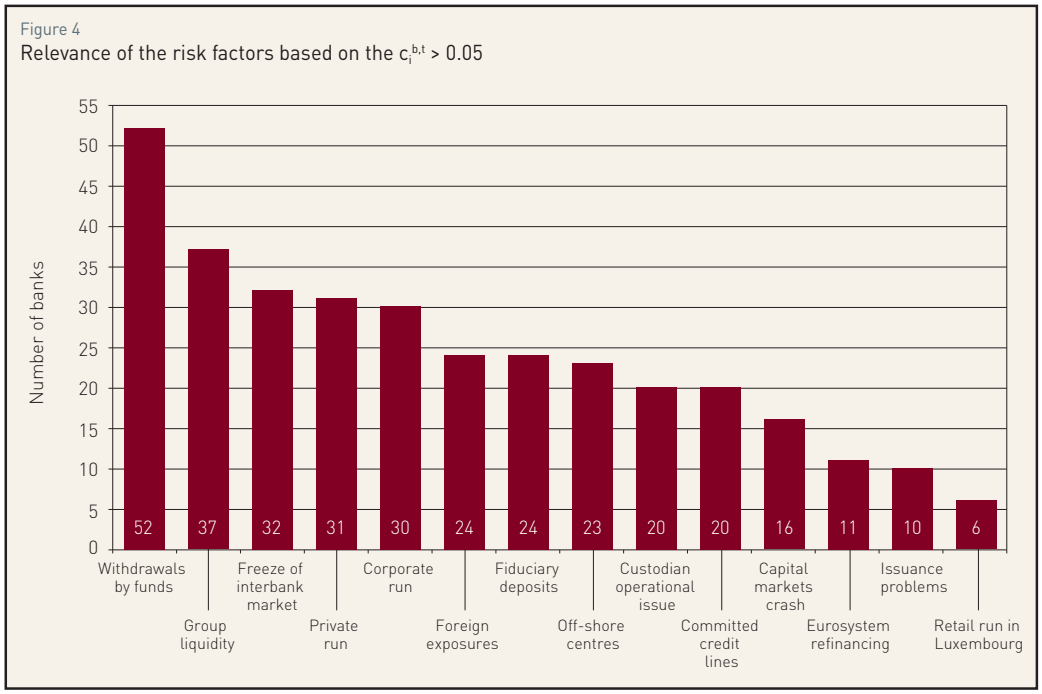
4.3 Decomposition of the scores

Since the final scores are weighted averages of scores calculated for different risk factors, we can calculate the contribution of each risk factor to the final scores. In the case of the peer score, such decomposition identifies the main balance sheet risk factors. As regards the time score, we can distinguish between the market and the balance sheet risk factors.

The decomposition of the scores helps us in understanding the main driving forces of liquidity risk of each bank in the Luxembourg banking sector. From a supervisory point of view and from an early warning perspective, such analysis is very important. According to the back-testing done on a sample of troubled banks, the composition of the score of these banks changed significantly, while the value of the score usually remained rather stable at high levels.

One further possible application of this off-site supervisory tool is the assessment of the most relevant risk factor at t_0. The number of banks with $c_i^{b,t}$ larger than 0.05 for different risk factors is shown on Figure 4 For every risk factor, we count the number of banks for which this factor contributes to the final peer score by more than 5%.

