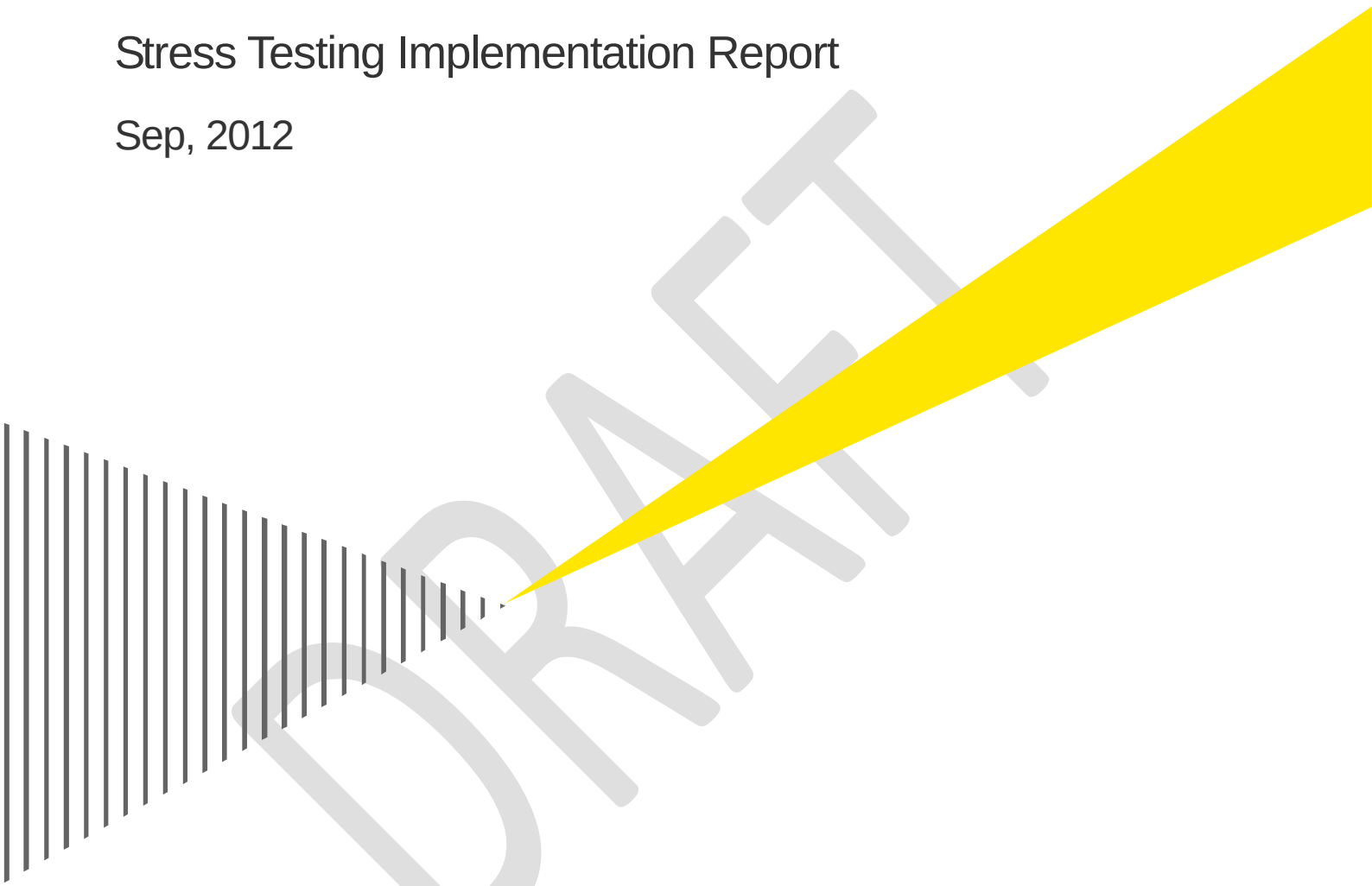
Bank of China (Hong Kong) Ltd

Enhancement of the Liquidity Risk Framework Project

Stress Testing Implementation Report

Sep, 2012



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30 Jul, 2012	EY	2.0	Changed the structure of Section 3; Provide complementary updates to last version.
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1. Executive Summary

1.1. Introduction

The Hong Kong Monetary Authority ("HKMA") issued the final version of Supervisory Policy Manual ("SPM") module LM-2 "Sound Systems and Controls for Liquidity Risk Management" ("LM-2") in April 2011.

LM-2 mainly follows the "Principles for Sound Liquidity Risk Management and Supervision" ("Sound Principles") issued by the Basel Committee on Banking Supervision ("BCBS") in August 2008 and also incorporates some requirements from the paper "Basel III: International framework for liquidity risk measurement, standards and monitoring" ("Basel III") issued by the BCBS in December 2010 .

To enhance the liquidity risk management framework in order to comply with the LM-2 requirements, Bank of China (Hong Kong) Limited ("BOCHK" or "the Bank") initiated the "Enhancement of the liquidity risk management framework Project" ("the LM-2 Project"). The overall goals of the LM-2 Project are to enhance the existing liquidity risk management framework to comply with the LM-2 requirements by Aug 2012 and to meet the Bank's internal management requirements, especially in the following areas:

- Cash flow projection

  Develop and implement cash flow projection methodologies, by taking into account estimated cash flows due to both contractual terms and customer behaviors.

- Stress testing

  Define liquidity stress scenarios and embed their impacts into the cash flow projection and thereby propose early warning indicators ("EWI") in the contingent funding plan ("CFP").

- Liquidity costs/premiums allocation

  Establish the liquidity costs and premiums allocation policy and incorporate the policy into the Bank's existing fund transfer pricing ("FTP") mechanism.

This document, as one of the major deliverables of the LM-2 Project, focuses on the stress testing implementation. It introduces the detailed methodology for liquidity risk stress testing, including the design of stress scenarios, quantification of parameter assumptions, computation of stress cash flow, EWI and contingency funding plan. It also documented the overall methodology for reverse stress testing.

1.2. Scope of implementation

The implementation scope covers BOCHK (solo) and two subsidiaries of the Bank, namely, Nayang Commercial Bank ("NCB") and Chiyu Banking Corporation ("CYB"). Stress testing was implemented for each of the three entities separately, and also on consolidated basis.

Generally, the methodology, approaches and assumptions in this document universally apply to all the three entities in scope, unless clarified specifically.

1.3. Structure of the report

The objective of the document is to provide detail around the work that was conducted under the Stress Testing work stream per SOW.

The summary of the document coverage is as follows:

- Stress Testing of Liquidity Risk

  A high level description of stress testing under the liquidity risk management framework.

- Stress Scenario Design

  Illustrate the frame work of scenario design according to regulatory requirements of LM-2, which starts from the analysis of balance sheet structure and risk profile, followed with specific background design of three scenarios and further impact direction based on key risks identified.

- Product Behavioral Analysis for Assumptions

  Given background design of each stress scenario, establish analysis approaches and detailed assumptions at product level, including run-off rate assumptions of deposits, haircuts applied to marketable securities, drawdown rate of off balance sheet commitments etc.

- Liquidity Stress Testing Impact Assessment

  Describe the process and calculation to evaluate impact over liquidity, profitability and solvency under stressed scenario.

- Early Warning Indicators

  Provide a list of suggested Early Warning Indicators to be applied, and the frequency, threshold of monitoring.

- Recommendation on Contingency Funding Plan

Provide detailed recommendation over the Bank's contingency funding plan for liquidity risk, considering requirements of LM-2 and our observed industry practice.

- Reverse Stress Testing

  Provide a high level framework and steps as a guideline to conduct reverse stress testing for liquidity risk.

- Liquidity Stress Testing Policy Enhancement

  Provide high level recommendation over the structure, main contents and principles for the "Liquidity Risk Stress Testing Guideline" to be established.

- Appendix

  Provide supplementary details to this report.

2. Stress Testing of Liquidity Risk

Stress testing is a key component of the overall liquidity risk management framework. The objective of the liquidity stress testing is to assess the impact of severe but plausible scenarios on the liquidity position and the ability to meet payment obligations as they come due. The outcome of stress testing should provide key input into the definition, monitoring and control of risk appetite, the Contingency Funding Plan, and to establish the core liquidity requirements for the institution. The diagram below shows the components of Liquidity Risk Management Framework and the focus areas for Stress Testing.

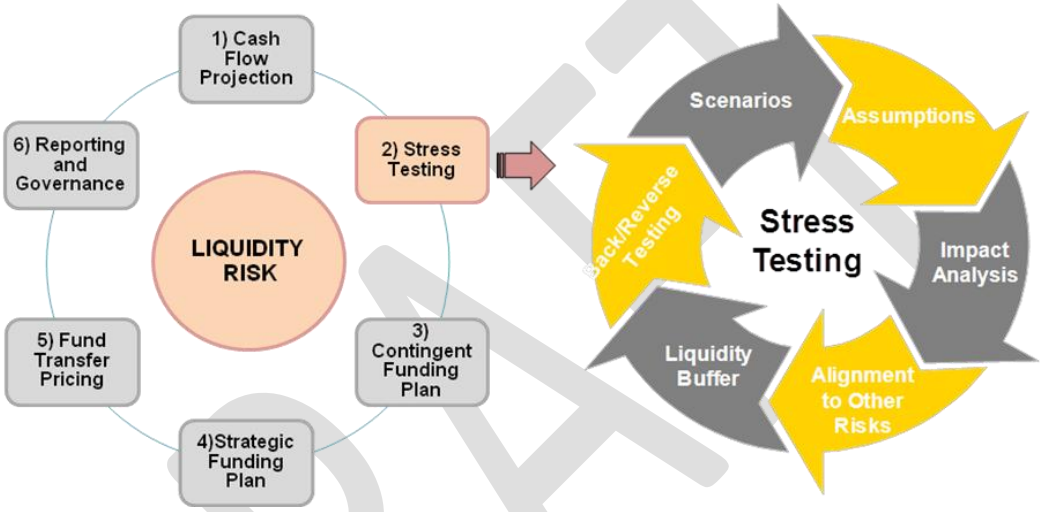


Figure 2.1: Liquidity and Stress Testing Framework

As required by LM-2, "in addition to conducting cash flow projections to monitor net funding requirements under normal business conditions, AIs should perform stress tests regularly by conducting projections based on "what if" scenarios on their liquidity positions to –

- identify sources of potential liquidity strain;
- ensure that current liquidity risk exposures remain in accordance with the established liquidity risk tolerance; and
- analyze any possible impact of future liquidity stresses on their cash flows, liquidity position, profitability and solvency.

2.1. Stress testing by currency

"Stress tests should be performed for all currencies in aggregate and separately for positions in the Hong Kong dollar and individual foreign currencies in which AIs have significant positions". (LM-2, 5.2.4)

Based on foreign currency exposure of BOCHK group at year end of 2011, RMB and USD have been identified to be significant foreign currencies. Thus, the designed liquidity risk stress testing will be performed for HKD, RMB, and USD position separately, and for all currency in aggregate[1].

2.2. Stress testing by entity

"Stress tests should enable an AI to analyze the impact of stress scenarios on its consolidated group-wide liquidity position as well as on the liquidity position of individual entities and business lines in order to understand where risks could arise." (LM-2, 5.2.3)

Hence, the designed liquidity risk stress testing will be performed separately for BOCHK and the two subsidiaries (NCB and CYB), and for BOCHK Group on a consolidated basis.

2.3. Stress testing frequency

"The design and frequency of stress-testing should be commensurate with the size and complexity of an AI and its liquidity risk exposures, as well as with the relative importance of the AI within the financial system." (LM-2, 5.2.5)

According to the "Liquidity Risk Management Policy of BOCHK Group" authorized by the Board, liquidity risk stress testing will be performed regularly on monthly basis, or ad hoc whenever this is warranted under special circumstances, such as in volatile market conditions or at the request of supervisors.

[1] All currency stress test report is generated by summing up by-currency stress testing result, using exchange rate of the reporting date.

