A Stress Testing Framework for Liquidity Risk

One of the most important lessons learned from the recent financial crisis is that liquidity risk is fundamentally different from other forms of risk such as market risk and credit risk. Liquidity risk, viewed earlier as a second order risk, is now considered a major risk class. The crisis showed us how quickly a risk which starts as a market or credit risk transforms into a liquidity event and how rapidly it develops into a systemic issue. The drying out of liquidity from the market results in the collapse of traditionally strong institutions.

Since liquidity risk is a key risk class, it needs its own risk measures such as Net Stable Funding Ratio (NSFR) and Liquidity Coverage Ratio (LCR) as prescribed by the Basel Committee on Banking Supervision (BCBS). It should also have some common measures which banks across the globe use such as gap ratios based on structural and tactical liquidity, concentration metrics and others. Since liquidity risk measures are unique, it would be logical to create a stress testing framework designed to suit the needs of liquidity risk.

The current economic environment is one wherein uncertainty and volatility have become the ‘New Normal’. Financial institutions have to devise techniques to continuously understand and analyze the factors that affect their business and develop strategies to ensure business-as-usual when things go wrong.
A well designed Stress Testing Framework provides the ability to design forward looking extreme, yet plausible scenarios and strategies to counter the effects of an extreme event. This paper proposes a Stress Testing Framework designed to handle liquidity risk.
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Introduction

Stress tests have traditionally been associated with market risk and credit risk. Liquidity risk had been considered a secondary risk and clubbed with Asset Liability Management (ALM). However, liquidity risk took center stage during the recent financial crisis. It was observed how quickly a contagion can dry up liquidity from the market, making even strong institutions run for cover. Banking behemoths such as Bear Sterns and Lehman Brothers collapsed as a result of liquidity mismanagement and too much reliance on short term funding. In the case of Lehman Brothers, it was also observed that if liquidity is managed at the parent company level, it puts subsidiaries at risk, prompting regulators to consider liquidity ringfencing, a widely debated topic today.

As a result, regulators are emphasizing the importance of liquidity risk management and liquidity risk stress testing more than ever before. Previously, liquidity risk stress testing was never a part of any bank’s stress testing framework (some banks ran some tactical scenarios under ALM). Hence, the magnitude of an idiosyncratic or market wide liquidity stress event was always underestimated. Besides, historically, there has been no incidence of liquidity events to make the case for liquidity risk stress testing stronger.

This paper proposes a Liquidity Risk Stress Testing Framework. The framework begins with identifying the composition of the balance sheet, understanding factors which affect the balance sheet the most, and then moves on to design scenarios based on the identified factors. The analysis of the stress tests feeds the contingency plan ensuring that all the extreme but plausible material scenarios are identified and a plan of action defined.

The Lifecycle of a Liquidity Crisis

Figure 1: Life Cycle of a Liquidity Crisis
The Liquidity Risk Life Cycle depicted in Figure 1 traces the evolution of a liquidity crisis from one that is limited to a bank (idiosyncratic) to a systemic one that affects the entire market. Such a crisis can be triggered by an event which is internal to a bank (huge trading loss, big counterparty default, fraud and so on) or external (market collapse, sub-prime crisis and so on). The event is big enough to affect the fundamentals of the bank and negatively impact the sequential quarterly numbers (top line and bottom line). Over a period of time, this brings down the credit rating of the institution. This chain of events affects funding cost, which starts going up, resulting in short term stress. If the bank does not have measures in place to contain short term stress, it transforms into long term stress resulting in drastic shrinking of funding sources to the point where there are none left. This creates stress in the markets and the liquidity and marketability of assets is greatly reduced. The bank may try to counterbalance the effect through fire sale of assets. However, distress selling can never make up for the gap created by long term stress, and the bank may eventually face liquidation (Liquidation occurs in a worst case scenario; normally there is an elongated period of stress with depressed asset prices and marketability and reduced funding sources which severely affect the institution’s health). When a bank enters into long term stress, the tremors are felt in larger markets where they affect other players as well. Whether it transforms into a contagion or not is dependent on factors such as the size of the institution affected, the severity of the event, central bank intervention and coupling of institutions.

