WORKING PAPER

MACROPRUDENTIAL LIQUIDITY STRESS TEST: APPLICATION FOR INDONESIAN BANKING

Aditya Anta Taruna
Cicilia A. Harun
R. Renanda Nattan

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This is a working paper, and hence it represents research in progress. This paper represents the opinions of the authors, and is the product of professional research. It is not meant to represent the position or opinions of the Bank Indonesia. Any errors are the fault of the authors
Abstract

This paper closes the gap of the need to have a macroprudential liquidity stress test model with consistent macroeconomic scenario and implementation of the propagation and amplification mechanism for Indonesian banking. The model breaks down the idiosyncratic, macroeconomic and unknown impacts on the liquidity portfolio of banks taking into account the solvency condition. The liquidity stress test should be implemented as a part of the overall macroprudential stress test that measures the systemic risk.

Keyword: Liquidity stress test; Stress test; Financial stability; Banking.
JEL Classification: G21; G33.
1. Introduction

Banking business is a management of liquidity mismatch. Banks gather short-term funds (deposits) to place them in long-term assets (credits). Despite the development of modern banking business, the practice of banking is mostly still traditional in an emerging market like Indonesia, as well as some other countries that rely on bank financing to fuel the economy. In managing mismatch risks, banks rely on the fact that depositors have different timing of withdrawal, hence they should be able to maintain a core deposit that could be considered stable for long-term placement. Problems emerge when depositors withdraw at the same time. Diamond & Dybvig (1983) provides the seminal paper in formulating the risk of depositors’ run from a bank. Many financial crises in the world involving bank runs had caused economic downturns. This includes the latest global financial crisis of 2008.

The global financial crisis (GFC) of 2008 has drawn attention toward the management of liquidity risk in banking practice as many view that global liquidity stress is the trigger of the financial market meltdown. One major improvement in the global financial regulatory reform for banks is the addition of requirements on liquidity ratios. Since the crisis, BCBS has prescribed two relatively new instruments: liquidity coverage ratio (LCR) for short-term liquidity need (BCBS) and net stable funding ratio (NSFR) for structural funding requirement. Although the design of the ratios has already incorporated the capacity of banks in facing liquidity stress, it has not given any information on how banks would react when they face the dynamic market-wide stress. This kind of stress also means the possibility of dry-up of the market liquidity, loss of values in liquid assets because of fire sale and the disappearance of contingent credit lines.

In order to assess the financial stability, financial authorities have been using stress tests to measure the loss absorbing capacity of banks in facing various macroeconomic scenarios. Although stress tests have gone beyond to find out about the solvency of banks during market-wide stress and idiosyncratic stress by running liquidity stress tests, generating a consistent scenario for all credit risk, market risk and liquidity risk is still challenging. In many occasions, liquidity stress tests still employ a scenario independent from the solvency stress test, which measures the credit and market risk. Therefore it is important that a framework of liquidity stress test not only be developed to gather information about the resilience of the banking system toward both system-wide and idiosyncratic liquidity stress but also able to carry out a consistent macro scenario implemented within the solvency stress test framework.

In addition to the need to implement a consistent scenario, in order to grasp the complete picture of the impact of a certain macroeconomic development to the banking system, stress tests also to implement the phenomenon of amplification and propagation. The amplification of a system-wide stress could be easily implemented on the first round of impact with the exposure data at the point of impact (common exposure). However, as the stress continues, the banking system is not out of the woods yet. Systemic risk may still be amplified and propagated through the transmission channels of financial linkages and information. In the second round, anything could happen. A troubled bank may provide additional stress to the other banks (especially if the bank is a systemically-important bank). Panic depositors may exacerbate the stress. Banks may reduce credit that could cause a decline in real sector activities. This later on could also reduce the repayment capacity of debtor corporations. As defense, banks may also start to hoard liquidity that dried up alternative funding from interbank loans. Implementing each scenario in a stress test model is a daunting task. However, some degree of effort to capture the phenomenon may help authorities to assess the banking system’s resilience in the face of macro shocks.
Liquidity stress test (LST) becomes very important, as liquidity is the component of banks’ portfolio most sensitive to the changes in the financial market. Many banking problems are propagated and amplified through liquidity risk. Tirole (2011) provides a nice narration of the illiquidity problems of banks. Some of the problems are also mentioned in the previous paragraph. Banks face two different liquidity risks: funding liquidity risk since they have to match their long-term asset to long-term or stable funding and market liquidity risk since they need to be aware about the price, interest rate and exchange rate that may affect the value of their counterbalancing capacity during market-wide liquidity stress. During system-wide stress, both types of liquidity risk may reinforce each other (Brunnermeier & Pedersen, 2008). Therefore, it is important to capture both risks in the liquidity stress test as well as the additional aspects that may be the reinforcing factor.

Before the global financial crisis of 2008, banks or financial authorities that conduct LST mostly focused on idiosyncratic risks, generating liquidity shock scenarios based on the historical liquidity shocks in the form of deposit withdrawal. Later, the additional scenario of reduced value of counterbalancing assets is also incorporated to take into account the macrofinancial environment. The crisis actually provides a case of a financial crisis triggered by the loss of asset value that happens to be a common shock to global banks. A liquidity stress of a certain group of banks, those that are exposed to the subprime mortgage products, could cause a liquidity squeeze to the global financial market. Taking into account only idiosyncratic shocks in a liquidity stress test exercise would undermine the impact of deteriorating macro-financial environment and global banking interconnectedness. In order to take into account the macro-financial environment that may cause a system-side liquidity shock, a liquidity stress test should be able to transmit the macro scenario built for the solvency stress test, and both solvency and liquidity stress test should be integrated. This actually also supports Diamond & Rajan (2005) study that a banking crisis could be caused not only by bank run, but also by contagious banking failure.

The purpose of this research is to produce a model of LST using consistent macroeconomic scenarios while taking into account idiosyncratic, system-wide and unknown aspects. The unknown aspect could be interpreted as the possibility of panic in the market that will provide a non-linear impact to the banking system. The model is built for Indonesian banking that mostly still practices traditional banking business as in most emerging markets. The model will be used to measure the liquidity-risk-absorbing capacity of the Indonesian banking system in the face of severe but plausible stress test scenarios. In this case, as Bank Indonesia already implemented a liquidity-based macroprudential instrument called macroprudential liquidity buffer, the result of the LST would become an insight to calibrate the magnitude and timing of the instrument. The macroprudential policy is still needed to provide discipline to the banking system with procyclical behavior (Levy-Yeyati et al, 2010)

The LST developed in the paper is also a part of the overall macroprudential stress test for Indonesian banking that was initiated in Taruna & Harun (2016a), and has been continued in Taruna & Harun (2016b) and Taruna & Harun (2017). The work is inspired by the macroprudential stress test built by the Bank of Korea called Systemic Risk Assessment for Macroeconomic and Social Stability (Moon et al, 2013).