3. Stress Scenario Design

3.1. HKMA Guidelines on Stress Scenarios

The HKMA supervisory policy manuals, including LM-2 and IC-5, provide AIs the guidance around the development of liquidity risk and general risk stress tests scenarios respectively. The following is a summary of the principles and expectations that we have been followed with when designing and developing stress scenarios:

- While AIs should aim to cover different stress events and levels of adversity, they should, at a minimum, include the following types of scenarios in their stress-testing exercise (LM-2, 5.4.1):
    - an institution-specific crisis scenario;
    - a general market crisis scenario; and
    - a combination of both.
- The design and frequency of stress-testing should be commensurate with the size and complexity of an AI and its liquidity risk exposures, as well as with the relative importance of the AI within the financial system (LM-2, 5.2.5).
- For stress-testing purposes, AIs are expected to analyze the behavioral characteristics of their assets and liabilities as well as off-balance sheet commitments and other contingent liabilities (including those that are non-contractual in nature) to facilitate understanding of how these items may contribute to, or place demands on, their liquidity under stress scenarios (LM-2, 5.3.1).
- Stress scenarios should, as far as possible, cover on- and off-balance sheet positions of all major portfolios in the trading book and the banking book. They should also reflect specific risk characteristics of an AI's portfolios (IC-5, 2.2.4).
- An AI should assume the minimum stress period for an institution-specific crisis scenario to last for no less than five business days, and that for a general market crisis scenario and a combined scenario, no less than one calendar month. AIs should adopt longer minimum stress periods if their liquidity risk profile warrants this (LM-2, 5.4.17).
- When conducting stress tests on their liquidity position, AIs should also consider the insights and results of stress tests performed for other risks, including possible interaction with these other risks (LM-2, 5.2.6).

- In designing stress scenarios, AIs should review lessons from history and tailor the events, or develop hypothetical scenarios, to reflect the risks arising from latest market developments (IC-5, 3.1.2).
- AIs which are part of a banking group should consider the appropriate treatment of their intragroup transactions, including short-term funding and committed liquidity lines provided to, or received from, other group entities in a crisis scenario (LM-2, 5.3.17).

3.2. Framework for Scenario Design

In order to further augment the current stress testing framework and comply with HKMA guidelines on sound liquidity management, a holistic approach was developed to design stress scenarios relevant to BOCHK. Figure 3.1 outlines the framework that was followed to design stress scenarios.

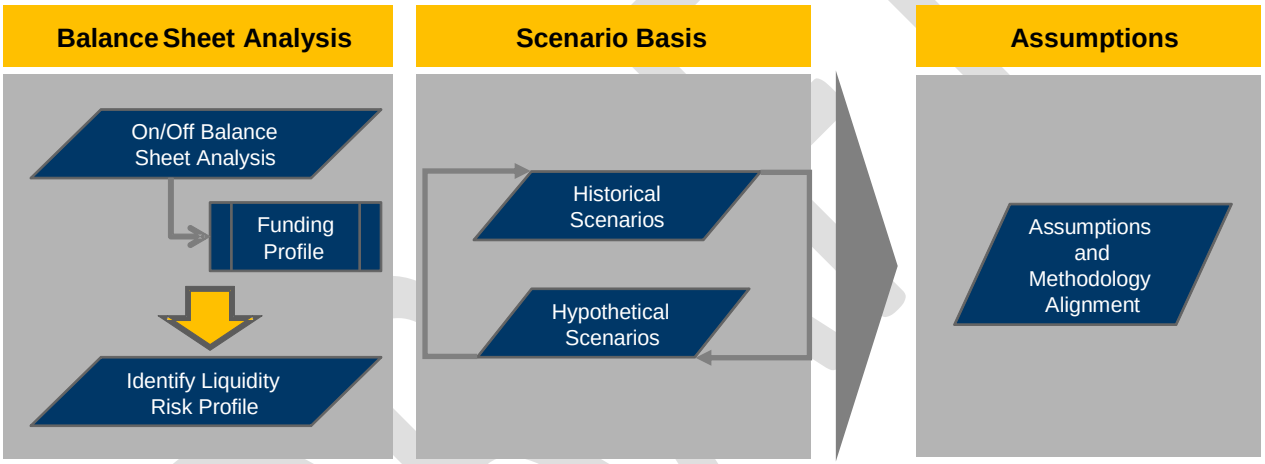


Figure 3.1: Framework for Scenario Definitions and Assumptions Development

3.2.1. Balance Sheet Analysis

The analysis of on and off balance sheet items formed the basis of scenario definitions. The information obtained helped to:

- Establish materiality of the assets and liabilities by type;
- Understand composition of the funding profile; and
- Identify source of contingent liquidity.

Section 3.3 of the document details the findings of the analysis as well as the liquidity risk identified relevant to BOCHK balance sheet profile.

3.2.2. Scenario Basis

The historical events impacting different assets and liabilities can provide a useful guide to scenario definitions. In addition to using the HKMA guidance on stress scenarios, the results from the balance sheet analysis was complemented with the lessons learnt from historical events to design plausible scenarios relevant to BOCHK. The proposed scenarios are outlined in Section 3.4 of the document.

3.2.3. Assumptions Methodology

The list of bank specific assumptions to accurately quantify liquidity impact under defined stress scenarios is an integral part of the overall stress scenario design. Section 4.2 & 4.3 of the document details the approach that was taken to provide baseline stress testing inputs.

3.3. Balance Sheet & Liquidity Risk Profile Analysis

This section discusses the results of balance sheet analysis covering on and off balance sheet items of BOCHK. As to CYB and NCB, their balance sheet mixes and structure are similar to that of BOCHK. Hence we do not perform the balance sheet analysis separately for CYB and NCB. For the balance sheet profile of CYB and NCB and its comparison with BOCHK, see Appendix I.

3.3.1. Balance Sheet Analysis

3.3.1.1. General Overview

As of December 2011 disclosures, BOCHK total assets were at HK$ 1,682B while the liabilities totaled HK$ 1,561B. The following table illustrates the balance sheet mix.

Assets (HK$'m)	Amount	% of Total	Liabilities (HK$'m)*	Amount	% of Total
Cash and balances with banks and other financial institutions	278,520	16.6%	Hong Kong SAR currency notes in circulation	65,890	4.2%
Placements with banks and other financial institutions maturing between one and twelve months	107,910	6.4%	Deposits and balances from banks and other financial institutions	236,694	**15.2%**
Financial assets at fair value through profit or loss	21,662	1.3%	Financial liabilities at fair value through profit or loss	3,237	0.2%
Derivative financial instruments	26,715	1.6%	Derivative financial instruments	22,072	1.4%
Hong Kong SAR Government certificates of indebtedness	65,890	3.9%	Deposits from customers	1,150,134	**73.7%**
Advances and other accounts	755,184	**44.9%**	Debt securities in issue at amortised cost	5,985	0.4%
Investment in securities	358,071	**21.3%**	Other accounts and provisions	41,009	2.6%
Interests in associates	234	0.0%	Current tax liabilities	2,237	0.1%
Investment properties	12,441	0.7%	Deferred tax liabilities	5,365	0.3%
Properties, plant and equipment	39,615	2.4%	Subordinated liabilities	28,656	1.8%
Deferred tax assets	68	0.0%			
Other assets	16,345	1.0%			
Total assets	**1,682,655**	**100.0%**	**Total liabilities**	**1,561,279**	**100.0%**

Table 3.1 Assets and Liabilities Exposure by Product

From the table, it can be seen that BOCHK had a large loans and advances (44.9%) and securities investment (21.3%) in its asset mix. And the liability side was mainly driven by customer (73.7%) and interbank (15.2%) deposits.

3.3.1.2. Investment Portfolio

Figure 3.2 shows the breakdown of the Invest portfolio by security type. The portfolio consists of Available for Sale (AFS) and Held to Maturity (HTM) securities making up approximately 23% of the asset side of the balance sheet. The objective of the investment portfolio is to generate yield on investments and at the same time manage the contingent liquidity pool for the group.

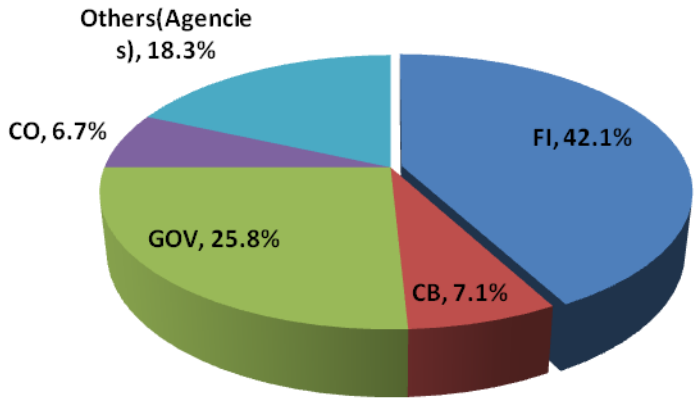


Figure 3.2: Breakdown of Investment Portfolio

3.3.1.3. Funding Mix

As shown in figure 3.3, more than 77% of the funding needs for BOCHK come from the deposit base, of which personal and corporate make up 39.4% and 37.9% respectively. The wholesale unsecured funding (interbank) deposits make up about 16% of the funding source. The rest of the funding comes in the form of Medium Term Notes (MTN) and HK notes, which sums to approximately, 6.8%.

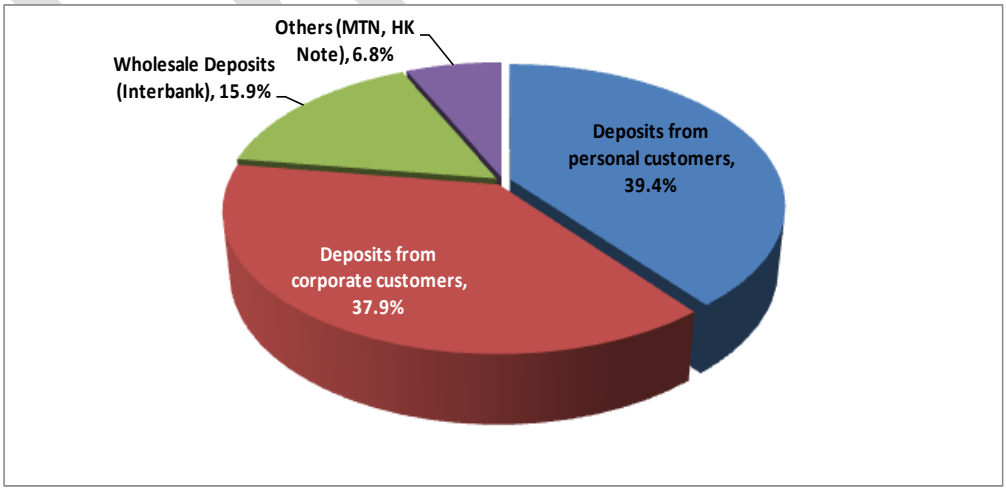


Figure 3.3: Breakdown of Funding Mix

As shown in figure 3.4 personal deposits accounted for 39.4% of the funding mix of which savings account make up the lion share with 58.3% followed by 39.2% of term deposits and the rest in demand deposits. For corporate deposit which is 37.9% of the total funding mix, 59.7% is term deposits followed by 29.0% and 11.3% of savings and demand deposits, respectively.

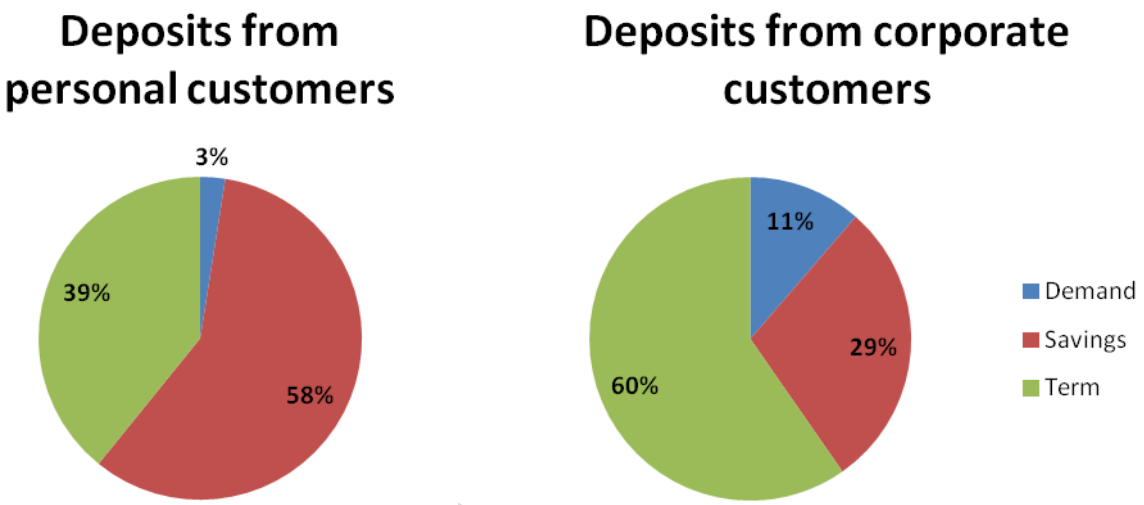


Figure 3.4 Breakdowns of Deposits

3.3.1.4. Off-Balance Sheet

As of December 2011, BOCHK had about HK$ 56.5B in irrevocable loan commitments, which represents 15% of total off-B/S exposures, and about HK$ 50B in trade related contingencies, which represents about 13% of total off-B/S exposures. Around 67% of total exposure (HK$ 263B) been commitments that unconditionally cancellable.