Figure 4
Relevance of the risk factors based on the $c_i^{b,t} > 0.05$

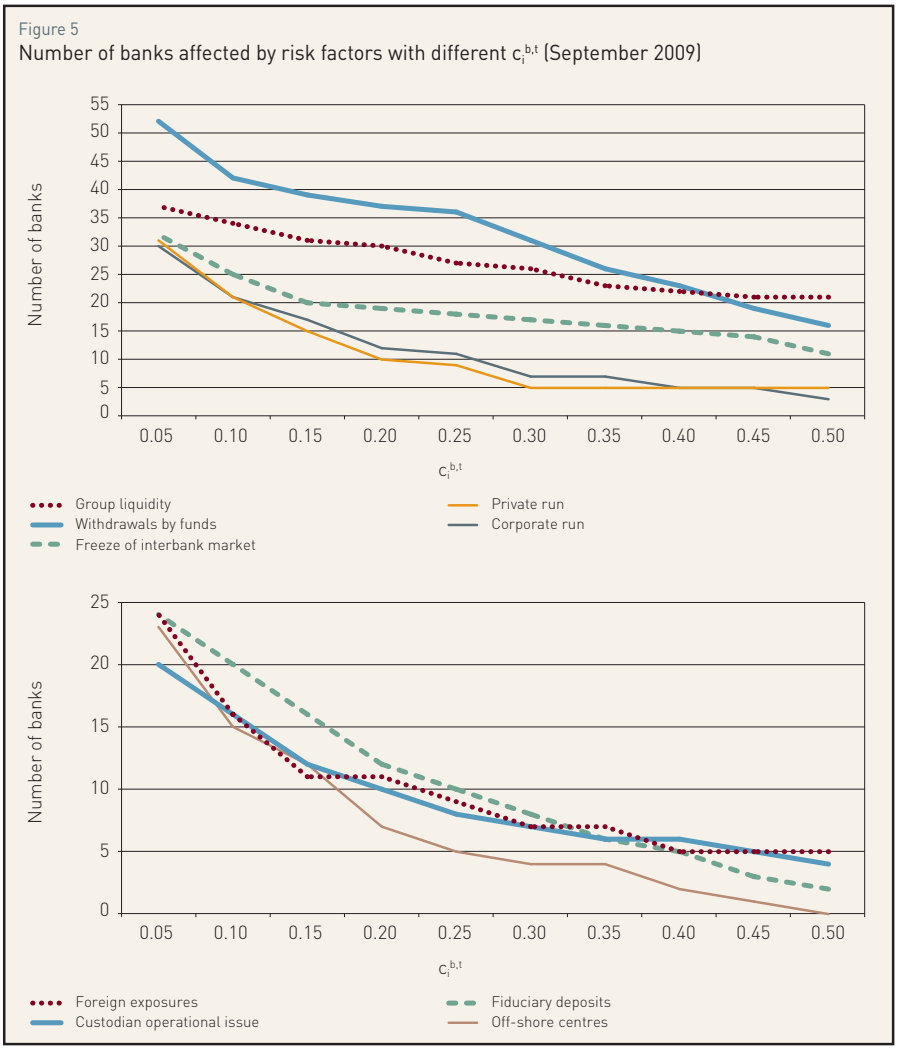


Source: BCL, authors' calculations

With this threshold of contribution of 5%, the most relevant risk scenarios are: withdrawal of deposits by investment funds (52 banks), netting of the position with the parent banking group (37 banks), inter-bank market (32 banks), and withdrawals of private banking and corporate deposits (31 and 30 banks). However, risk factors such as foreign lending, fiduciary deposits and off-shore centres still affect 24 banks. Such conclusions are in line with the general knowledge about the Luxembourg banking sector namely that it services the fund industry and is active in private banking. The Luxembourg banking sector is also very much a host banking sector; this is reflected in the relevance of parent banking group in terms of liquidity risk.

In Figure 4, we only see those banks which would be affected by risk factors (scenarios) with a contribution of more than 5%. To identify the most relevant scenario, we also need to analyse the impact with higher values of $c_i^{b,t}$ (Figure 5). In this context, sensitivity to deposit withdrawals by investment funds and dependence on the parent banking group seems to be very relevant, as the number of banks concerned does not decrease significantly with increasing $c_i^{b,t}$. Even where the contribution exceeds 50%, 16 and 21 banks, respectively, remain affected by these risk factors. By contrast, the relevance of the private banking scenario decreases significantly as $c_i^{b,t}$ increases (5 banks with a contribution of more than 50%). This implies that, even if many banks located in Luxembourg are involved in private banking, this scenario is the most important risk factor for only a few of them.