The rest of the paper is organized in chapters. Chapter II follows up with some descriptions of the practice of liquidity stress testing in various jurisdictions as well as the liquidity risk indicators already implemented in Indonesia. Chapter III describes the modeling and data that will be used in the liquidity stress test in this research. Analysis and results will be discussed in Chapter IV. Chapter V concludes and adds some notes about implementation of the liquidity stress test.
2. Macroprudential Liquidity Stress Test

2.1. Liquidity Stress Test in Other Countries

BIS (2013) distinguished 3 groups of stress testing methods used by the authority i.e., bottom up macro test approach, top down approach, and combined approach. Financial institutions using scenarios or assumptions instructed by the authority usually carry out bottom up stress test. However, the bottom up stress test macro test is performed by authorities and consists of regular liquidity risk reports and occasional horizontal exercises using common stress assumptions. Authorities are more likely to count on banks for liquidity stress tests since more data are required than in solvency stress tests.

Table 1. Bottom Up Stress Test Practice in Other Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>China Bank Regulatory Commission</th>
<th>European Union Authority</th>
<th>Italy Bank of Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authority in charge</td>
<td>China Bank Regulatory Commission</td>
<td>European Banking Authority</td>
<td>Bank of Italy</td>
</tr>
<tr>
<td>Explanation</td>
<td>• Banks report the outcomes of a standardized liquidity stress test on a quarterly basis</td>
<td>• EBA has conducted several EU wide stress test based on common scenario and implemented by local supervisors</td>
<td>• Conducting several bottom up liquidity stress tests with focus on potential weakness due to the drying up of wholesale funding.</td>
</tr>
<tr>
<td></td>
<td>• Scenario: unexpected deposits withdrawal, shocks to liquid assets, drying up of market funding, increasing funding cost</td>
<td>• Authority aggregates the individual results.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Scenario type: mild, medium, severe</td>
<td>• Liquidity risk is changes in spreads on retail and wholesale funding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Use cash flow gap for each horizon by the shortest survival period</td>
<td>• Use cash flow model</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Scenarios include market wide and idiosyncratic shocks.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Bottom Up Stress Test Practice in Other Countries (continued)

<table>
<thead>
<tr>
<th>Country</th>
<th>Japan Bank of Japan</th>
<th>Brazil Central Bank of Brazil</th>
<th>Sweden Sveriges Riksbank</th>
<th>Italy Bank of Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authority in charge</td>
<td>Bank of Japan</td>
<td>Central Bank of Brazil</td>
<td>Sveriges Riksbank</td>
<td>Bank of Italy</td>
</tr>
<tr>
<td>Explanation</td>
<td>• BoJ provides severe assumptions used by Japanese banks</td>
<td>• The liquidity stress test compares the amount of liquid resources with the estimated</td>
<td>• Producing a liquidity metric, similar to LCR</td>
<td>• Top down stress test as part of the ongoing supervisory analysis on liquidity risk.</td>
</tr>
<tr>
<td></td>
<td>• The purpose of stress testing is for system-wide</td>
<td></td>
<td></td>
<td>• The focus is wholesale and</td>
</tr>
</tbody>
</table>
Authorities regularly performed top down stress tests to measure the banking system resilience. One way to assess top down stress tests is using balance sheet data. Scenario shocks are manifested through haircuts on assets and run-off rates of liabilities applied to balance sheet positions. As mentioned by BIS (2013), this method is able to identify the source of individual vulnerabilities yet backward-looking, static, and limited to the first-round impact of liquidity stress. Beside the balance sheet approach, several central banks employ a top-down approach with methodology varying from basic simulation to a more complex integrated framework. Regardless of the sophisticated level of this approach, an integrated model for macro stress testing has the potential to make causal linkages and results less transparent.

Table 3. Bottom Up Stress Test Practice in Other Countries (continued)

<table>
<thead>
<tr>
<th>Authority in charge</th>
<th>The Netherlands</th>
<th>Austria</th>
<th>Canada</th>
<th>England</th>
</tr>
</thead>
</table>
| Explanation          | Employ Liquidity Stress Tester – an empirical algorithm based on supervisory data on banks’ liquidity positions. Scenarios are generated through stochastic simulations of univariate shocks to market and funding risk. Including
|                     | Invented ‘Systemic Risk Monitor’ – an integrated stress testing. Comprising satellite models of credit and market risk. Completed with a network model to evaluate the probability of bank default. Including
|                     | Invented Macro Financial Risk Assessment Framework, which identifies systemic risk by estimating spillover effects. Linking solvency, market, and funding liquidity risk. Including
|                     | Invented Risk Assessment Model of Systemic Institutions that consists of satellite models to estimate resilience in a stress scenario. Including |
Moreover, there are central banks, which combine bottom up and top down stress tests. For instance, the Central Bank of the Republic Austria has implemented an approach incorporating second round effects into liquidity stress tests by adding behavioral reactions into a bottom-up stress test design. According to reported behavior reactions, the Austrian authorities concluded that a complete drying up of liquidity was a likely second round-effect. The benefit of combined bottom-up and top-down stress tests is that they allow a cash flow rather than a stock approach and weigh market liquidity shocks against the counterbalancing capacity.

2.2. Liquidity Risk Measurements in Indonesia

Indonesia has already complied with the BASEL III requirement, which is the implementation of liquidity coverage ratio (LCR), and net stable funding ratio (NSFR), in addition to other liquidity indicators such as the ratio of liquid asset to total asset to measure liquidity risk in the banking system. To ensure bank resilience against liquidity risk, Bank Indonesia has performed Granular (bottom up) Liquidity Stress Test\(^1\) (GLST) by the Financial System Surveillance Department. This GLST received Technical Assistance (TA) from IMF in 2015 and applied its recommendations since then. Currently, GLST is carried out to assess the individual liquidity risk of only systemic banks as a part of macroprudential surveillance.

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\(^1\) Please refer to the note of GLST from the Financial System Surveillance Department for more detailed information.
stemming from liquidity pressure within the internal bank and market wide stress stemming from global and domestic shocks. The methodology employed is cash flow based analysis with three distinct components: counterbalancing, inflow, and outflow. This analysis assesses banks' resilience based on the net cash balance after funding outflow shocks in two currencies – Rupiah and foreign currency (USD)- in several time buckets.

\[
\text{Net Counterbalancing Capacity} - (\text{Net Outflow} - \text{Net Inflow}) > 0, 
\]

for all time buckets and currencies.