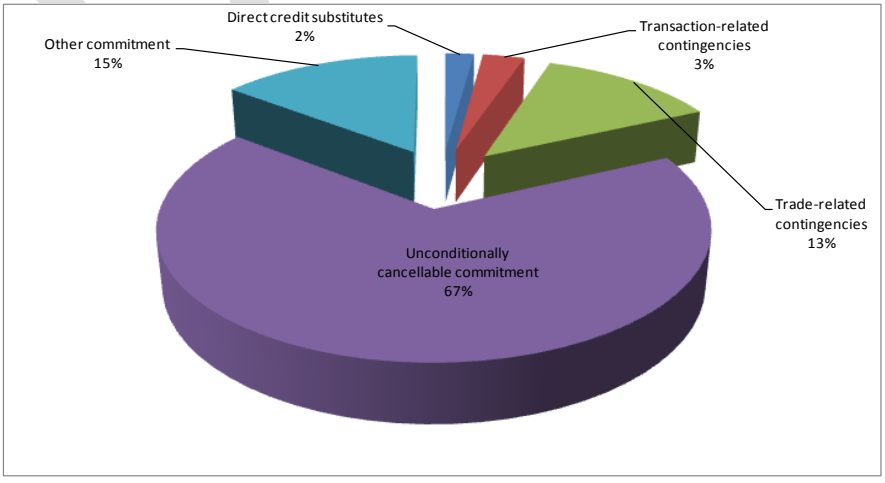


Figure 3.5 Breakdowns of Off B/S Exposure

3.3.2. Liquidity Risk Profile

The following subsections discuss liquidity risk drivers for BOCHK which are deemed high or medium level risks.

3.3.2.1. Retail Funding Risk – Customer Deposits

The risk that outflows of retail deposits would significantly affect the liquidity position in times of stress. Customers may become concerned about the safety of their savings and seek to withdraw funds either from specific firms or the banking industry as a whole for a period of time. The risk is therefore driven by customer behavior.

In the case of BOCHK, deposits (Personal & Corporate) make up to approximately 77% of the source funding thus posing the primary liquidity risk for BOCHK.

As shown in section 3.3.1.3, there is a high concentration in savings and term deposits in personal and corporate categories. This could pose a liquidity risk under stress conditions as each of the segments would show varying degree of deposit run-off rates.

Similarly, the customers who have account balances in excess of the insurance coverage through HKMA insurance policy could be expected to react more sharply to any negative media reports relevant to an institution versus the customers with balances below the insurance level.

3.3.2.2. Wholesale Funding Risk – Interbank Deposits

The risk that it may not be possible to rollover or refinance maturing wholesale funding in times of stress, especially when not secured against the most liquid securities.

In the case of BOCHK, Interbank deposit (wholesale unsecured) is the second largest funding source making up to about 16% of the funding mix. In times of stress, interbank deposits can be characterized as sensitive, especially in the ON bucket, to changes in the credit quality of BOCHK. The volatility of interbank deposits can be considered as a primary source of liquidity risk.

Currently, wholesale secured funding (repo) makes up a very small percentage of BOCHK funding.

3.3.2.3. Intra-Group Funding Risk

The risk arising from contractual intra-group assets and liabilities in which member or members of the group may need to rely on the parent to provide liquidity support during the time of stress.

Currently per agreement BoC is obliged to provide liquidity backstop of up to HK$ 40B to BOCHK under stress conditions when the agreed upon liquidity trigger is breached. Similarly under the agreement, BOCHK is obliged to provide $8BHK of liquidity backstop to the two subsidiaries, Nanyang and Chiyu.

The intragroup dependencies between the BOCHK and the subsidiaries are considered a medium level liquidity risk. However, consideration should be given to the risk level if the parent was required to fund BOCHK in a scenario when itself was undergoing firm specific or systemic stress conditions.

3.3.2.4. Off-Balance Sheet

The off-balance sheet liquidity risk may arise from retail mortgage and commercial loans commitments not yet drawn, as well as retail customers drawing down on their overpayment reserve. The Off-balance sheet risks may also arise from derivative activities where movements in interest rates and exchange rates result in the need to post additional collateral and in the event of a short-term downgrade where cash flow requirements are incurred by breaches of legal covenants in our structured funding vehicles.

As of December 2011, the BOCHK had HK$ 56.5B in irrevocable loan commitments, and about HK$ 62B in trade related contingencies, transaction related contingencies, and direct credit substitutes, which under stress could be a source of liquidity drain.

Derivatives related collateral flows are not material at this time.

3.3.2.5. Investment Portfolio

The risk is when the marketable assets can be used to generate cash inflows but their expected value may not be fully realized in times of stress with the result that they are unable to mitigate the effect of the liquidity stress.

As of December 2011, the investment portfolio accounted for approximately 22.6% of Balance Sheet assets. The pool which is designed to take advantage of the market conditions to provide return on asset also contains the pool of contingent liquid assets. The liquidity cushion consists of securities including US Treasury, HK EF paper, Japanese Bonds, US agency, and supranational. And as of Jan 2012, the pool was about HK$ 100B.

The high proportion of FI held in the portfolio as indicated in Figure 3.2 could pose a liquidity risk given in severe systemic risk condition due to higher haircuts applied to FI securities.

3.3.2.6. Funding Concentration Risk

The risk is possible when funding sources are not sufficiently diversified so that the concentration results in a greater impact on liquidity in times of stress.

As of Dec 2011, BOCHK obtained approximately greater than 90% of the funding from Deposits and Interbank Bank deposits which could pose a funding risk in times of certain firm specific (run-on the bank) and systemic stress scenarios.

3.4. Stress Scenarios Definitions

In accordance with the latest regulatory guidelines from HKMA on stress testing and based on balance sheet analysis described above, three plausible scenarios relevant to BOCHK have been developed. The three scenarios are:

- firm specific crisis scenario;
- systemic (general market) crisis scenario; and
- combination of both.

The background design of each stress scenario and related impact analysis are discussed below.

3.4.1. Scenario 1: Firm Specific Short Term Severe

A firm specific stress scenario allows the firm to simulate the impact on liquidity unique to Bank's situation.

The description of the proposed firm specific scenario, duration up to 30 days, is as follows:

- Assumes that political or financial scandal of BOCHK has caused huge loss that one of the major rating companies has issued a 3 notches downgrade and bank run occurs as people try to seek safer harbor for their fund.

In the above proposed scenario, the impact of BOCHK's credit rating on its liquidity position in the short term is explored.

3.4.1.1. Impact on Sources of Liquidity

Under the firm specific downgrade stress scenario, the expected impact on sources of liquidity can be summarized as follows:

- Withdrawal of interbank deposits across all customer spectrums especially from depositors with whom the Bank does not have a long standing relationship, overseas depositors/investors and credit sensitive clients.

- No access to untapped short and medium term wholesale unsecured funding capacity including unsecured debt securities like CP, certificate of deposits and medium term notes.
- No access to wholesale secured funding (repos) and no roll-overs of existing deals. Limited accessibility availability over time with increased collateral requirements by counterparties. Contingent lines extended by other financial institutions not available.
- Response from retail depositors expected to be less negative than institutional investors due to deposit insurance and relationship considerations:
- Corporate deposits are expected to be more volatile compared to deposits from individuals.
    - Deposits account transactional or relationship with BOCHK can be expected to have lower run-off rates.
- Although the market value of marketable securities will not be affected by the firm-specific crisis, certain discount should be applied when the Bank need get funding through sale or repo of those liquidity assets. Also, the expected length of time needed to settle sale or repo transactions would be longer than BAU condition.
- Intragroup contingency flow from BOC to BOCHK per agreement once the liquidity limit is breached.

3.4.1.2. Impact on Uses of Liquidity

Similar to the impact on sources of liquidity, the downgrade scenario of BOCHK credit will impact the uses of liquidity as follows:

- Increased draw down on loan commitment (irrevocable) beyond expected and historic levels.
- Intragroup contingency flows to subsidiaries Chiyu and Nanyang;
- Increased liquidity needs due to downgrade triggers in derivatives and other financing transactions.
- Certain amount of cash inflow from loans upon maturity will be used to finance the continuously renew/roll-over of the Bank's loan portfolio.

3.4.2. Scenario 2: Systemic Short Term Severe

The systemic scenario focuses on the market driven event impacting the funding market in the short term and its impact on institution's liquidity position.

The description of the proposed systemic short term severe scenario, duration up to 30 days, is as follows:

- An unprecedented expansionary monetary policy by the US Fed from the fall out of the

financial crisis in 2008 has fueled significant increase in asset prices in HK through the linked exchange rate system.

- Market speculators are anticipating a significant correction of the markets, liken to the 1998 crash which saw a large outflow of capital in a very short period of time and reduced money supply in the economy, resulting in a sharp increase in ON borrowing rates in HK.

The proposed scenario ground itself on the interaction of HK and US economies and the potential impact of US's monetary policy on the HK economy. The scenario also considers the events of 1998 when the exchange rate between Hong Kong and the US was under attack and the overnight interbank rates as shown in Figure 3.5 spiked impacting the short term borrowing capacities of the banks and reducing the money supply in the economy. This scenario is relevant to BOCHK given that interbank borrowing is the second largest source of funding for the bank. Additionally, the bank's large investment portfolio of marketable securities on the balance sheet could see a sharp drop in the overall market value due to market volatility (high haircuts), which could pose a liquidity risk in case BOCHK use the portfolio for contingency liquidity needs.

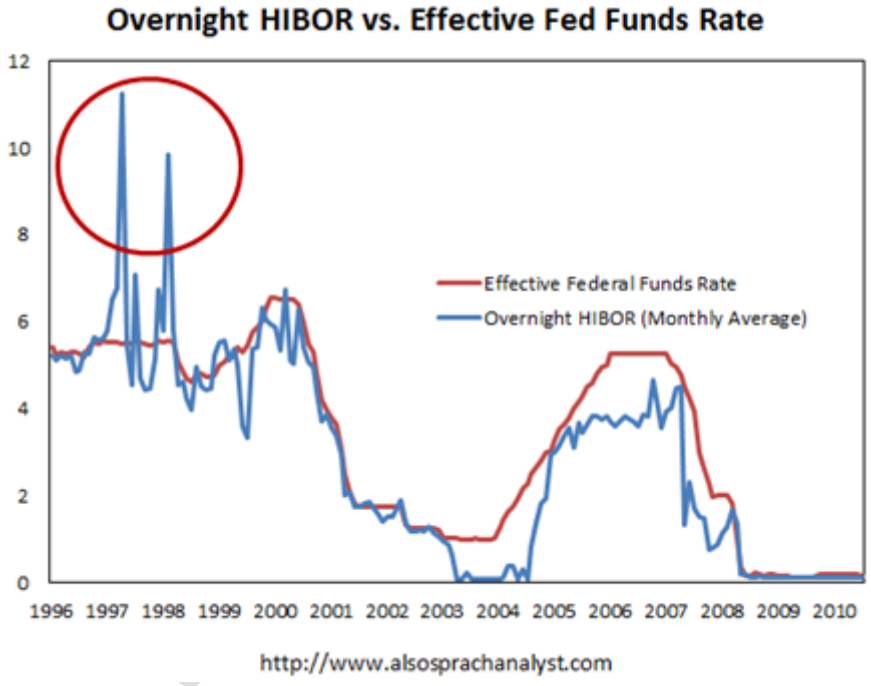


Figure 3.5: Overnight borrowing rates in HK during the 1998 financial crisis.

3.4.2.1. Impact on Sources of Liquidity

Under the Systemic Short Term severe stress scenario, the expected impact on sources of liquidity can be summarized as follows:

- Placement with other banks will be repaid as of maturity date with certain hair-cut.