**Liquidity Risk Stress Testing Framework**

Given the balance sheet composition, behavioral profile, concentration of the assets and liabilities, and organizational strategy, the objective of a liquidity risk stress test is to:

- Identify key risk factors and drivers affecting assets and liabilities
- Design scenarios (extreme yet plausible) which align with assets and liabilities
- Test the resilience of funding sources and alternatives under idiosyncratic and systemic disruptive events

It is important to understand that stress testing is not just about identifying the breaking point. It is also about understanding an institution’s internal composition, how it would react to the vagaries of the internal and external environment and what measures can be proactively built in to act as shock absorbers to keep it afloat in a worst case scenario.

The stress testing framework should evolve from an understanding of the fundamentals of the bank. This will help the bank react proactively as soon as an event which might develop into a crisis is identified.

Figure 2 charts out a Liquidity Risk Stress Testing Framework. This framework comprises four stages:

- Assess
- Identify
- Build and execute
- Quantify and control
Assess Understanding the composition of the balance sheet is crucial to designing relevant stress scenarios. Each institution will have a unique balance sheet hence the composition of assets and liabilities will differ from institution to institution. An understanding of the behavioral characteristics of assets and liabilities is one of the most crucial elements in designing relevant stress scenarios. This can be analyzed in terms of:

- **Pre-payment characteristics** - The pre-payment characteristics of and drivers for a mortgage loan are different from that of a commercial loan, although there are common drivers such as age of the facility, charges and interest rate cycle. Liquidity risk typically occurs when there is a mismatch in terms of the funding and the tenor of the loan or mortgage, and the issue becomes complicated as pre-payment needs to be included in the model.

- **Deterministic and non-deterministic cash flows** – It is important to gauge the composition of such cash flows and their proportion in funded and non-funded products and maturity-based and perpetual products. Models based on identifying core and volatile parts of such cashflows are key in obtaining a view of the behavior of non-deterministic cashflows.

The concentration of assets and liabilities and the corresponding sources and alternatives of funding play a crucial role in designing relevant stress scenarios. It is crucial to understand the concentration of funding sources—retail, wholesale, structured—and funding alternatives—call money, commercial paper, interbank, certificate of deposit, structured alternatives—and so on. Each source behaves differently under different business scenarios as its sensitivity varies. For example, in terms of increasing sensitivity and complexity, the order will be retail—wholesale—structured, hence, the haircuts required for structured sources are higher than the other two.
Identify
The next step after assessing and understanding the DNA of the balance sheet is to figure out which liquidity risk factors or drivers affect the balance sheet the most. In most cases, the genesis of liquidity risk lies within a market risk, credit risk and/or an operational risk event or a combination of these risk classes. The canvas of liquidity risk is therefore larger than any other form of risk and hence the risk factors to be considered for designing scenarios is also larger. The analysis of the concentration of assets and liabilities and their behavioral profile will aid in identifying the main risk factors from the larger population. Techniques such as Principal Component Analysis (PCA) can help in reducing the number of factors to be considered for designing stress scenarios, by choosing those which explain 95% or 99% of historically observed variations.

Build and Execute
The previous two steps (Assess and Identify) ensure that the scenarios which are built to perform stress tests are in sync with the nature of the balance sheet and the factors affecting it. We also have to consider a concentrated set of factors from the larger population by using techniques such as PCA.

The Build and Execute phase of the framework is more computationally intensive. Regulators need banks to design scenarios taking into consideration both idiosyncratic stress and system wide stress.

The scenarios can be built by adopting Historical, Simulated and Hybrid methods. A comparison of the three methods is depicted in Table 1 below:

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<th>Parameter</th>
<th>Methods</th>
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<tr>
<td></td>
<td>Historical</td>
</tr>
<tr>
<td>Historical Data</td>
<td>![High]</td>
</tr>
<tr>
<td>Reliance on judgment</td>
<td>![Medium]</td>
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<tr>
<td>Ease to design build and execute</td>
<td>![High]</td>
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<tr>
<td>Probability of over/under estimation</td>
<td>![High]</td>
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Table 1: Methods to Design Scenarios
Figure 3 shows the Building Blocks of Stress Scenarios and consolidates the factors (sample) which affect liquidity risk under three headings:

- **General market factors** such as changes in interest rates, spreads and currency rates
- **Bank specific factors** such as adverse changes in assets and liabilities, funding sources, contingent claims, rating downgrade and large counterparty default
- **Systemic disruptions** such as country risk, war and collapse of a large institution. Historic systemic disruptive events such as the Russian crisis, the Long Term Capital Management (LTCM) crisis and the 2008 financial crisis can be good sources to build scenarios. It has to be noted that systemic disruptive events cause changes in the market factors and bank specific factors, from which scenarios can be built.
The Shock Grid in Figure 3 defines the severity of movements in risk factors over different time periods. This is a simplistic representation of a grid, the actual grid that a bank designs will be much larger and granular in terms of tenor coverage and shock points. The severity, in terms of Bad, Severe and Catastrophic on the Shock Grid, helps in sorting out the scenarios for each run. It is important to consider that the timing of the cashflows as well as the settlement cycles of currencies and markets can differ resulting in a severe strain on the liquidity position. Since the grid charts out the shock points across tenors (short term and long term), it would aid in the final calculation of Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR).

The biggest challenge a bank is likely to face while building and executing scenarios is availability of quality data. Well-established frameworks for market and credit risk still face hurdles due to unavailability of correct data. As such, the challenge for liquidity risk will be more pronounced.

**Quantify and Control**

After developing the scenarios based on the building blocks shown in Figure 3, each scenario is executed. The scenarios which produce negative net cash flows are studied carefully and probabilities of occurrence assigned accordingly. Based on the bank’s priorities and policies, each of the identified negative cash flow scenarios under Bad, Severe and Catastrophic are mapped. A plan of action should be defined to counterbalance the effects of these cash flows. One of the standard methods of counterbalancing is to use the unencumbered asset pool. Guidelines prescribed by the Basel Committee on Banking Supervision (BCBS) for the classification of High Quality Liquid Assets (HQLA) should be considered for assessing the means available for countering liquidity stress under different scenarios.

The board should be regularly informed of the results of the stress testing exercise, which should also be used to set limits, allocate capital, provide inputs for risk appetite definition, and prepare contingency plans. The scenarios should be reviewed periodically to ensure suitability to market dynamics and the geo-political environment.

All counterbalancing strategies along with the related stress scenarios should then be fed into the Contingency Funding Plan, which becomes the master document at an enterprise level, to chalk out the following:

- How does a liquidity crisis evolve and how might it affect the bank?
- What are the risk factors which affect the balance sheet the most, given the composition, concentration, and the behavioral profile of its assets and liabilities?
- What are the early warning indicators?
- What action should get triggered under various stress scenarios – short term, long term, idiosyncratic, market wide?
- What are the counterbalancing strategies (primary plan A, secondary plan B) and when do they get triggered?
Which team is responsible for dealing with stress under different conditions and what should be their communication plan with internal and external stakeholders?

What is the system to incorporate a feedback mechanism?

A contingency plan has to be dynamic in nature. Hence, it should be linked to the stress testing framework and derive continuous inputs from each phase of the framework. It is advisable to have dry runs at pre-defined intervals to ensure the efficacy of the contingency funding plans. A dry run should include a simulation of an event across the organization including communication plans, assumptions on haircuts, validity of the sensitivity of risk factors and alternate sources of funding.

The governance of the framework should be under the control of the board, but it is equally important to have a structure for the organization with clear representation of all lines of businesses and geographies to make the framework operational.

**Conclusion**

Stress Testing for Liquidity Risk is extremely essential to understand the behavior of the balance sheet and its components during extreme scenarios, which are now becoming more frequent. Stress tests, when properly designed and executed, enable the management to have contingency plans in place. These plans allow the management to take into consideration scenarios where things could go wrong and the resulting impact. Stress testing results are also increasingly being used by banks for strategic decision making and capital allocation. The process should become a part of business-as-usual for the institution as it is more than just protection against the unknown—it is about better management, which is reassuring to all stakeholders.

However, it is very important to understand that in the case of stress scenarios, ‘one size does not fit all’. Each bank is unique and therefore the scenarios designed to execute stress tests have to be in line with the bank’s profile. Demands from regulators will keep increasing with the passage of time and the more prepared a bank is, the better its ability to garner and retain goodwill in the market place.
Reference Acknowledgements

- GARP, A New Regulation for Liquidity Risk, Garp December 2011
- Chris Matten, PRMIA Members’ Meeting, Stress testing liquidity and the contingency funding plan, 24 February 2009
- Bank for International Settlements (BIS), Basel Committee on Banking Supervision: International framework for liquidity risk measurement, standards and monitoring, December 2010
- Bank for International Settlements (BIS), Basel III: A global regulatory framework for more resilient banks and banking systems, December 2010
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