A bank is experiencing a liquidity shortfall should there be any threshold exceeded in any time bucket calculations in both Rupiah and foreign currency. Threshold is exceeded when counterbalancing capacity is not enough to cover the net cash flow, as mentioned in the above formula. Referring to the following table, every inflow and outflow components are subject to roll off rates and run off rates subsequently. When there is a negative gap, i.e., net outflow is greater than net inflow, the liquidation of assets in counterbalancing capacity will be executed. The liquidation of assets is calculated by applying haircuts. Different scenarios are reflected by different haircuts, roll of rates, and run off rates. Guidance on haircuts, roll of rates, and run off rates are provided by TA IMF, besides the granularity of data used in GLST. Market wide scenario is pictured through the change in government bond yield (one of counterbalancing capacity components) using present value-stressed yield approach.

| Table 4. Information on Counterbalancing Capacity, Outflow, and Inflow |
|---|---|---|---|
| Component | Counterbalancing capacity (liquid asset) | Outflow | Inflow |
| Example | Unencumbered assets: cash, central bank placements, securities | Deposits, secured borrowing, interest expense, derivatives, undrawn committed credit/liquidity, securities issued | Loans, secured lending, interest income, derivatives |
| Rate | Hair cut | Run off rates, contractual | Roll off rates, contractual |
| Formula | \[ \text{Net Counterbalancing} = \sum_{i=1}^{l} \text{Counterbalancing}_i \times (1 - \text{hair cut}_i) \] | \[ \text{Net Outflow} = \sum_{j=1}^{m} \text{Outflow}_j \times \text{run off rates}_j \] | \[ \text{Net Inflow} = \sum_{k=1}^{m} \text{Inflow}_k \times \text{roll off rates}_k \] |

The GLST uses two different scenarios, (i) idiosyncratic risk; and (ii) market wide stress. In an idiosyncratic scenario, GLST estimates run-off/haircut rates on each liquidity instrument by estimating a percentile 5% of historical data. The rates will indicate the stress condition that is unique to each bank. Different from idiosyncratic scenarios, market wide stress is defined as a stress that causes a huge loss to a bank's counterbalancing capacity and worse liquidity run. In order to create this scenario, the GLST approaches two risk channels:

1. Capital markets (counterbalancing instruments) run which are reflected by increase in run-off/haircut rate. The rates are calculated by twice the average of percentile 5% of DSIB run-off/haircut rates, applied to all banks;
2. In addition to run-off/haircut rate to counterbalancing instruments, GLST estimates government bond price drop. The GLST uses two approaches in order to re-estimate bond price (i) modified duration method; and present value with stressed yield. Both estimations have pros and cons as shown by table 5.2

<table>
<thead>
<tr>
<th>Modified Duration</th>
<th>Present Value with stressed yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Capture only duration of bonds</td>
<td>- Assumes not only duration but also convexity of bonds</td>
</tr>
<tr>
<td>- Assumes all the bonds uniformly along the yield curve</td>
<td>- Assumes all the bonds in every tenure are liquid thus reflects efficient yield</td>
</tr>
<tr>
<td>- Easier to be aggregated across asset-liability profile</td>
<td>- Shape of yield curve might vary significantly across observation period</td>
</tr>
<tr>
<td>- Easier to communicate as portfolio risk manager used same method</td>
<td>- Can be used to estimate realized stressed bond price, especially in stress condition</td>
</tr>
<tr>
<td>- Can be used to check general condition especially in stress condition</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Bond pricing methods - pros & cons

Benefited from a discussion with Mario Simatupang, Financial Markets Deepening Department

Similar to other balance sheet approaches, GLST is able to reveal individual vulnerabilities based on its historical performance, yet it fails to connect with macroeconomic state directly. The focus of this paper is to make improvements in terms of the transmission of the macroeconomic scenario toward the liquidity shock. This improvement is crucial for the macroprudential surveillance and helps in calibrating any macroprudential buffer before a shock happens.

3. Modeling and Data
3.1 Stylized Facts of Indonesian Banking System

3.1.1 The dynamics: procyclicality of liquidity

Harun, et al (2016) pointed out the existence of liquidity procyclicality in Indonesian Banking, as seen in the figure below. The ratio of liquid asset to non-core deposits and the ratio of liquid asset to deposits, which serve as the proxy of Indonesian banking liquidity, move in opposite direction with the ratio of credit to GDP, which serves as the proxy of the economy. This means when the economy is growing, the banking liquidity is decreasing emphasizing the banks preference to shift their placement into loan to generate bigger profit. This liquidity procyclicality is also exhibited in the Netherlands as found by Duijm and Wierts (2014).

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2 Mathematical expressions on both approaches are written in appendix.
3.1.2 Liquidity Distress

According to Muljawan, et al (2014), banks will decrease or limit their interbank placement due to asset price hike in the time of liquidity distress. In times of crisis, every financial institution tends to secure a liquidity position by increasing the amount of cash (anticipatory steps). At the same time, banks may be forced to sell liquidity instruments at discounted prices to meet their liquidity obligations. Interbank placement rate will increase and/or its nominal will drop thus contagion risk of a defaulted bank to other banks will increase. With such situations, the Central Bank may provide a system to provide liquidity source options to prevent a bank from becoming insolvent.  

Referring to Figure 3, the existence of shock will lead into liquidity run and eventually contagion risk. In this paper, we examine the possibility of subsequent contagion risk, which emerged after a liquidity distress. Using the event of Taper Tantrum in 2013 as the point of reference of shock, the existence of liquidity run and contagion risk in Indonesian banking system will be examined. Liquidity run will be signified by ratio of liquid asset (LA)

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3 This liquidity assistance is known as Emergency Liquidity Assistance. For further discussion on ELA, please refer to Muljawan et al (2014).
to deposit and the ratio of liquid asset to total asset (LA/TA), while contagion risk could be seen through the interbank placement of DSIB and non-DSIB. DSIB classification follows the result in December 2017.

![Figure 4. Interbank Money Markets Contagion Flow](image)

From the sample of 12 DSIB, the ratio of LA/TA of several banks dropped more than 20% in 2013, as shown by Table 3 (left table). This has breached the analytical threshold of 15%. In more detail, there are 14 times of bank liquidity ratio monthly growth that drops below the threshold. This number is 8 times more than in 2012 and 3 times more than in 2014. While in terms of annual growth, the ratio has dropped below threshold 15 times more than 3 year average (2010-2012) and 11 times more than 2014. In total, the ratio has dropped 42 times in 2013.

### Table 6. Liquidity Distress in Taper Tantrum

<table>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DSIB</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>nDSIB</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</table>

Similar to the previous finding, the ratio of LA/Deposit also conveyed the same message (referring to Table 6 – right table.) Bank liquidity monthly growth dropped below the threshold in 2013 six times more than in 2012 and 3 times more than in 2014. While in terms of annual growth, the ratio has dropped below threshold 13 times more than 3 year average (2010-2012) and 15 times more than 2014. In total, the ratio has dropped 46 times in 2013.
2013. All of the findings conclude that banks will experience liquidity stress/run in times of financial distress/shock.