- High volatility in the interbank deposits especially for the deposits in HKD.
- Limited or no access to untapped short and medium term wholesale secured/unsecured funding capacity for the first two weeks into the crisis. Some of the funding sources return but at increased cost and reduced maturities. Contingent lines extended by other financial institutions not available.
- Reduced valuation of financial assets specifically those originated by financial sector due to market volatility, leading to illiquidity of the marketable securities to generate funding through direct sale or secured funding arrangements. Also, the expected length of time needed to settle sale or repo transactions would be longer than BAU condition
- Response from retail depositors expected to be less negative than institutional investors due to deposit insurance and relationships considerations.
    - BOCHK receives additional retail deposits from vulnerable institutions due to its position as one of the largest local banks in HK.
- Outflows from corporate deposits at elevated levels with lower run-off rates in the transactional and operational relationships segments from vulnerable institutions.
- Intragroup contingency flow from BOC to BOCHK upon reaching the limit trigger.

3.4.2.2. Impact on Uses of Liquidity

Under the Systemic Short Term severe stress scenario, the expected impact on uses of liquidity can be summarized as follows:

- Increased draw down on loan commitment (irrevocable) beyond expected and historic levels.
- Increased liquidity needs due to valuation changes on posted collateral securing derivatives and other transaction.
- Certain amount of cash inflow from loans upon maturity will be used to finance the continuously renew/roll-over of the Bank's loan portfolio.
- Increased liquidity needs due to pressure on intraday liquidity management.
- Intragroup contingency flows to subsidiaries Chiyu and Nanyang.

3.4.3. Scenario 3: Combined Long Term Severe

A combined stress scenario allows the firm to simulate the impact on liquidity when the market volatility and the firm specific stresses occur simultaneously, with a duration up to 3 months.

3.4.3.1. Impact on Sources of Liquidity

Under the Combined Long Term Severe scenario, the expected impact on sources of liquidity can be summarized as follows:

- Placement with other banks will be repaid as of maturity date with certain hair-cut.
- More severe impact on withdrawal of interbank deposits compared to scenario 1 & 2.
- Limited or no access to untapped short and medium term wholesale unsecured funding capacity including unsecured debt securities like CP, certificate of deposits and medium term notes.
- Very limited access to wholesale secured funding (repo) but with increased collateral requirements and reduced maturities by counterparties. Contingent lines extended by other financial institutions not available.
- Continued pressure on valuation of financial assets specifically those originated by financial sector, leading to reduced valuation of the marketable securities to generate funding through direct sale or secured funding arrangements. Also, the expected length of time needed to settle sale or repo transactions would be longer than BAU condition
- After 30 days of the crisis, in addition to initial decrease of market value, the investment portfolio suffered from further valuation loss as a second round effect of market panic.
- Overall response from retail and business depositors are severe than both scenario 1 & 2, but lower than the "simple summation" of the two scenario considering interaction effect.
- Intragroup contingency flow from BoC to BOCHK upon breaching the limit.

3.4.3.2. Impact on Uses of Liquidity

Under the Systemic Short Term severe stress scenario, the expected impact on uses of liquidity can be summarized as follows:

- Increased draw down on loan commitment beyond expected and historic levels.
- After the first month, the loan delinquency rate increased when the impact of crisis spread from financial market to real economy, which reduced the cash inflow from matured loan and advances.
- Increased liquidity needs due to downgrade triggers in derivatives and other financing transactions.
- Increased liquidity needs due to valuation changes on posted collateral securing derivatives and other transaction.
- Intragroup contingency flows to subsidiaries Chiyu and Nanyang.

- Increased liquidity needs due to pressure on intraday liquidity management.
- Certain amount of cash inflow from loans upon maturity will be used to finance the continuously renew/roll-over of the Bank's loan portfolio.

3.4.4. Summary of impact assumptions

In LM-2 5.4.4, for illustrative purposes, the guidance provides a list of factors to be covered when setting stress assumptions. The table below summarizes how these factors are considered under the three designed scenarios.

Factors per LM-2	Scenarios		
	Firm Specific	Systematic	Combined
Funding Sources			
Asset market illiquidity and erosion in the value of liquid assets	Y	Y	Y
The run-off of retail funding	Y	Y	Y
The loss or impairment of secured and unsecured wholesale funding sources	Y	Y	Y
The correlation between funding markets and effectiveness of diversification across available sources of funding	Conservatively, no diversification effect across available sources of funding is recognized.		
The availability of contingent lines extended by other financial institutions to the AI	Contingent lines extended by other financial institutions not available.		
Access to standing facilities (e.g. discount window) provided by the HKMA or other relevant central banks (for locally incorporated AIs operating in overseas jurisdictions	Conservatively, no standing facilities provided by the HKMA or other relevant central banks are available.		
The expected length of time needed to settle sale or repo transactions	Y	Y	Y
Fund needs			
Contingent claims, including potential draws on committed lines extended to third parties or AIs' subsidiaries, branches or head office	Y	Y	Y
Liquidity drains associated with contractual obligations or non-contractual obligations involving off-balance sheet vehicles and activities, as well as complex products or transactions	Not applicable to BOCHK since no such securitization exposure or other complex products or transactions exist.		
Additional margin calls and collateral requirements (e.g. in derivative or other contracts with embedded trigger clauses)	Y	Y	Y
Estimates of future balance sheet growth	Roll over of loan considered. Assume no growth of balance sheet position.		
Other assumptions			
Currency convertibility and access to foreign exchange markets	Assume that the convertibility between HKD, RMB and USD will not be affected.		
The transferability of liquidity across entities, sectors and national borders, taking into account legal, regulatory, operational and time zone restrictions and constraints;	Not applicable to BOCHK		
Access to payment and settlement systems on which an AI relies	N	Y[2]	N

Table 3.2 Summary of Impact Assumptions

[2] The potential impact will be separately considered under intraday liquidity management.

4. Product Behavioral Analysis for Assumptions Setting

4.1. HKMA Guidelines on behavioral considerations for stress items

Per HKMA LM2 guidelines, the AIs are expected to analyze the behavioral characteristics of their assets and liabilities as well as off-balance sheet commitments and other contingent liabilities (including those that are non-contractual in nature) to facilitate understanding of how these items may contribute to, or place demands on, their liquidity under stress scenarios.

The following is a summary of the principles and expectations that the institutions need to comply with when designing and developing stress scenarios assumptions:

- The liquidity of an AI's assets is essentially determined by their marketability. AIs may analyze assets in accordance with their relative level of market liquidity and classify them broadly as follows - (LM-2, 5.3.2):
  - Cash;
  - Marketable assets such as government securities;
  - Other marketable assets;
  - Saleable loan or asset portfolios;
  - Other assets which are illiquid or not marketable.
- In each of the above categories, assets pledged to third parties or tied to other positions should be separately identified as being incapable of generating liquidity (LM-2, 5.3.3).
- The liquidity of an AI's liabilities is determined by the reliability, stability or "stickiness" of its funding sources. AIs are expected to analyze funding sources (other than capital) that would tend to stay with the AI under most circumstances and those that would likely run off quickly at the first sign of problems - (LM-2, 5.3.6).
- AIs should assess the potential contingent liquidity risks arising from off-balance sheet commitments and other contingent liabilities, including the related triggering events associated with off-balance sheet positions, under adverse situations (LM-2, 5.3.10).
- AIs which are part of a banking group should consider the appropriate treatment of their intragroup transactions, including short-term funding and committed liquidity lines provided to, or received from, other group entities in a crisis scenario. This would depend on whether the crisis scenario is localized or affects the group as a whole (LM-2, 5.3.17).

Here we only list considerations for high-level product types, and the detailed treatment for the subcategories will be further discussed in the analysis of each product according to their materiality in BOCHK.

4.2. Framework for Assumptions Setting

Figure 4.1 outlines the framework that was used to facilitate the process of assumptions development. The key parts of the process included:

- Identify categories and subcategories of on and off-balance sheet items that were relevant for stress testing impact analysis
- Define approaches to approximate initial assumptions (run-off rates, drawdown rates, etc.) for market risk, firm specific and combined scenarios
- Finalize the assumptions using a combination of BoCHK data and expert judgment including distribution of cash inflow and outflows under various stress scenarios

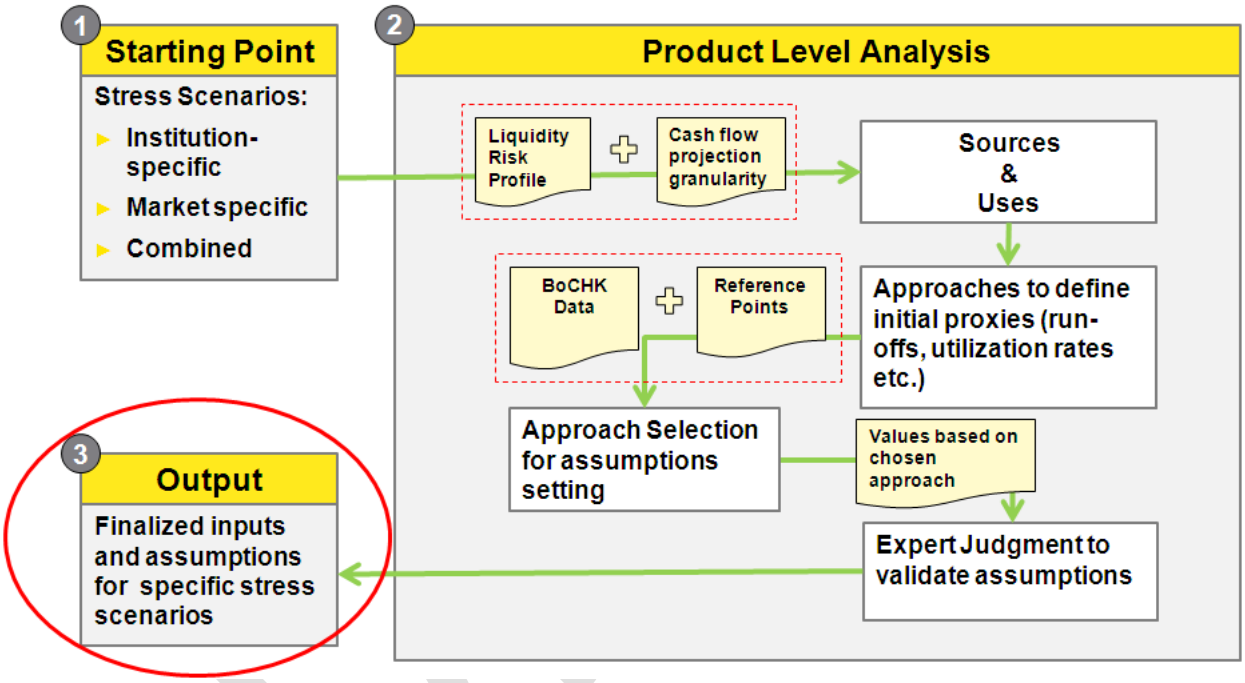


Figure 4.1: Framework for Assumptions Setting

4.2.1. Approaches For Assumptions Setting

Three approaches were proposed to define initial set of inputs (run-off rates of deposits, draw-down rates on commitments, etc.) that characterize the behavior of items to be stressed. The following section describes each of the approaches along with advantages and disadvantages for each.

Approach 1: Statically Analysis

The first approach makes use of the statistical analysis (on deposits, commitments) to arrive at run-off rates, drawdown rates etc. for the items to be stressed. It uses historical data to obtain

distribution table of historical volatility to proximate rates from which relevant cash flows at a given confidence interval can be calculated.

The advantages and disadvantages of using the cash flow projection model approach are as follows:

Advantages:

- Ability to capture and quantify low probability events;
- Given the outcome of the approach is a distribution covering time horizons, the cash flow can be calculated for a wide variety of horizons;

Disadvantages:

- Requires large of amount of data with specific granularity to accurately model the behavior of the product;
- Requires a strong models governance framework to ensure proper use and maintenance of models;
- Smaller data set could lead to erroneous model outcomes especially when low probability high impact events are modeled.

Approach 2: Basic Trend Analysis

The second proposed approach proximate the behavioral assumption of the product(s) by analyzing the historical trends experienced during relevant crisis time. The approach is used to spot a pattern, or *trend*, in the information. For example, a run-off rate for a demand deposit could be assessed by looking at quarter over quarter change in balances during a defined stress period and calculating the weighted average of the worst quarters of the timeline analyzed.

The advantages and disadvantages of using the above approach are:

Advantages:

- Less data intensive and easy to implement;
- Less complex than the statistical modeling and analysis approach;

Disadvantages:

- Not based on sound statistical theory and may not fully reflect the behavioral characteristics of institutions assets and liabilities as well as off-balance sheet commitments and other contingent liabilities.