Figure 5
Number of banks affected by risk factors with different $c_i^{b,t}$ (September 2009)



Source: BCL, authors' calculations

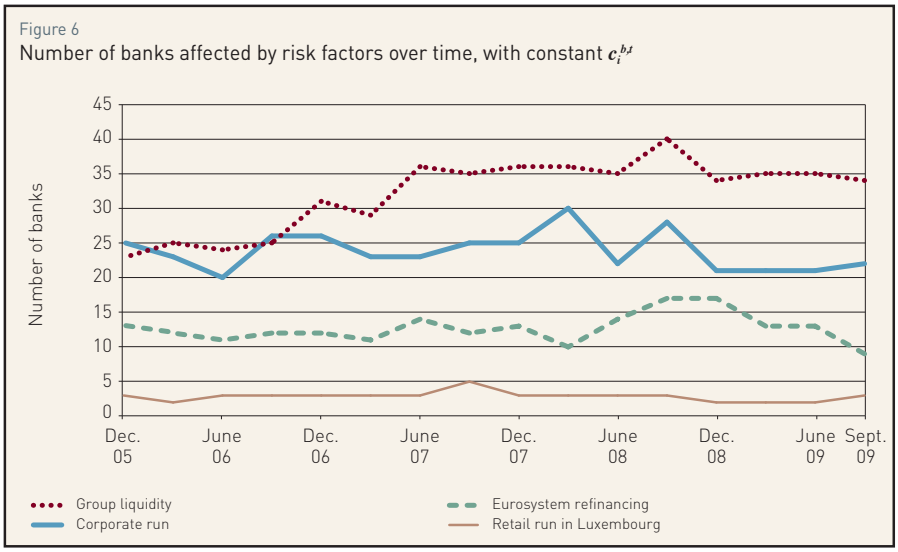
4.4 Evolution of the risk factor relevance over time

With a constant $c_i^{b,t}$ [8], we can observe the evolution of the risk factor relevance over time (Figure 6). As a result, we can analyse the potential influence of the financial crisis on the general risk profile of the Luxembourg banking sector.

The number of banks exposed to a retail run in Luxembourg is rather stable and does not significantly change during the first peak of the crisis. This is a logical consequence of the long term nature of this business line. Risks associated with the possibility of using Eurosystem liquidity are very different examples. The number of banks dependent on refinancing operations with the Eurosystem increased significantly during the stress period, and decreased again only in March 2009.

8 For this purpose we set the $c_i^{b,t}$ to 0.05, meaning that contribution to the score of more than 5% is considered as relevant

Figure 6
Number of banks affected by risk factors over time, with constant $c_i^{b,t}$



Source: BCL, authors' calculations

As it has been argued, the main objective of the off-site supervisory framework is to identify possible weaknesses in the liquidity positions of individual banks. Nevertheless, it also serves as a basis for drawing conclusions about the relevance of different risk factors (stress scenarios) for the banking sector as a whole.

5 CONCLUSIONS

In this paper, we described the off-site liquidity risk monitoring framework used by the BCL. Our framework integrates several types of data (regulatory reporting, financial markets, macroeconomic data) and therefore takes into account different sources of liquidity risk, including potential problems at the mother company level or general market stress. The methodology is based on a matrix of 14 on- and off-balance sheet and 7 market risk factors assigned with different weights to each bank and then evaluated in relative terms. As a result, the liquidity position of every bank is described by two liquidity scores (comparison to the peers and comparison over time).

The practical application of our framework can be summarised in the following way: Firstly, we have calculated both dimensions (peer and time score) of the liquidity position of every bank located in Luxembourg. In this matrix, we could spot the banks which are less liquid than their peers or less liquid than before, and evaluate the systemic importance of these institutions.

Secondly, we have chosen several examples of banks with different business models to demonstrate the evolution of both scores over the last four years. Such trend analysis proved to be important mainly in the case of banks with a weak liquidity position. In these cases, we could discriminate between structural illiquid banks and those whose liquidity position deteriorated recently.

Thirdly, using one bank as an example, we have shown the potential benefits of a thorough analysis of the scores. By decomposing the scores, the most relevant risk factors can be identified for each and every bank. We have also demonstrated the importance of this approach on examples of troubled banks, which witnessed similar patterns in the composition of their scores and in terms of their evolution before the recent crisis.

Finally, the relevant risk factors of all banks located in Luxembourg can be aggregated and sorted by frequency of occurrence to determine their general relevance to the banking sector as a whole. In such analysis, we could observe risk factors with a rather constant contribution (e.g. the retail business), and risk factors whose contribution depended more on recent market developments (e.g. dependence on the refinancing operations with the Eurosystem).