After the existence of a liquidity run has been confirmed, the existence of contagion risk is checked through the interbank placement. Majority of DSIB has decreasing interbank placement to either other DSIB or non-DSIB. In June 2013, 58% DSIB had negative monthly interbank placement growth to non-DSIB. While 47% DSIB has negative monthly interbank placement growth to other DSIB and 37% DSIB has negative monthly interbank placement growth to both DSIB and non-DSIB.

As explained in the previous chapter, FARS consists of seven possible developments to the current stress-testing framework. In which, one other development is to integrate all the modules that have been developed and are going to be done. Our findings of liquidity distress and contagion risk relation will be used for FARS next project, FARS – The Integration of Macroprudential Stress Testing Framework.

3.2 Scenario Challenge: How to Implement

Scenario is one of components used in stress tests, which play an important role. Scenario analysis and stress testing could be employed to evaluate the effect of unexpected and serious stress events in liquidity (Deutsche Bank, 2016). Further mentioned by Deutsche Bank, scenario is usually drafted from historic events such as the Global Financial Crisis 2008. While there is no exact guidance in determining or composing scenarios in any literature up to this moment, scenarios can be made and tailored according to the specific need. Scenarios can be viewed from several perspectives.

3.2.1 Systemic Bank VS Non Systemic Bank

IMF (2014) mentioned that the breakdown of large banks is likely to be more disruptive to the financial system than the breakdown of small banks, and creates more liquidity stress in the banking system. This is in line with the establishment of globally systemically important banks (GSIBs) by BCBS and the reforms to improve the resilience of GSIBs due to its failure to extend or impact (BIS, 2013). Thus, systemic banks should have a more severe scenario than non-systemic banks since their failure leads to bigger impact in the economy. While the different scenario is sensible to make, there is yet any publication available on this matter.

3.2.2 Static VS Dynamic

Another perspective to look at the scenario is based on the nature of the model used whether it is a static or dynamic model. Both static and dynamic approaches employ sensitivity/what-if-analysis. Yet, differences start coming in terms of parameter conditions. In a static approach, when one parameter changes, other parameters/variables stay the same (ceteris paribus). This is completely opposite with the dynamic approach when one parameter changes, other parameters/variables follow the macroeconomic variable path. In this sense, a dynamic approach is more flexible and allows feedback impact. However, the more complex model of dynamic approach compared to static approach comes at the cost of more resources needed to build and execute. BIS (2013) mentioned that the static approach fails to consider disruptions of all or majority key funding markets, herd behavior, and the interaction of funding and market liquidity. Nevertheless, the choice of static approach and dynamic approach must be balanced with the cost-benefit analysis.
3.2.3 **Idiosyncratic VS Systematic**

This perspective of scenario is the most common one. Idiosyncratic scenario is associated with risk originating from the specific bank itself while systematic or market-wide stress is associated with risk originating from the banking system. Beside the two distinct scenarios, there is the third option, which is the combination of idiosyncratic and systematic scenarios. According to ECB (2008), it is very important to simulate using both idiosyncratic and systematic/market-wide scenarios, including the combined scenario meaning testing the impact of an idiosyncratic shock under adverse market conditions. Surveying banks, ECB provides more information on idiosyncratic and systematic scenarios.

Most banks design the idiosyncratic scenario around the rating downgrades in long term and short term, and the potential loss of trust from depositors due to several factors such as stock performance, and loss on credit. Furthermore, banks identify the top 5 categories within idiosyncratic scenarios to be credit lines, interbank market, central bank, group transfer (if applicable), and sale of liquid assets. Example of specific scenario assumptions used are i) loss on retail deposit with run off rate of 10% to 30%; ii) loss on interbank deposits with run off rate of 0%-100%; and iii) outflow from investors with run off rate either 0% or 100%. The stress test assumptions are made generally based on expert judgments, and statistical analysis.

On the other hand, systematic/market-wide scenarios can be differentiated into two categories i.e., specific situations and varying intensity/severity assumptions. Specific situations will be a set of negative economic situations such as increase in bond yields, decline in stock prices, widening credit spreads, and increase in short-term interest rate, and also the root of the stress such as subprime market liquidity crisis, change in monetary policy, sudden and deep economic recessions. Whereas the example of varying intensity/severity assumptions will be a condition where marketable securities cannot be sold immediately and only at a lower price, a time when repo market and unsecured interbank markets are suddenly closed, a condition when depositors withdraw their placements and the stability of retail deposit decreases. The survey results also come up with example scenarios of market-wide stress used by the banks such as the unsecured interbank market and bond market, the withdrawal of deposits and disruptions in the repo, and the disruptions to the covered bond market.

3.2.4 **Channels of liquidity risk transmission**

Immediately after liquidity shock takes place, liquidity risk spreads out and is transmitted within the banking system and eventually the financial system. This phenomenon is in accordance with Blancher, et al. (2013) where shock materialization is followed up with propagation and amplification. Based on ECB (2008), liquidity risk is transmitted through three channels i.e., asymmetric information, contagion, and market risk/fire sale.

In asymmetric information, a liquidity crisis taking place in a bank may result in uncertainty in retail market and wholesale of other banks, and eventually lead to a drying-up of money market liquidity or even bank run to a severe extent. In a less severe extent, other banks might have to pay more when raising the liquidity needed and suffer from increasing uncertainty of the possible future cash flows; nevertheless, the aspects still aggravate the liquidity management. Furthermore, asymmetric information is one of three features of the financial fragility hypothesis, originated by Band and Hartmann (2000).

The second channel is liquidity contagion. The enormous number of interbank and money market instruments in banks’ funding may lead to a contagion if the bank fails. This liquidity problem at one bank will then escalate liquidity pressure on its interbank
counterparties, since banks’ liability can be other banks’ assets. This situation can be worsened if there is asymmetric information about the failed bank in the society.

The last channel of liquidity risk transmission is asset fire sale. Liquidity problems faced by banks may enforce the sale of liquid assets such as bonds. The almost together asset sale in panic condition creates asset fire sale, which leads to a market meltdown. This will then lower the value of assets sold hence decreasing the counterbalancing capacity for the bank or diminishing the liquidity risk-bearing capacity of banks. Once again, this condition can be worsened with the existence of asymmetric information about the asset fire sale.

3.3 Macro Scenario Interpretation for Liquidity Stress Test

Past crises showed that liquidity risk was an important aspect in the financial system. Failing to satisfy liquidity claims from depositors can be a huge problem. In some/many cases, a financial institution may default due to being unable to satisfy the claims albeit solvent. In 2015, Bank Indonesia received Technical Assistance from the International Monetary Fund. In the sessions, BI and IMF developed a liquidity stress-testing framework (LSTF), which is currently run by BI Financial Surveillance Department (DSSK.) In general, the LSTF sees systemic risk transmission into a bank's balance sheet through run-off or haircut rates. The rates are applied into three channels, (i) bank’s counterbalancing capacity; (iii) liquidity outflows and liquidity inflows.