Approach 3: Regulatory Guidance

In the absence of good quality historical data, regulatory guidance could be an alternative starting point based on which the final assumptions could be assigned. BASEL III and FSA provide specific assumptions for relevant assets and liabilities with potential implications on liquidity.

The advantages and disadvantages of using the regulatory guidance approach are as follows:

Advantages:

- Provide a good starting assumptions for institution;
- Easy to comprehend and less data intensive;

Disadvantages:

- Not based on institution data so does not fully capture institution specific characteristics and depends on expert judgment which may not be based on quantitative grounds;
- Does not comply with the regulatory expectations where the guidance for the institution is to conduct analysis on behavioral characteristics of their assets and liabilities as well as off-balance sheet commitments and other contingent liabilities.

4.2.2. Approach Selection

Based on the discussion with the MRD team, approach one involving statistical analysis was chosen to conduct first level inputs estimations. The drivers for the approach selection included:

- Complementing work conducted by the cash flow modeling team on behavioral modeling and aligning the two work streams;
- Robustness of the methodology over other two approaches given the theoretical basis of analysis that incorporates historical BOCHK data;
- Regulatory guidance which expects the institutions to conduct behavioral analysis of their balance sheets.

4.3. Product Level Assumptions

4.3.1. Deposits and Off-balance Sheet Commitments

The BOCHK IT team provided historical data covering period from Nov 2008 to Feb 2012. This data represents a time when the global economy was recovering from the financial crisis of 2007, which nevertheless does not cover the beginning, escalation and peak of the crisis period, especially the collapse of Lehman Brother, hence the available historical data reflect more on the risk drivers of the Bank itself instead of the market. As a result, the existing information was used as a proxy to the firm-specific scenario. A conservative approach was recommended whereby a 99% confidence interval for the month period (severe stress period) was used to compute run-offs rates for on and off balance sheet items that were identified as key liquidity risk drivers.

To obtain assumptions covering market and combined scenarios, a combination of industry references, including historical bank runs across different regions and survey data of stress testing assumptions published by European Union banks, regulatory prescribed rates and expert judgment

were used as guidelines. The industry specific and historic stress events reference data is shown in Section 4.3.1.3.

4.3.1.1. Granularity of Analysis

Assumptions of customer and interbank deposit run-off rate and commitment drawdown rate under stress scenarios are analyzed according the granularity illustrated in the table below:

Stressed Items	Product Granularity	Currency Granularity
Retail Deposit	▶ Current Account ▶ Saving Account and Call Deposit ▶ Fixed Deposit ▶ Other Deposit	▶ HKD ▶ RMB ▶ USD ▶ All currency ▶ Other currency (equals to HKD)
Wholesale Deposit	▶ Current Account ▶ Saving Account and Call Deposit ▶ Fixed Deposit ▶ Other Deposit	▶ HKD ▶ RMB ▶ USD ▶ All currency ▶ Other currency (equals to HKD)
Interbank Deposit (Vostro)	▶ Clear Bank ○ Peer Banks ○ Intra Group ▶ Participating Bank ○ Peer Banks ○ Intra Group ▶ HKMA Deposit	▶ HKD ▶ RMB ▶ USD ▶ All currency ▶ Other Currency (equals to HKD)
Commitment	▶ Irrevocable Undrawn Lending Commitment ○ Personal (including SSE) ○ Corporate (including SME/Corporate) ○ Others ▶ Commitment Related to Trade Services ○ Corporate (including SSE/SME/Corporate) ○ Others	▶ All currency

Table 4.1: Analysis Granularity of Deposit and Commitment

Product Granularity

Retail, wholesale and interbank (vostro) deposits, identified in balance sheet analysis, as key liquidity risk drivers, were further subcategorized based on the granularity prepared by the cash flow projection team. The granularity proposed by the cash flow projection team is based on the teams understanding of the BOCHK products based on the discussions with various business units and takes into account regulatory expectations around data availability and reporting requirements.

Though the intent was to conduct analysis at the granularity (transaction, non-transaction, insured and uninsured etc.) outlined in the regulatory guidelines, however, due to lack of data availability, the initial set of assumptions are mostly at the product level, for example, current account for retail and wholesale deposits.

The recommendation is to conduct data collection that would support behavioral analysis of products at higher level of granularity to improve stress testing framework and meet regulatory expectations.

Currency Granularity

Deposit run-off rate assumptions are further analyzed by each significant currency, namely, HKD, RMB and USD. For other insignificant currencies, instead of perform analysis one by one, results of HKD deposit were use as a proxy.

As in the commitment several clients may share a total limit denominated in one currency, and on top of that, those client can drawdown in different currencies due to their different needs, hence it is not feasible to segment the commitment in different currencies. As a result, the drawdown rate is calculated by converting the limit and drawn amount to HKD equivalent.

4.3.1.2. Firm-specific Scenario

4.3.1.2.1. Retail Deposits

To capture the retail deposits characteristics, volatilities tables were developed for the four sub-product categories, i.e., current account deposit, saving account and call deposit, fixed deposit and other deposit by calculating the month over month changes in the outstanding balances. The monthly volatility was calculated as:

$$vol_k = \frac{Bal_k - Bal_{k-1}}{Bal_{k-1}} \qquad (1)$$

where vol_k is the monthly volatility for the k^{th} month, and Bal_k is the outstanding balance as of the end of the k^{th} month. Please refer to Appendix II for related historical volatility and statistics results.

In our approach, the monthly historical volatilities at 99% percentile are taken as the run-off rates for the firm-specific scenario. They are illustrated in the following table.

Retail Deposits (HKD)	Run-off Rate (99%)
Current Account Deposits	4%

Saving Account and Call Deposits	5%
Fixed Deposits	9%
Other Deposits	7%

Table 4.2: Retail deposit run-off rates (HKD)

Results of other significant currencies (RMB, USD and all currency consolidated) were separately analyzed with detailed results showed in Appendix III.

4.3.1.2.2. Wholesale Deposits

Similar to retail deposits, volatility analysis was conducted on wholesale deposits. The volatility rate was calculated using equation (1) above:

$$vol_k = \frac{Bal_k - Bal_{k-1}}{Bal_{k-1}} \qquad (2)$$

where vol_k is the monthly volatility for the k^{th} month, and Bal_k is the outstanding balance as of the end of the k^{th} month.

Please refer to Appendix II for related historical volatility and statistics results.

Similar to the retail deposits, the monthly historical volatilities at 99% percentile are taken as the run-off rates for the firm-specific scenario. They are illustrated in the following table.

Retail Deposits (HKD)	Run-off Rate (99%)
Current Account Deposits	40%
Saving Account and Call Deposits	37%
Fixed Deposits	26%
Other Deposits	25%

Table 4.3: Wholesale deposit run-off rates (HKD)

Results of other significant currencies (RMB, USD and all currency consolidated) were separately analyzed with detailed results shown in Appendix III.

4.3.1.2.3. Interbank Deposits

As of December 2011, the interbank deposits make up to approximately 17% of the funding mix for BOCHK. The past crisis such as the one in 2007 has shown that interbank deposits are subject to high volatility under crisis events and could be a source of liquidity constraints for institutions.

BOCHK divides its interbank deposits into clearing and participating bank deposits for HKD and RMB denominations. The segments are further broken into deposits from Peer Banks, Intra group and HKMA. It should be note that the bank has a unique position as it is the only bank in Hong Kong, with the license to provide clear bank services of off-shore RMB business to other participating banks and RMB deposits from other banks for clearing purposes represents large portion of the total interbank deposits.

Separate analysis should be conducted for clearing and participating deposits (for RMB and Non-RMB) as set out in the section 4.3.1.1 Granularity of Analysis to ensure that characteristics of the RMB deposits and non-RMB are appropriately captured. However, due to the inability to identify the clearing and participating deposits accurately at this moment, the volatility analysis is conducted on a currency level. As with the retail and wholesale deposits, the 99% percentile of the historical monthly volatilities is approximated as the run-off rate for the firm-specific scenario. The run-off rates for different currencies are shown in the following table.

Interbank Deposits	Run-off Rate (99%)
CNY	46%
HKD	73%
USD	60%

Table 4.4: Run-off Rates for interbank deposits of different currencies

4.3.1.2.4. Off Balance Sheet Commitment

For stress testing purposes, drawdown characteristics of off balance sheet commitment was considered. Based on the analysis of the Bank's historical data, the drawdown rates of Irrevocable Undrawn Lending Commitments and Commitment Related to Trade Services for the Firm-specific scenarios are assumed to be the 99% percentile monthly drawdown rates. The parameter inputs of drawdown rates by customer segment are listed in the following table:

Irrevocable Undrawn Lending Commitment	Drawdown Rate (99%)
Personal	10%
Corporate	13%
Others	13%
Commitment Related to Trade Services	**Drawdown Rate (99%)**

Corporate	14%
Others	14%

Table 4.5: Drawdown Rates

4.3.1.3. Market Scenario and Combined Scenario

As mentioned above, the input assumptions for the firm-specific scenario were computed using the Bank's historical data at 99% percentile of the monthly volatility or drawdown rate. Due to paucity of historical data to cover the systematic crisis, a combination of industry references, including historical bank runs across different regions, survey data of stress testing assumptions published by European Union banks, regulatory prescribed rates and expert judgment were used as guidelines to compute the input assumptions for the market and combined scenarios.

To assign assumptions for the market and combined scenarios the following process was used:

- Identified relevant industry references, including historical bank runs across different regions and survey data of stress testing assumptions published in various papers – see Figure 4.2.
- Utilized relevant industry reference (normalized to stress period) and applied expert judgment (business and MRD) to assess a scaling factor which was multiplied to the estimated initial market scenario input assumptions to arrive to market or combined numbers. This can be represented as :

$$V_{market/combined} = (ScaleFactor)_{market/combined} \times V_{firm-specific}$$

where, $V_{market/combined}$ is the estimated input parameters for the market or combined scenario. The table below lists the ranges for industrial references about the run-off and drawdown rates under stress used to compute the "Scale Factor". In the case of the market scenario, the "Scale Factor" is 0.6 (the midpoint of the range for the market scenario divided by that for the firm-specific scenario). As to the scale factor for the combined scenario, it is determined by

$$80\% \times (1 + ScaleFactor_{market})$$

to reflect the interaction among the stress characteristics of both a firm-specific and a market crisis.

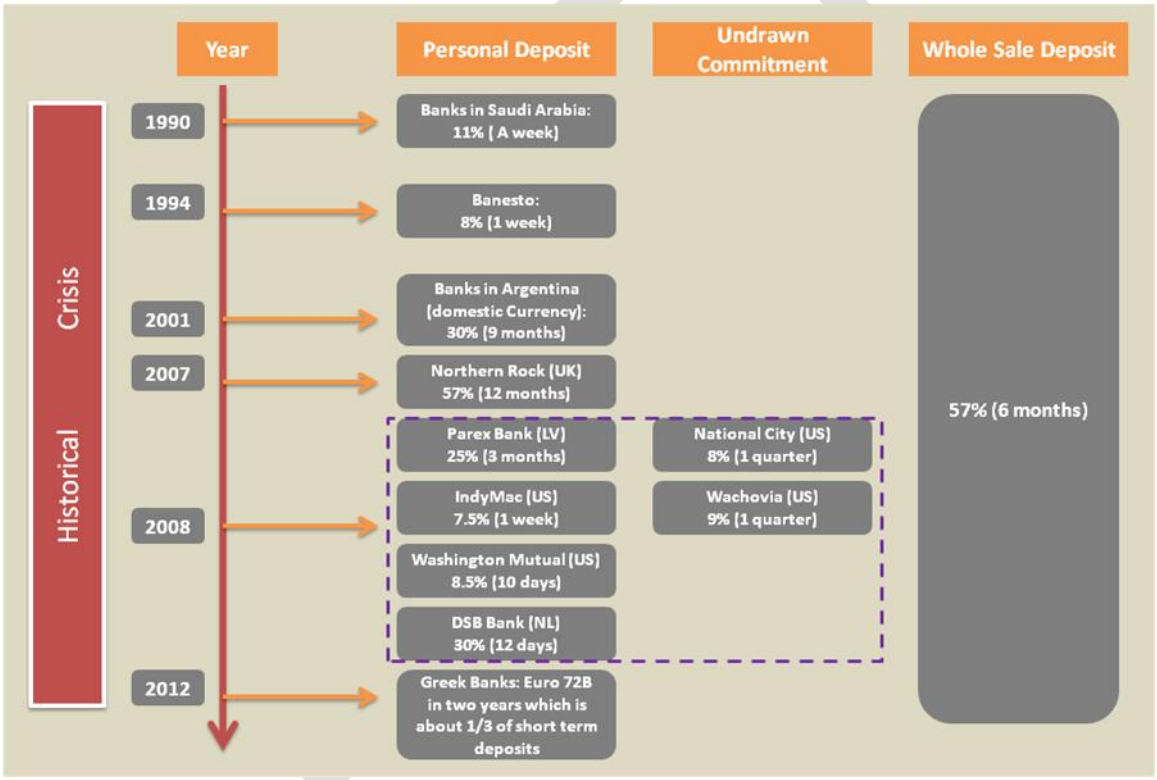
Product	Industrial Reference	
	Firm -specific	Market

Retail Deposit	4-17%	2-9%
Wholesale Deposit	11-22%	7-17%
Commitment	2-7%	1-3%

Table 4.6: Ranges of industrial reference for run-off rates

The drawdown rates of commitments for the market and combined scenarios are the higher of the drawdown rates calculated through the above steps and the 50% percentile historical drawdown rates.