As a result, two major sources of information can be obtained from the framework. Firstly, the most vulnerable banks can be filtered from the whole sample and can be identified as candidates for further supervisory analysis. Secondly, the most relevant liquidity risk factors for the Luxembourg banking sector can be determined.

References

Bank of Japan [2009] "*The Bank of Japan's Approach to Liquidity Risk Management in Financial Institutions*", available at: http://www.boj.or.jp/en/type/release/adhoc09/data/fss0906a.pdf

Bank of England [2009] "*Special liquidity scheme: information*" and "*Special liquidity scheme: market notice*", available at: http://www.bankofengland.co.uk/publications/news/2008/029.htm

Bank for International Settlement [2008] "*Principles for Sound Liquidity Risk Management and Supervision*", BCBS, September 2008, available at: http://www.bis.org/publ/bcbs144.pdf

Bank for International Settlement [2000] "*Sound Practices for Managing Liquidity in Banking Organisations*", BCBS, February 2000, available at: http://www.bis.org/publ/bcbs69.htm

Banque centrale du Luxembourg [2009] "*Revue de stabilité financière 2008*", available at http://www.bcl.lu/fr/publications/bulletins_bcl/Revue_de_stabilit___financiere_2008/index.html

Boss, M., G. Krenn, M. Schwaiger and W. Wegschaider [2004] "*Stress Testing the Austrian Banking System*" Öesterreich National Bank, 11/04, 841–852, also available on http://www.oenb.at/de/img/artikel_9_841852_boss_et_al_11_tcm14-27296.pdf

Committee of European Banking Supervisors [2009] Interim Report on Liquidity Buffers & Survival Periods. 2009, also available on http://www.c-ebs.org/News--Communications/Latest-news/CEBS-is-today-publishing-an-interim-report-on-liqu.aspx

European Central Bank [2008] "*The Implementation of Monetary Policy in the Euro Area. General Documentation*", Eurosystem monetary policy instruments and procedures.

Financial Services Authority [2009-a] "*Strengthening liquidity standards 2: liquidity reporting*" consultation paper 09/13, also available at: http://www.fsa.gov.uk/pubs/cp/cp09_13.pdf

Financial Services Authority [2009-b] "*Strengthening liquidity standards 2: liquidity reporting*" consultation paper 08/22, also available at: http://www.fsa.gov.uk/pubs/cp/cp08_22.pdf

Frankel, J., and Shang-Jin W. [2004], "*Managing Macroeconomic Crises: Policy Lessons*", Chapter 7, in Economic Volatility and Crises: A Policy-Oriented Guide, edited by Joshua Aizenman and Brian Pinto, World Bank, Washington DC.

Gaytán, A. and Johnson C. A. [2002], "*A review of the literature on early warning systems for banking crises*", Working Papers No. 183 October, Central Bank of Chile.

González-Hermosillo B. [1999] "*Developing Indicators to Provide Early Warnings of Banking Crises*" Finance & Development, IMF quarterly magazine, Volume 36, Number 2, June, available at http://www.imf.org/external/pubs/ft/fandd/1999/06/gonzalez.htm

Jurča, P. and Rychtárik, Š. [2006] "*Stress testing of the Slovak banking sector*", Biatec Volume XIV, 4/2006

Kaminsky G. L., [1998] "*Currency and banking crises: the early warnings of distress*" International Finance Discussion Papers 629, Board of Governors of the Federal Reserve System (U.S.).

Kaminsky, G. and al. [1998] "*Leading Indicators of Currency Crises*" IMF Staff Papers, 5 (1):1-48.

Kaminsky, G. and Reinhardt, C. [1999] "*The twin crises: the causes of banking and balance-of-payment problems*" American Economic Review 89: 473-500.

Rychtárik, Š. [2009] "*Liquidity scenario analysis in the Luxembourg banking sector*" Banque centrale du Luxembourg, Working paper n. 41/ September.

Stragiotti, F. [2009] "*Stress testing and contingency funding plans: an analysis of current practices in the Luxembourg banking sector*" Banque centrale du Luxembourg, Working paper n. 42/ December 2009

Van den End, J.W. [2008] "*Liquidity stress-tester: a macro model for stress testing banks' liquidity risk*" DNB working paper No. 175, May 2008.