We can consider three aspects, which can trigger liquidity, run (i) idiosyncratic factor; (ii) macroeconomics condition; (iii) unknown factors, the factors can be everything else that cannot be explained by idiosyncratic factors and macroeconomics conditions. Despite the different response of depositors to the source of the run, it will be translated into the bank's balance sheet, the three channels mentioned before. From the three factors, idiosyncratic factors could be extracted directly using past run-off/haircut rates. IMF and later modified by DSSK, approached the factor to best replicate a liquidity run in the banking system. The IMF used Indonesia's banking system run-off/haircut rates in the event of the Global Financial Crisis in 2008 to determine the run-off/haircut rates. While the estimation was using GFC to best capture stress events, IMF estimation has not considered individual bank response to liquidity stress events. To best capture this, DSSK used a similar approach to IMF but applied the approach to individual banks.4

Both IMF and DSSK estimation were using percentile approaches, which could be interpreted as an idiosyncratic approach. By our comparison on the run-off/haircut rate, we found that some of the estimates based on IMF estimates were over/underestimate. Table 4 showed our comparison on IMF and individual bank estimations on high quality liquid assets (HQLA.) The differences might be due to (i) different estimation period than IMF; (ii) IMF’s estimation on run-off/haircut rates used international best practice – derived from Global Financial Crisis; and (iii) some run-off/haircut rates indicate that Indonesia banking system has different behavior than International bank sample (used to estimate the rates.)

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4 Further explanation on DSSK’s estimation on run-off/haircut rates please refer to (_______)
Table 7. Run-off/haircut Rates – IMF and BI Estimation Comparison

<table>
<thead>
<tr>
<th>Run-off/Haircuts</th>
<th>Rate III Rp</th>
<th>Rate III Va</th>
<th>Rate Govt Rp</th>
<th>Rate Govt Va</th>
<th>Rate Other Va</th>
</tr>
</thead>
<tbody>
<tr>
<td>average</td>
<td>20.4%</td>
<td>271.8%</td>
<td>20.4%</td>
<td>38.2%</td>
<td>1.0%</td>
</tr>
<tr>
<td>min</td>
<td>-21.4%</td>
<td>-100.0%</td>
<td>-15.8%</td>
<td>-20.2%</td>
<td>-20.2%</td>
</tr>
<tr>
<td>Perc 5% (run off)</td>
<td>-12.9%</td>
<td>-100.0%</td>
<td>-3.7%</td>
<td>-16.6%</td>
<td>-15.9%</td>
</tr>
<tr>
<td>Perc 10% (run off)</td>
<td>-7.0%</td>
<td>-84.0%</td>
<td>6.2%</td>
<td>-11.1%</td>
<td>-10.8%</td>
</tr>
<tr>
<td>IMF's model</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Run-off/Haircuts</th>
<th>Rate Other Va</th>
<th>Rate Corp AA Rp</th>
<th>Rate Corp AA Va</th>
<th>Rate Corp AA Grand Total</th>
<th>Rate MBS AA Rp</th>
</tr>
</thead>
<tbody>
<tr>
<td>average</td>
<td>2.2%</td>
<td>332.3%</td>
<td>11.4%</td>
<td>311.5%</td>
<td>8.7%</td>
</tr>
<tr>
<td>min</td>
<td>-14.6%</td>
<td>-9.0%</td>
<td>-48.2%</td>
<td>-10.0%</td>
<td>-6.9%</td>
</tr>
<tr>
<td>Perc 5% (run off)</td>
<td>-1.6%</td>
<td>-6.7%</td>
<td>-33.9%</td>
<td>-5.6%</td>
<td>-18.4%</td>
</tr>
<tr>
<td>Perc 10% (run off)</td>
<td>-3.0%</td>
<td>-10.0%</td>
<td>-23.5%</td>
<td>-3.5%</td>
<td>-31.5%</td>
</tr>
<tr>
<td>IMF's model</td>
<td>-26.2%</td>
<td>-26.2%</td>
<td>-26.2%</td>
<td>-26.2%</td>
<td>-26.2%</td>
</tr>
</tbody>
</table>

Note: Highlighted in green is the closest rate to IMF’s estimation

In line with run-off/haircut rates estimation on HQLA, individual estimations on the rates showed that some rates from IMF’s estimation might over/underestimate the bank’s stress level. As shown in the Table 8, IMF’s estimation indicates possibility of over/underestimation on bank’s liquidity level.

Table 8. IMF and BI Rate Comparison for HQLA

<table>
<thead>
<tr>
<th>Run-off/Haircuts</th>
<th>Rate Within 1D Rp Government</th>
<th>Rate Within 1W Rp Government</th>
<th>Rate Within 2W Rp Government</th>
<th>Rate Within 1M Rp Government</th>
<th>Rate Within 3M Rp Government</th>
<th>Rate Within 6M Rp Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>average</td>
<td>-1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>min</td>
<td>-100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Perc 5% (run off)</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Perc 10% (run off)</td>
<td>-1.3%</td>
<td>-1.3%</td>
<td>-1.5%</td>
<td>-5.3%</td>
<td>-5.3%</td>
<td>-5.3%</td>
</tr>
<tr>
<td>IMF's model</td>
<td>-56.6%</td>
<td>-56.6%</td>
<td>-56.6%</td>
<td>-56.6%</td>
<td>-56.6%</td>
<td>-56.6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Run-off/Haircuts</th>
<th>Rate Within 1M Rp Others</th>
<th>Rate Within 3M Rp Others</th>
<th>Rate Within 6M Rp Others</th>
<th>Rate Within 3M Va Others</th>
<th>Rate Beyond 6M Va Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>average</td>
<td>-82%</td>
<td>-82%</td>
<td>-82%</td>
<td>-77%</td>
<td>-77%</td>
</tr>
<tr>
<td>min</td>
<td>-100%</td>
<td>-100%</td>
<td>-100%</td>
<td>-100%</td>
<td>-100%</td>
</tr>
<tr>
<td>Perc 5% (run off)</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Perc 10% (run off)</td>
<td>-4%</td>
<td>-4%</td>
<td>-4%</td>
<td>-5%</td>
<td>-5%</td>
</tr>
<tr>
<td>IMF's model</td>
<td>-64%</td>
<td>-64%</td>
<td>-64%</td>
<td>-54%</td>
<td>-54%</td>
</tr>
</tbody>
</table>

We agreed with DSSK’s approach on individual run-off/haircut rates. Individual rates should be able to capture a bank’s unique business model compared to one rate fits for all. Based on this finding, in the next section we run regression estimation to check the three aspects of the liquidity run.