The following graphic shows some detailed withdraw rates and drawdown rates used in industry during historical crisis.



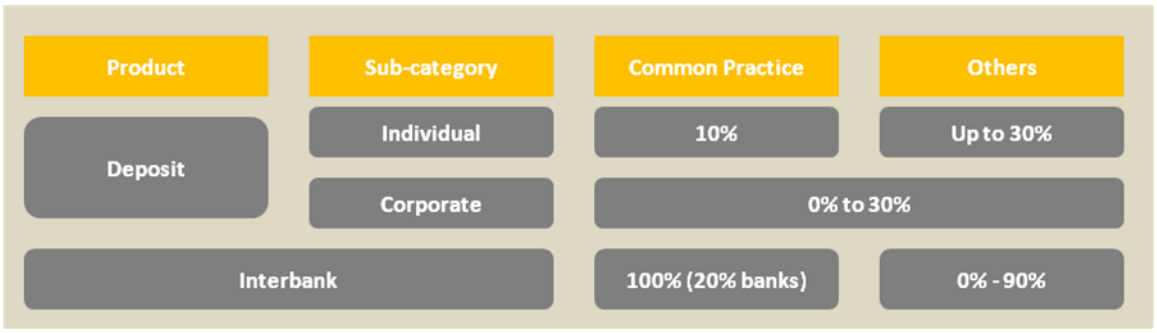


Figure 4.2: Some Industrial and Historical Reference

Historical events provide a good benchmark for the institution, setting up assumptions based on these reference data have limitations such as:

- Inability to fully capture institution's business complexity and risk on its balance sheet.
- Deposit run-offs reflected in historical events may not be representative of what BoCHK may experience in a crisis scenario.
- Key risk drivers leading to crisis relevant to one economy may not be applicable to the HK economy.

The HKD run-off rates estimated by using above approach are listed in the following tables.

Retail Deposits	Run-off Rate		
	Firm-specific	Market	Combined
Current Account Deposits	4%	2%	6%
Saving Account and Call Deposits	5%	3%	8%
Fixed Deposits	9%	5%	14%
Other Deposits	7%	4%	11%

Table 4.7: Retail deposit run-off rates

Wholesale Deposits	Run-off Rate		
	Firm-specific	Market	Combined
Current Account Deposits	40%	32%	72%
Saving Account and Call Deposits	37%	30%	67%
Fixed Deposits	26%	21%	47%
Other Deposits	25%	20%	45%

Table 4.8: Wholesale deposit run-off rates

Interbank (Vostro) Deposits	Run-off Rate		
	Firm-specific	Market	Combined
CNY	46%	36%	74%
HKD	73%	58%	100%
USD	60%	48%	96%

Table 4.9: Run-off rates of interbank deposits

Irrevocable Undrawn Lending Commitment	Drawdown Rate		
	Firm-specific	Market	Combined
Personal	10%	10%	12%

Corporate	13%	13%	16%
Others	13%	13%	16%
Commitment related to Trade Services	**Firm-specific**	**Market**	**Combined**
Corporate	14%	14%	17%
Others	14%	14%	17%

Table 4.10: Commitment drawdown rates

4.3.2. Marketable Securities

Under stress, the liquidity buffer assets, which consist of high quality government bonds and super national bonds, are assumed to be sold to cover the liquidity need. A haircut is applied to the market value of those bonds to reflect the stress.

As mentioned in Section 3.3.1.2 of the document, the contingent liquidity assets buffer pool is the part of the investment portfolio, managed by the IMD group. As of January 2012, there were HK$ 100B of contingent liquidity assets, mainly including following category of securities

- HK EF Paper
- US Treasury
- JGB
- US Agency
- Other Govt
- Super-nation

The range of haircuts rates relevant to the sale of contingent liquidity buffer for stress scenarios was determined based on the discussions with IMD and are outlined in Table 4.5. To analyze stress testing impact, the haircuts at the higher range were used to be conservative.

Buffer Composition	Firm-specific	Market	Combined
HK EF Paper/US Treasury/JGB	2%	4%	3%
US Agency/Other Govt	3%	5%	4%
Super-nation	4%	5%	4%

Table 4.11: Haircut Range for Liquidity Buffer Assets

Considering the second round effect when the market is undergoing stress, it is assumed that the haircuts based on the Table 4.11 will increase by 100 bps after 30 days for the combined scenario. For the firm-specific and market scenario, the haircuts are assumed flat due to the short stress horizon.

We assume that the convertibility of foreign currencies will not be affected under stressed scenario. The liquidity buffer assets could be used to mitigate potential liquidity gap of HKD, USD and other currencies.

In addition to liquidity buffer assets listed above, the investment portfolio of the Bank also contain considerable size of other unencumbered marketable securities, which could be used as secondary source of liquidity (as part of management action) in case the liquidity buffer assets can't fully mitigate the liquidity gap. The applied haircuts by credit rating for non-buffer unencumbered securities are listed below:

Rating	Firm-specific	Market	Combined
AAA Rating	20%	20%	20%
AA Rating	30%	30%	30%
A Rating	40%	40%	40%
BBB Rating	50%	50%	50%
Others	70%	70%	70%

Table 4.12: Haircut Range for Non-buffer Unencumbered Securities

4.3.3. Loan Adjustment

Roll-over assumption

In order to reflect the need for a bank to conduct ongoing loan origination/roll-over with different types of counterparties, even during a time of stress, a certain percentage of contractual inflows from matured loans during the stressed period was assumed to be used to finance the continuously renew/roll-over of the Bank's loan portfolio.

The roll over rate under combined scenario was set to be 50%, same with the requirement under Basel III LCR rule. For firm specific and market scenario, a lower rate of 40% was assumed considering the management's action to control the loan portfolio in short term under severe liquidity crisis.

The roll-over rate assumption was applied to loan position of all currencies.

Loan default assumption

Under normal condition, the default risk of counterparties and related cash flow impact was deemed neglectable. Under firm-specific and market wide scenario, it is believed that the 30 days stressed period are too short to have any significant impact to the default risk of loan book. Only under the combined scenario, it is assumed that after 1 month, when the crisis of financial market

show its impact over real economy, certain cash inflow from matured loans will not be received due to increased default risk.

Classified or impaired loan ratio of the BOCHK Group as at year end from 2007 to 2011 is 0.44%, 0.46%, 0.36%, 0.14%, 0.10%. Here, we assume a delinquency rate of 1% is conservative enough for the combined scenario.

It is also assumed that the interbank call loans settle at stated maturity with 20% haircut for market and combined scenarios, and no roll-over.

	Firm-specific Scenario	Market Scenario	Combined Scenario
Delinquency Rate	N.A	N.A	1%
Call Loan Haircut	0%	20%	20%
Roll-over Rate	40%	40%	50%

Table 4.13: Loans Adjustment Rates

4.3.4. Margin Calls

To consider the additional collateral that needs to be posted due to certain trigger events (for example the credit rating downgrade, which especially applies to the firm-specific scenario) or fair value changes (which applies to all scenarios), the cash outflow of margin calls should be taken into account. Yet, considering that current positions in the Bank's portfolio that entered the Credit Support Annex to the ISDA Master Agreement are immaterial, the impact of margin calls is neglected at current stage. In the future, as the deals that are subject to the margin calls grow, cash outflow of margin calls shall be estimated.

Increased liquidity needs related to downgrade triggers embedded in derivatives and other contracts:

Often, contracts governing derivatives and other transactions have clauses that require the posting of additional collateral, drawdown of contingent facilities, or early repayment of existing liabilities upon the bank's downgrade by a recognized credit rating organization.

For each contract in which "downgrade triggers" exist, assumes that 100% of this additional collateral or cash outflow will have to be posted.

The assumption above is only applicable to the designed firm-specific and combined scenario.

Increased liquidity needs related valuation changes on posted collateral securing derivative

Related potential liquidity needs could be quantified by

Liquidity needs = (total value of posted collaterals) * (applicable haircut)

Where, applicable haircut could be refer to the haircut assumption listed in section 4.3.3.

The assumption above is only applicable to the market-wide and combined scenario.

Increased liquidity needs related to market valuation changes on derivative

As market practice requires full collateralization of mark-to-market exposures on derivative and other transactions, banks face potentially substantial liquidity risk exposures to these valuation changes. Inflows and outflows of transactions executed under the same master netting agreement can be treated on a net basis.

When quantify the extent of derivative valuation change, the established market risk stress testing result should be considered and be applied. Another way (as permitted by CBRC) is to use "maximum derivative valuation change during past 18 months" as a proxy.

The assumption above is only applicable to the market-wide and combined scenario.

4.3.5. Intragroup

According to the arrangement between BOCHK, CYB and NCB, BOCHK shall provide contingency funding of 6 billion for NCB which should be available evenly within 3 working days, and 2 billion for Chiyu whereas 0.6 billion, 0.6 billion and 0.8 billion should be available for the next 3 working days respectively.

4.3.6. Other Assumptions

Firm Specific Stress Scenario:

- Retail deposit along with wholesale deposit is one of the major sources of liquidity risk and is the major contributor of the outflows for the stress period. For testing purposes, we've assumed that the cash outflows will occur straight-line within the 30 days period.
- For wholesale deposits, we assume that 60% of cash outflow would happen in the first two weeks and the rest in the last two weeks of the stress testing horizon.
- The run-off cash flows for the interbank deposits are assumed to occur overnight to account for the high volatility.
- Undrawn commitments are assumed to be withdrawn straight-line for the 30 days period.
- Intragroup flows to Chiyu and Nanyang will take place in day two and three of the start of the stress period per agreement.

- Interbank call loans settle at stated maturity with no roll-over.
- Intraday flows not considered.

Market Stress Scenario:

- It is assumed that the cash outflow of retail deposits will occur straight-line within the 30 days period.
- For wholesale deposits, we assume that 60% of cash outflow would happen in the first two weeks and the rest in the last two weeks of the stress testing horizon.
- The run-off cash flows for the interbank deposits are assumed to occur overnight to account for the high volatility.
- Undrawn commitments are assumed to be withdrawn straight-line for the 30 days period.
- Intragroup flows to Chiyu and Nanyang will take place in day two and three of the start of the stress period per agreement.
- Interbank call loans settle at stated maturity with 20% haircut, and no roll-over.
- HK$ 10b liquidity is reserved for intraday cash outflow due to the stress on the functioning of payment and settlement systems.

Combined Stress Scenario:

- Given this scenario has assumed to be of 'more' severity, it is assumed that 70% of the cash outflow to take place in the first month, the remaining are evenly allocated over the last two months.
- Undrawn commitments are assumed to be withdrawn with 70% occurring in the first month and the remaining evenly over the last two months.
- The run-off cash flows for the interbank deposits are assumed to occur overnight to account for the high volatility.
- Interbank call loans settle at stated maturity 20% haircut, and no roll-over.
- HK$ 10b liquidity is reserved for intraday cash outflow due to the stress on the functioning of payment and settlement systems.

4.4. Management Actions

The following management actions could be considered as additional funding sources to mitigate the penitential liquidity gap after the utilization of liquidity buffer assets, if any. The timing of management action should depend on the severity of cash outflow.

- Sale/repo of securities contained in the investment portfolio

  Subject to haircut assumption as described in section 4.3.3.