3.4 Modular and Data Design

Based on our previous findings on run-off/haircut rates, we checked following liquidity instrument variables interaction with liquidity run trigger aspects:

- Corp bond rated AA- (both Rupiah and foreign exchange rate) rollover rates;
• Corp bond rated A+ to BBB (both Rupiah and foreign exchange rate) rollover rates;
• Individual, non-financial legal entities, non-resident entities, government entities and other financial institution deposit run-off rates;
• Interbank placement haircut rates;
• As for customer deposits, we used DSSK’s classifications. The detail of customer deposits instruments as follows:
  o In terms of depositor: individual, non-financial agent entities, non-residence, government, other financial institution, and interbank;
  o In terms of currency denominations: Rupiah and foreign exchange (as a total nominal of available foreign currency deposit in Indonesia);
  o In terms of guaranteed by Indonesia Deposit Insurance Company: insured and uninsured;
  o In terms of time horizons: within 1 day, within 1 month, within 3 months, within 6 months, and beyond 6 months.

Based on its nature, government securities were excluded due to its price stability and backed by the government. Unless the issuer, government, defaulted then the securities are secure. MBS and other securities were excluded due to their small outstanding value. All bank data was taken from the monthly bank report. The data sample ranges from January 2011 to June 2018. Moreover, all data are in form or month-to-month rates. In total, we used 4 liquidity instruments from counterbalancing (HQLA,) and 11 instruments from customer deposits.

Macroeconomics conditions were captured using yearly GDP growth and inflation rate, as suggested by Claudio Borio (various papers.) All macroeconomics data was sourced from the CEIC database. In the purpose of this paper, all data was interpolated from quarter basis into monthly basis. Data range had the same specification to bank data.

As mentioned before, we believe that other factors, macroeconomics condition and unknown factors might also have an impact on liquidity run beside idiosyncratic run. To complete our hypothesis on liquidity driving factors, in this paper we built an ARDL panel model. The model tried to capture the three trigger aspect dynamics for each liquidity instrument. Figure 5 described our approach to integrate three liquidity run trigger aspects.

Figure 5. Liquidity Run Trigger Factors

The model is as follows:

\[
y_{i,t} = \alpha_i + \beta_x \sum_{n=0}^{L} X_{i,t-n} + \gamma \sum_{n=1}^{L} y_{i,t-n} + \vartheta \sum_{n=1}^{L} CAR_{i,t-n}
\]

Where:

\[
y_{i,t} \quad = \text{month-to-month rates of liquidity instrument for each } i; \\
t \quad = \text{time}; \\
i \quad = \text{individual bank};
\]
\( \alpha_i \) = fixed effect coefficient;  
\( \beta_z \) = macroeconomics variable coefficient;  
\( \text{CAR} \) = capital adequacy ratio for each I;  
\( X_{z,t-n} \) = macroeconomics variables;  
\( z \) = GDP and CPI;  
\( \gamma_i \) = lagged liquidity instrument coefficient for each i;  
\( y_{i,t-n} \) = lagged month-to-month rates of liquidity instrument variable;  
\( L \) = maximum lags (0, -6 and -12);  
\( \epsilon_{i,t} \) = residual for each i and t;

To control the estimation, we used the bank’s capital adequacy ratios (CAR). CAR was used in order to fully grasp the liquidity interaction with the triggering factors. We did not use any liquidity related variable(s) as a control variable due to the fact that each liquidity instrument is a part of the ratio, to avoid cointegration between dependent variables and the control variable. Moreover, in the previous financial crisis, liquidity shock may cause an illiquid but solvent bank into default.

In the regression we use three different distributed lag, (i) no lag – to capture contemporaneous liquidity run, we assume all run in this period were caused by idiosyncratic factor and unknown factors; (ii) up to 6 months – to capture possible impact of macroeconomics deterioration aside from idiosyncratic and unknown factors; and (iii) from 6 to 12 months – in this lag term, macroeconomics condition should has the biggest impact to prolonged liquidity run.

Since we also believe that unknown factors have a big role in causing liquidity run, we run a second panel estimation, which integrates the unknown factors. To best capture unknown factors, we extracted each panel estimation residual as a proxy for unknown factors and re-estimate the regression. We could rewrite the first estimated residual as follows:

\[
\epsilon_{i,t} = \text{Resid}_{i,t} + \epsilon'_{i,t}
\]

In macroprudential perspective, we could say that \( \text{Resid}_{i,t} \) as known unknown and \( \epsilon'_{i,t} \) as unknown. The unknown factors may represent incapturable factors in either financial institution or capital market data, for example herding behavior, markets perspective on the financial institution.

Embedded residual variable formula:

\[
y_{i,t} = \alpha_i + \beta_z \sum_{n=0}^{L} X_{z,t-n} + \gamma_i \sum_{n=1}^{L} y_{i,t-n} + \theta_i \sum_{n=1}^{L} \text{CAR}_{i,t-n} + \delta_i \text{Resid}_{i,t} + \epsilon'_{i,t}
\]

In the above formula, \( \text{Resid}_{i,t} \) equals to first estimated residual (\( \epsilon_{i,t} \)). In the second estimation, residuals still exist due to the complexity of unknown factors. Estimated residual alone will not suffice to explain all the unknown factor(s.)
4. Analysis and Result

As explained in the previous chapter, in order to capture the liquidity run trigger aspect, we only focused on the significance level of each triggering factor. The coefficient value of each variable was ignored since we assume whether the value is big or small, as long as it is a shock to the system, it will have impact, especially to liquidity run.

Table 9 shows all significance variables to HQLA. From the results, only lagged dependent variables significantly impacted the change in run-off/haircut rates. When we did not consider unknown factors, liquidity run was purely caused by an idiosyncratic factor and the condition of the bank itself (indicated by CAR.) Here we found that macroeconomics conditions do not trigger run on liquidity in the short run which is confirming our hypothesis.

Table 9. HQLA Panel Estimation Recap

<table>
<thead>
<tr>
<th></th>
<th>short</th>
<th>medium</th>
<th>long</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>GDP</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>CAR</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lagged</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Using the 2nd estimation approach which we consider unknown factors in the model, proxied by residuals, we have three conclusion (i) in short term it will affect run on corporate bond with rate at A+ to BBB; (ii) in midterm, it will only affect corporate bond in foreign currency; and (iii) in long term, most liquidity run were caused by idiosyncratic factor and macroeconomics condition (Table 10.)

Table 10. Embedded Residual in HQLA Panel Estimation Result

<table>
<thead>
<tr>
<th></th>
<th>short</th>
<th>medium</th>
<th>long</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GDP</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>CAR</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Lagged</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Residual</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Similar to HQLA, based on our estimation, run on customer deposits mostly affected by idiosyncratic factors and unknown factors. From all estimation periods, macroeconomics conditions only triggered run on liquidity on the longest term, see Table 11. Based on the estimations, we concluded:

- Run on customer deposits highly affected by the bank’s liquidity condition and unknown factors;
- Macroeconomics condition did affect liquidity run on short and medium term, but it depends on the instrument(s);
In short term (and medium term), customer run on bank’s liquidity based on unknown factor (herding behavior, reference bias, narrative); Financial authorities should consider handling the unknown factor by decomposing the residual (next step) – potential for machine learning tools.

Table 11. Customer Deposits Estimation Result

<table>
<thead>
<tr>
<th></th>
<th>short</th>
<th>medium</th>
<th>long</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>GDP</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>CAR</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Lagged</td>
<td>11</td>
<td>9</td>
<td>7</td>
</tr>
</tbody>
</table>

Historically, when financial distress occurred, bank’s liquidity also experienced distress. Based on the estimation result, liquidity distress is not necessarily caused by macroeconomics conditions. It could be triggered by the bank’s condition or other unknown aspect.

Our findings on factors that affect liquidity run were backed by previous research or hypothesis. For example, historically, Taruna and Harun (forthcoming,) explained that when a financial distress occurred, bank’s liquidity also experienced distress. As shown in Figure 6 (left side and right side,) when financial distress occurs (the paper used Financial Institution Stability Index as a proxy to financial distress level), liquidity distress subsequently occurs (reflected by AL/DPK ratio.) In all three financial distress post Asian Financial Crisis, AL/DPK ratio dropped. Whilst the paper argued that the liquidity stress might be caused by a specific event, it did not investigate the triggering effect. Based on our estimation result, liquidity distress may be triggered by many causes. It could be triggered by the bank’s condition or other unknown aspect.

Figure 6. Liquidity Distress Period in Indonesia

Other research or that confirms our findings are:

- Gorton and Metrick (2009 and 2017) pointed out that while in the Global Financial Crisis MBS only suffered 21 bps of losses but it still triggered on Repo markets. The failure of Lehmann Brother was affecting not only MBS but also other securities (Figure 7 – left side.)
Barberis (2018) argued that it was because of wealth loss expectation that triggered the run in GFC (interpreted as unknown factor to the bank’s liquidity run – Figure 7 – right side.)

Figure 7. Unknown Factor in Liquidity Run

When a liquidity run takes place, it will be hard to determine the triggering factors. While the liquidity stress-testing framework could help financial authorities to grasp a bank’s liquidity capability level, the authority still has to consider the worst. Furthermore, the test might under/overestimate the loss and might cause irrelevant policy responses.5

4.1 Analysis on HQLA

The details to HQLA could be classified into two categories, safe assets and investment grade assets. Corporate bonds with AA- rate fall into safe assets and corp. bond with A+ to BBB as investment grade bonds. Gorton and Metrick (2011) explained that safe assets and investment grade bonds were information insensitive which means investors do not require more information to value the price of the assets. the bonds should be stable over time. Unless a huge shock occurs to the financial system the bond’s value should not be changed.

Looking through each bond estimation result in Table 12, safe assets and investment grade bonds were unaffected by macroeconomics conditions. This is true to their characteristic, unless the investors need an effort to assess the assets, its value should stay at its normal prices. In short and medium terms after a shock happens to the financial crisis, run on the types of bonds is caused by unknown factors. If the financial system turmoil lasts longer than 6 months, macroeconomics conditions make the liquidity run worse. When the financial system turmoil stays for a long period, investors become more worried about their investment prospects, and fire sale their assets further deep; thus causing the liquidity run worse.

Table 12. HQLA Instrument Estimation Results

<table>
<thead>
<tr>
<th>corp bond AA- Rp</th>
<th>Short Term (coincide w/shock)</th>
<th>Medium Term (till 5 months)</th>
<th>Long Term (till 1 year)</th>
<th>corp bond AA- FX mtn rate</th>
<th>Short Term (coincide w/shock)</th>
<th>Medium Term (till 6 months)</th>
<th>Long Term (till 1 year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>t0</td>
<td>-</td>
<td>-.9</td>
<td>CPI</td>
<td>-</td>
<td>-.3</td>
<td>-.9</td>
</tr>
<tr>
<td>GDP</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>GDP</td>
<td>-</td>
<td>-</td>
<td>-4, -6, -7, -10, -11</td>
</tr>
<tr>
<td>CAR</td>
<td>-</td>
<td>-</td>
<td>-7, -9, -11, -12</td>
<td>CAR</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lagged</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Lagged</td>
<td>-</td>
<td>-1, -2, -4</td>
<td>-3</td>
</tr>
</tbody>
</table>

5 Lucas’s critique on how statistical estimation based on historical data might not be able to capture current conditions.
Using our second approach, the results still stand. In short and medium periods were significantly affected by macroeconomics conditions. In both safe assets and investment grade bonds, liquidity runs triggered by the idiosyncratic risk and/or unknown factors. While we extracted the known unknown as a measured variable (Resid_{it}), estimation result shown by Table X, the result indicates that liquidity run cannot simply be explained by known unknown factors.

Table 13. Unknown Factors in HQLA Estimation Results

<table>
<thead>
<tr>
<th>corp bond A+ to BBB-Rp mtm rate</th>
<th>Short Term (coincide w/shock)</th>
<th>Medium Term (till 6 months)</th>
<th>Long Term (till 1 year)</th>
<th>CPI</th>
<th>GDP</th>
<th>CAR</th>
<th>Lagged</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GDP</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CAR</td>
<td>t0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lagged</td>
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<td>-1, -2, -4, -5, -7</td>
<td>-1, -2, -4, -7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 14. Selected Customer Deposits Estimation Results

4.2 Estimation Results on Customer Deposit

Estimation on Customer deposit instruments is similar to HQLA estimation result. Increasing claims on customer deposits are highly affected by the bank condition (idiosyncratic) and unknown factors. Although not significantly causing liquidity run on customer deposits, macroeconomics conditions may worsen the run on some customer deposit liquidity, for instance deposit sourced from interbank placement.

Table 14 shows several results on the regression of the triggering effect to customer deposits. Unknown factors and idiosyncratic risks were mostly the main trigger to customer deposits. As mentioned in the previous section, regardless of whether they are classified as either safe assets or investment grade bonds, running on HQLA might happen due to panic arising in the financial system; and the expectation of wealth loss.

Table 14. Selected Customer Deposits Estimation Results

<table>
<thead>
<tr>
<th>Interbank within 1 Mo Rp mtm rate</th>
<th>Short Term (coincide w/shock)</th>
<th>Medium Term (till 6 months)</th>
<th>Long Term (till 1 year)</th>
<th>CPI</th>
<th>GDP</th>
<th>CAR</th>
<th>Lagged</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GDP</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CAR</td>
<td>t0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lagged</td>
<td>-1</td>
<td>-1, -2, -4, -6, -7</td>
<td>-1, -2, -4, -6, -7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

6 Please refer to appendix X for the rest of regression results on customer deposits.
When comparing local currency and foreign denominated customer deposits, we found that Rupiah denominated deposits are more susceptible to unknown factors. Historically, when a financial turmoil occurs, investors tend to buy foreign currency and push the Rupiah value down, arguably that this factor is embedded in the unknown factors. The triggering factors in corporate deposits, both in Rupiah and foreign denominations, are the bank’s condition and unknown factors. Moreover, similar to HQLA, macroeconomics conditions may worsen the run if the financial turmoil lasts more than 6 months.