- Cash inflows from the parent bank

  Assume that the parent will provide BOCHK (with an upper limit of HK$ 40B according to agreement) with cash infusion when needed and will not require it to be returned within the stress period.

  Also, NCB and CYB could consider the liquidity supporting from BOCHK amounts up to HK$ 6B and HK$ 2B respectively.

4.5. Summary of Stress Inputs

Appendix III provides the list of input that was used in the stress testing impact analysis. Additionally, it should be noted that same inputs (run-off rates, haircuts) were used to conduct stress testing on the subsidiaries given that the funding mix of the subsidiaries are similar to that of BOCHK.

5. Liquidity Stress Testing Impact Assessment

5.1. Analysis of Liquidity

This section discusses the impact of stress scenarios to estimate cumulative net cash outflows and liquidity gap over the time horizon as defined in the stress scenarios. The impact analysis was conducted for the three scenarios defined as a firm-specific stress, a market-wide stress and a combined stress of firm-specific and market-wide and covered analysis with or without management actions.

The stress testing is based on a point-in-time balance sheet. The test starts with BAU ("business as usual") net cash flow excluding those of the customer deposits (retail and wholesale), interbank deposits, and irrevocable commitments (including Irrevocable Undrawn Lending Commitment and Commitment Related to Trade Service) and then apply the stress assumptions developed in previous sections to reflect BOCHK's view of the expected conditions for each crisis type to consider stressed risk drivers such as the run-off and drawdown of deposits and contingent drawdown as well as the response by the Bank. The crisis assumptions are applied to both sources and uses of liquidity, including on and off balance sheet categories, to measure the overall impact on BOCHK's liquidity levels.

In addition to running BOCHK view of the stress test, the impact analysis was conducted for the two subsidiaries as well, using the same assumptions set given they have similar funding mix as BOCHK, as mentioned before.

5.1.1. Computation Process

Please refer to the Appendix IV for a stress testing reporting table. The first column of the reporting table is the index indentifying the cash flow items. The second column and third show the balance and applied rate (run-off rate, drawdown rate, or delinquency rate, rollover rate depending on the cash flow item) of the corresponding cash flow item. The subsequent columns are the reporting time buckets. They starts with daily buckets day 1 ("D1") to day 35 ("D35"), then are followed monthly time buckets month 1 to month 2 ("M1_2"), month 2 to month 3 ("M2_3"). The last column aggregates cash flows of all time buckets.

The process and associated calculations can be decomposed into the following step:

1. The starting point is the BAU cash flows excluding those of the customer deposits, interbank deposits, and irrevocable commitments, and certain adjustment (add back or subtract certain cash flow under BAU) to in line with the actions under stress. An adjustment is made to the liquidity buffer asset by subtracting their contractual cash flows from BAU as it is assumed that they are readily to be sold to provide liquidity when the Bank is under stress.

2. Then the impact of stress is considered which consists of the cash flow due to stress. We take into the following factors:

   a. The run-off of retail deposit and wholesale deposit. The total run-off in the horizon of stress scenario equals to:

      Outstanding balance * run-off rate

      The total run-off will be allocated over the stress horizon to the reporting time bucket according to a predetermined speed. For the details of the run-off rate and allocation assumptions, see section 4.3.1 and 4.3.6. The run-offs are cash outflows and are shown with negative signs on the reporting table.

   b. The run-off of interbank deposits. The total run-off equals to:

      Outstanding balance * run-off rate

      The total run-off will allocated to over the stress horizon according to a predetermined speed. For the details of the run-off rate and allocation assumptions, see section 4.3.1. and 4.3.6 The run-offs are cash outflows and are shown with negative signs on the reporting table.

   c. Drawdown of off balance sheet commitment. The total drawdown amount in the stress scenario is calculated as:

      Unused line * drawdown rate

      Similar to the run-off of deposits, it is assumed that the drawdown will occur following a pattern throughout the stress horizon. For the details of the run-off rate and allocation rules, see section 4.3.1 and 4.3.6. The drawdown are cash outflows and shown with negative sign on the reporting table.

   d. Intragroup actions. This will consider intragroup cash flows between BOCHK, CYB, and NCB. They are cash outflows and shown with negative sign for BOCHK and positive sign for CYB and NCB on the reporting table.

   e. Margin calls. This will consider the additional collateral that need to be posted. They are cash outflows and shown with negative sign on the reporting table. However, currently very few deals conducted by the Bank require collateral, hence the impact of margin calls is deemed to be immaterial and neglected at the current stage.

   f. Loan adjustment. Two factors are considered here. The cash inflow of loans (excluding interbank call loans) is subtracted by a delinquency rate, on top which, a rollover rate is multiplied to reflect the need for a bank to conduct ongoing loan origination. At each time

bucket, the adjustments equals to:

Loan delinquency adjustment = Cash inflow of loans excluding interbank call loans * delinquency rate

Loan rollover adjustment = (Cash inflow of all loans excluding interbank call loans – loan delinquency adjustment) * rollover rate

Interbank call loan adjustment = Cash inflow of call loans * haircut

The three adjustments are cash outflows and are with negative sign of the reporting table.

g. Cash flow impact of expected transactions. In the dynamic cash flow projection under BAU, cash flow impacts from certain transactions with reliable information (usually short-term) are considered. Under stressed scenario, the probabilities of those expected transactions should be re-evaluated, and only those transactions still be expected to be executed would be included in the stress testing impact analysis. Examples of those transactions including (not limited to):

- IPO deposit: IPO subscription amount are deposits into the Bank before the allotment date, which results in a sharp increase in cash inflow.
- Notified significant cash withdrawal: the Bank is notified for significant deposits withdrawal happening in a particular future dates, which will results in a sharp increase in cash outflow.
- Significant loans drawdown: the Bank is notified for significant loan drawdown happening in a particular future dates, which results in a sharp increase in cash outflow.
- Significant bond investments: refer to large amount of bond purchase to be happened according to the Bank's investment plan.
- Merger and acquisition activities: cash flow fluctuates significantly due to the Bank's merger and acquisition activities. Future cash flow can be adjusted according to the planned schedule.

h. The available amount of utilizing liquidity buffer assets as mitigation to liquidity gap at each time bucket equals to:

Market value of marketable securities * haircut + cash position

For the details of the haircuts, see section 4.3.2. They are cash inflows and shown with positive sign on the reporting table.

i. Proposed Management Actions. Cash inflow from two possible actions including "sale/repo of securities contained in the investment portfolio" and "cash inflows from the parent

bank" are assessed here.

3. Allocate the total cash flow from above steps to each reporting time bucket.

   a. Retail deposits, wholesale deposits, interbank deposits and commitments. The stress scenario is spitted into two periods where the user determines the date to divide the stress scenario inputs the ratios to the total cash outflow amount. Hence, the cash outflow per day for each of the sub periods equals to

      Total cash outflow / number of days in the sub-period

      Then we find the start date and end date for each reporting time bucket and sum up the all the cash flows that happen between the two dates. The result is the cash flow to the corresponding time bucket.

   b. Loan adjustment. As input to the loan adjustment is the cash inflow of the loans under BAU and it is obtained by processing the BAU cash flow projection results. As the reporting time buckets for the BAU cash flow projection and stress test are identical, hence we do not need to allocate the cash flow to align with the reporting time bucket of stress test.

   c. Intragroup. BOCHK shall provide 6 billion for NCB which should be available evenly within 3 working days, and 2 billion for Chiyu whereas 0.6 billion, 0.6 billion and 0.8 billion should be available for the next 3 working days respectively

For each reporting time bucket, summing up all the cash flows of each item will arrive at the Net Cash Flow under stress. There is a row showing the Accumulative Net Cash Flow by aggregating all the Net Cash Flow prior to and including the standing time bucket. If the cash flow of proposed management actions is included, then we will get the Net Cash Flow after Management Actions and Accumulative Net Cash Flow after Management Actions.

5.1.2. Result Analysis

The following figure illustrates the sample results from test run of one stress scenario.

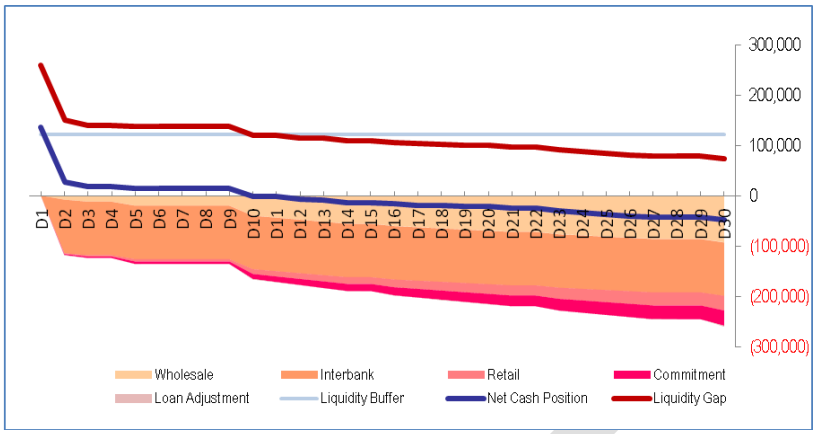


Figure 5.1a Stress Testing Result

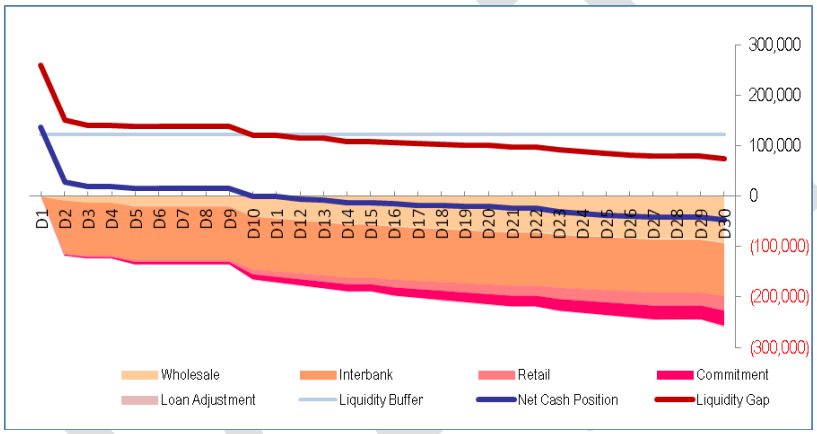


Figure 5.1b Stress Testing Result

In Figure 5.1a the Net Cash Position is the accumulated net cash flow including cash equivalent, but excluding marketable securities (liquidity buffer) *before* the Management Actions are taken. And Liquidity Gap is the accumulated net cash flow including cash equivalent and marketable securities (liquidity buffer) *before* the Management Actions are taken.

In Figure 5.1b the Net Cash Position is the accumulated net cash flow including cash equivalent, but excluding marketable securities (liquidity buffer) *After* the Management Actions are taken. And Liquidity Gap is the accumulated net cash flow including cash equivalent and marketable securities (liquidity buffer) *After* the Management Actions are taken.

For the detailed stress test results, please refer to Appendix IV – Stress Test Results.

5.2. Analysis of Profitability and Solvency Impact

As the recent global financial crisis has show, there is a natural link between solvency and liquidity. During the European crisis in 2010, market concerns about solvency of some sovereigns as well as their domestic banks led to a liquidity crisis with banks finding it harder to access wholesale and

interbank funding and haircuts increasing for collaterals at the ECB. Downgrades by rating agencies further exacerbated this situation.

5.2.1. *Analysis of Profitability Impact*

The impact to profitability could be analyzed through consideration of following factors:

- Potential loss on sale of liquidity buffer assets

  Certain amount of liquidity buffer assets might have to be sold out with discounted price to mitigate the liquidity gap identified under stressed scenarios. The loss thereof subject to the amount of the assets sold out and the haircuts applied.

- Potential trading book loss

  Under the scenario of market wide crisis and combined crisis, the bank's trading book will very likely suffer from the volatility of financial markets. The size of the potential loss could be estimated by referring to the market risk stress testing results.

- Interest income loss due to reduced loan growth and increased default

  Under stressed scenario, due to liquidity restriction, certain amount of cash inflow from matured loans will be used to finance the potential cash outflow of deposit run-off, instead of be continuously extended to customers. The low roll-over rate of granted loan under stressed scenario will lead to loss of interest income there from.

  In addition, under the combined scenario, the default rate of granted loans would be expected to increase, which will lead to certain amount of credit loss.