4.3 Final Say on Triggering Effect

As Bagehot and former US Treasury Secretary Tim Geithner (2009) argued, in times of financial crisis, the financial system should be flooded with liquidity. The source of liquidity could be in many forms, as long as it could shorten the liquidity run and calming the unknown factor (uncertainty) circulating in the system. In the Great Depression, a liquidity run happened in the banking sector. Some banks experienced a run whilst it was in good condition. The fear of being unable to get back their money was causing investors to claim their deposit immediately.

Our findings confirm that unknown factors which could be expressed by fear of losing wealth, market perception on financial system conditions are the primary triggering factor to liquidity run. Macroeconomics conditions can worsen the run if the financial crisis lasts for a long period. This framework should be considered when financial authority assessing the probability of a run, especially in doing liquidity stress testing.

5. Conclusion and Future Implementation

5.1 Conclusion

As one of the stress testing modules, liquidity ST plays a huge role in assessing a bank’s condition. Currently, this module is run separately from solvency stress tests. While, island-by-island run test might be proper to conduct a single test, it cannot reflect the real banking system business process. Furthermore, our finding pointed out that since the liquidity run might be triggered by unknown factors despite bank solvency level, financial authorities should consider integrating the module into a bigger stress-testing framework. Taruna and Harun (2015) examined that next round module which integrates all available stress testing modules is highly recommended to be implemented in future BI’s stress testing framework.

Concluding our paper, we have four conclusions. The conclusions are as follows:

1. Concerning the counterbalancing part (without incorporate unknown factor) are:
   - only lagged variable of CAR and GPD which significantly impacted the change in run-off/haircut rates;
   - macroeconomics conditions do not trigger run on liquidity in the short run.
2. In terms of unknown factor impact to counterbalancing part are:
   - In the short term, unknown factors will affect run-off of corp. bond in Rupiah rate A+ to BBB
   - In midterm, unknown factors will affect run-off of corp. bond in foreign currency rate A+ to BBB
   - In the long term, most liquidity runs were caused by idiosyncratic factors and macroeconomics conditions.

3. In line with HQLA, we concluded that run on customer deposits were heavily triggered by the bank’s liquidity condition and performance overtime. Detail conclusions as follows:
   - Run on customer deposits highly affected by the bank’s liquidity condition and unknown factors;
   - Macroeconomics condition did have affected liquidity run on short and medium term, but it depends on the instrument(s);
   - In short term (and medium term), customer run on bank’s liquidity based on unknown factor (herding behavior, reference bias, narrative);
   - Macroeconomics condition may trigger run on liquidity depends on the liquidity instruments;

4. Financial authorities should consider handling the unknown factor by decomposing the residual (next step.) In conjunction with Liq ST framework, run-off rates estimation using percentile approach could somehow reflect all triggering factors to the bank's idiosyncratic run on liquidity. Macroeconomics impact to HQLA can be reflected by solely haircut rates. Transmission of macroeconomics conditions using change in bond price could be checked using both modified duration and present value of the bond using stressed yield.

5.2 Future Implementation

Based on our conclusion there are four possible implementations to the FARS. The ideas are:

1. Solvency ST and liquidity ST integration of stressed CAR value and liquidity shortfall. This module will integrate the impact of CAR deterioration from solvency ST and liquidity shortfall from liquidity ST. Furthermore, the module should provide a stable bank’s loss consider the module integrate several other modules;

2. Estimated unknown factors vs. Sentiment Index (forthcoming). Based on other research, liquidity runs are caused by unmeasured variables such as market perception. By using sentiment index which measure markets view on both financial institution and capital markets, we might be able to understand the unknown factor;

3. Shock to residual impact to liquidity instrument run-off/haircut rates current estimation on individual run-off/haircut rates were sufficient to imitate past financial crises. However, our findings suggest that we might consider macroeconomics condition impact to the rates if the crises last more than 6 months;

4. Individual Liquidity ST implementation is possible using data that are more granular on the liquidity instrument available to the bank. Although the aggregated result may not tally with the overall top down LST, the supervisor may gain some insight on the impact of macro scenarios on the individual bank.
References


IMF. (2014). “Bank Size and Systemic Risk, IMF Staff Discussion Note SDN 14/04”, May


Appendix I – Bond Pricing Methods, Mathematical Expression

Modified Duration Mathematical Expression

\[ Mod\ Dur = \left[ \frac{Macaulay\ Duration}{(1 + yTM)} \right] \]

\[ Mac\ Dur = \sum_{t=1}^{n} \frac{PV(C)\times t}{Market\ Price\ Bond} + \cdots + \frac{PV(C+F)\times n}{Market\ Price\ Bond} \]

Let us rewrite the formula:

\[ Mod\ Dur = \frac{1}{PV(C+F)} \left( \sum_{t=1}^{n} PV(C) \times t + PV(C + F) \times n \right) \frac{1}{(1 + yTM)} \]

Where \( \sum_{t=1}^{n} PV(C) \times t + PV(C + F) \times n \) is the remaining cash flow.

Let \( X \) be Mod Dur and \( H \) be adjusted cash flow, above formula could be rewritten into

\[ X = \frac{1}{PV(C+F)}; \quad H = \frac{1}{(1 + yTM)} \]

Rearranging the formula

\[ PV(C + F) = H \frac{1}{X} \]

Here we have PV of a bond as a function of discount factor and its adjusted cash flow \( \frac{H}{X} \).

The adjustment comes from change in interest rate or yield to bond price.

Present Value with Stressed Yield

\[ PV = \frac{C}{(1 + y_t + x + s_t)^t} + \cdots + \frac{C+F}{(1 + y_t + x + s_{t+n})^{t+n}} \]

Where \( x + s_t \) and \( x + s_{t+n} \) are additional factors to yield.

Let us rewrite the additional factors:

\[ x + s_t = \delta_t \]

Now we have:

\[ PV(C + F) = \frac{C}{(1 + y_t + \delta_t)^t} + \cdots + \frac{C+F}{(1 + y_t + \delta_{t+n})^{t+n}} \]

Simplifying the formula, we have:

\[ PV(C + F) = CZ_t^t + \cdots + (C + F)Z_{t+n}^{t+n} \]

Here we have PV of a bond as a function of its cash flow and adjusted discount factor. The adjustment considers yield changes in all tenure.