- Decrease of fee and commission income

  Under stressed scenario, the Bank's fee and commission income would be expected to decrease, either due to the diminished reputation, or due to a more volatile financial market as a significant part (around 25%) of the BOCHK's fee and commission income represents commission fee from stock broking.

5.2.2. *Analysis of Solvency Impact*

The impact over the Bank's solvency under stressed scenario could be expressed through a potential decrease of capital adequacy ratio, which could be reflected through the potential decrease of capital base and increase of RWA:

Impact over CAR :

$$\frac{\text{Capital}_0 - \Delta\text{Capital}}{\text{RWA}_0 + \Delta\text{RWA}} - \frac{\text{Capital}_0}{\text{RWA}_0}$$

- Potential decrease of capital base (Δ Capital)

The impact over capital base could be quantified as:

(Total decrease of profit) * (1 – tax rate)

- Potential increase of RWA (Δ RWA)

Under the designed liquidity stress testing scenario, credit risk is not the main focus and we only expect a mild increase of default rate of loans under the combined scenario, related impact over credit risk RWA could be neglected.

However, under both market wide crisis and combined scenario, the financial market volatility will probably result in an increase of the banks market risk VaR and corresponding capital requirement. The Bank's established stress testing scenario and results of market risk could provide a good reference for related impact assessment.

As to operational risk, we simply assume that no impact would be expected.

The table below summarized suggested calculation of profitability impact from factors above under each stressed scenario.

Factors	Profitability & Solvency Impact Quantification		
	Firm Specific Crisis Scenario	Market Crisis Scenario	Combined Scenario
Profitability Impact (Before Management Actions)			
Potential loss on sale of liquidity buffer assets	= 30 day accumulated liquidity gap (before using buffer) * weighed average hair cut of liquidity buffer	= 30 day accumulated liquidity gap (before using buffer) * weighed average hair cut of liquidity buffer	= 1 year accumulated liquidity gap (before using buffer) * weighed average hair cut of liquidity buffer
Potential trading book losses	N.A	Use the market risk stress testing (severe) result of trading book.	Use the market risk stress testing (severe) result of trading book.
Interest income loss due to reduced loan growth and increased default	= (total cash inflow from loan in 30 days) * (roll over rate decrease) * Average Yield of Loan (2011: 2.04%) * (1/12) * 0.5	= (total cash inflow from loan in 30 days) * (roll over rate decrease) * Average Yield of Loan (2011: 2.04%) * (1/12) * 0.5	= (total cash inflow from loan in 30 days) * (roll over rate decrease) * Average Yield of Loan (2011: 2.04%) * 0.5 Plus: '=loan balance * default rate* LGD (or use the credit risk stress testing result)
Decrease of fee and commission income	40 million=80*0.5 (assume 50% of the market crisis scenario)	2008 fee income decreased by 960 million (1180 decrease of stock broking, which accounts more than 25% of total fee income), about 80 million per month	1200 million = 960 * 1.25 (assume 25% increase based on market crisis scenario)
Profitability Impact (Management Action)			
Sale of securities contained in the	= accumulated liquidity gap (after using buffer) *	= accumulated liquidity gap (after using buffer) *	= accumulated liquidity gap (after using buffer) *

investment portfolio	hair cut of investment portfolio	hair cut of investment portfolio	hair cut of investment portfolio
Solvency Impact			
Potential decrease of capital base	(Total decrease of profit) * (1 – tax rate)	(Total decrease of profit) * (1 – tax rate)	(Total decrease of profit) * (1 – tax rate)
Potential increase of RWA	N.A.	Use the market risk stress testing (severe) result.	Use the market risk stress testing (severe) result

Table 5.1: Profitability Impact

5.3. Sensitivity Analysis

"In order to identify and analyze factors that could have a significant impact on its liquidity profile, an AI may conduct an analysis of the sensitivity of the stress-testing results to certain key assumptions. Such sensitivity analyses can provide valuable additional indications of an AI's degree of vulnerability to certain factors." (LM-2, 5.5.2)

Our designed sensitivity analysis process as follows:

1. Select key assumptions to be analyzed. As discussed in section 4.3, the following parameters could be deemed as key assumptions:
   - Run-off rate of retail deposit;
   - Run-off rate of wholesale deposits;
   - Run-off rate of inter-bank deposits;
   - Drawdown rate of commitments;
   - Haircuts applied to marketable securities
2. Using the parameters above as independent variables, change the value of the inputs by +/- 1-5% and re-perform stress testing, observe the corresponding change of stress testing result (expressed and minimum survival period under each scenario). When one assumption is changed, other assumptions should be kept constant.
3. Summarize the analysis to find the degree of vulnerability of the Bank's liquidity to each factor of assumptions.

Please refer to Appendix V – Sensitivity Analysis.

6. Early Warning Indicators

The Early Warming Indicators, EWI, are a tool to assist the liquidity managers to assess the current market situation and inform the organization of any emerging liquidity crisis. The set of indicators should be a part of regular liquidity monitoring and should complement liquidity metrics already in place to provide the senior management a holistic position of liquidity.

As part of the project deliverable, a list of relevant internal and market driven EWIs was proposed for implementation into BoCHK's current liquidity risk management framework including the CFP. The initial list was devised by looking at BoCHK's balance sheet, potential liquidity risk drivers and the regulatory expectations relevant to EWIs.

Table 6.1 shows the finalized list that was agreed upon with the BoCHK's LM2 project team. The table below provides information on:

- Indicator category – market versus internal
- Reporting frequency - daily versus monthly. The frequency can be adjusted based on business needs and ease of data access.
- Guide to using individual indicators. Increasing or decreasing trend. For example, an increasing trend in deposit run-off would signal a lack of confidence by retail and corporate clients in the financial health of the bank that could lead to liquidity strains. Similarly and increase in count of breaches of regulatory and internal indicators would indicate an emerging stress in liquidity position. It is important to note that , an increasing trend or decreasing trend in one indicator

It is recommended that the list of EWIs are reviewed on a regularly basis to ensure that the indicators, the frequency and the thresholds assigned are current and relevant to the current business strategy and risk profile of the organization.

Market/ Internal	Indicator Type	Indicators	Sub-category	Measured as	Frequency	Data Requirement & Availability	How to Read?	What is Measures?
Internal	**Increasing** currency mismatches	Swapped fund ratio	RMB USD G7	Reliance on foreign currency to fund domestic currency or vice versa.	Daily	1 month behavior cash flow	>Threshold increased risk	Cross currency
Internal	**Decreasing** in weighted average maturity of term deposits	Weighted average maturity of term deposits	Retail Wholesale	Weighted average maturities	Monthly	Contractual maturity and balance of retail and wholesale	<Threshold increased risk	Funding access
Internal	**Increasing** incidents of positions or breaches in internal or regulatory limits	Number of incidents of breaches in internal or regulatory limits		Number of breaches per reporting period	Daily	Number of incidents	>Threshold increased risk	Overall liquidity status
Internal	**Increasing** delinquencies rate	Overdue >3 months & Rescheduled Loan Ratio		(Balance of Overdue > 3 months + balance of rescheduled loan)/ total balance	Monthly	Overdue > 3 months & Rescheduled Loan Ratio	>Threshold increased risk	Asset quality
Internal	**Increasing** funding cost	Weighted average interest rate of the whole deposits		Weighted average interest rate of the whole deposits	Daily	Amount and annual interest rate of each deposit transaction	>Threshold increased risk	Proxy for funding access
Internal	**Decreasing** in deposit base	Deposit balance	Retail Wholesale	Outstanding balances percentage	Daily	Monthly balance	<Threshold increased risk >Threshold increased risk	Funding access

Market/ Internal	Indicator Type	Indicators	Sub-category	Measured as	Frequency	Data Requirement & Availability	How to Read?	What is Measures?
Internal	**Increasing** wholesale funding concentration	Concentration ratio of funding source		Balance of top 20 wholesale depositor/ total wholesale deposit balance	Monthly	Balance wholesale deposits of top 20 counterparties	>Threshold increased risk	Concentration
Market	**Decreasing** market access	Daily 1-y HK/US CCS index		CCS index	Daily	1-y HK/US CCS index	<Threshold increased risk	Indicator for funding access
		Daily 3-m HK/US SWAP index		SWAP index		3-m HK/US SWAP index		
Market	**Decreasing** in equity market indicators	Equity market indices	BOCHK	Stock indices	Daily	Stock indices	<Threshold increased risk	Market sentiments about market and financial services
			S&P					
			Hang Seng					
			SSE 180					
			Dow Jones					
Market	**Increasing** CDS spreads	Daily CDS spreads	BOCHK	CDS spreads	Daily	CDS data	>Threshold increased risk	Credit worthiness
			Standard Charted					
			HSBC					
			Citi					

Table 6.1: Recommended EWI's

To facilitate monitoring of the indicators, individual trigger level can be assigned to each. The market practice is to combine statistical analysis on historical data and expert judgment to establish limits.

Table 6.2 provides threshold ranges for market indicators and the methodology that can be used to set up thresholds for internal indicators.

Num.	Indicator Type	EWIs	Subcategory	Threshold - Reference	Threshold - Methodology
1	Internal	Swapped fund ratio	RMB		36 months avg. at 1 Std. Dev.
2			USD		
3			G7 currencies		
4		Weighted average maturity of term deposits	Retail		36 months avg. at 1 Std. Dev.
5			Wholesale		
6		Number of incidents of breaches in internal or regulatory limits			> 2 per monthly reporting cycle
7		Overdue >3 months & Rescheduled Loan Ratio			36 months avg. at 1 Std. Dev.
8		Average interest rate of the total deposits			36 months avg. at 1 Std. Dev.
9		Deposit base	Retail	> 1-3%	
10			Wholesale		
11		Balance of top 20 wholesale depositor / total wholesale deposit balance			36 months avg. at 1 Std. Dev.
12		Stock market price (BOCHK)		< 5 - 10%	
13	Market	Daily 1-y HK/US CCS index		> 20-30 bps	
14		Daily 3-m HK/US SWAP index - LIBOR		> 15-25 bps	
15		Equity market indices	S&P	> 4-5%	
16			Hang Seng	> 4-8%	
17			Shanghai SSE 180	> 4-8%	
18			Dow Jones	> 4-5%	
19	Peers	CDS spreads	Standard Chartered	> 20 - 50 bps	Rolling 24 months avg. at 1 Std. Dev.
20			HSBC		
21			Citi		
22			BOC	> 25 - 50 bps	

Table 6.2: Guidelines to Set-up Thresholds

7. Recommendation on Contingency Funding Plan

The contingency funding plan sets out the plan of action that the organization would use to fund business activity in crisis situations and periods of market stress. The contingency funding plan outlines a list of potential risk factors, key reports and metrics that are reviewed on an ongoing basis to assist in assessing the severity of, and managing through, a liquidity crisis and/or market dislocation. The contingency funding plan also describes in detail the firm's potential responses if the assessments indicate that the firm has entered a liquidity crisis, it outlines the mitigates and action items to address specific risks which may arise during crisis period.

The contingency funding plan identifies key groups of individuals to foster effective coordination, control and distribution of information, all of which are critical in the management of a crisis or period of market stress. The contingency funding plan also details the responsibilities of these groups and individuals, which include making and disseminating key decisions, coordinating all contingency activities throughout the duration of the crisis or period of market stress, implementing liquidity maintenance activities and managing internal and external communication. Additionally, the plan outlines the governance structure around maintaining the plan on a continuous basis.

The following sections list recommendations based on the gap analysis between the existing CFP document, LM2 and market practice.

7.1. Roles and Responsibilities

- Consider incorporating information related to the role played by senior management and functional groups around CFP governance including overseeing development and implementation of CFP policies, reviews (at least annually) and operational testing of CFP.
- Consider incorporating composition/structure of the crisis team and the responsibilities played by each member of the crisis team during liquidity crisis.
    - Consider formalizing the CFP with names, addresses and telephone numbers of the members of the crisis team.

7.2. Crisis Identification and Early Warning Indicators

Current crisis identification is based on Three Level Crisis matrix and does not include list of Early Warning Indicators as a part of liquidity risk management tool.

- Consider incorporating the list of recommended EWIs into the existing CFP framework to monitor key risk drivers.

- Consider incorporating thresholds based on the EWIs for crisis identification and escalation management. The threshold could be qualitative or quantitative and should serve as a flag for the emerging crisis.

7.3. Escalation Management

Currently CFP escalation process is based on three levels of crisis and does not take into account EWI's for escalation management.

- Expand the existing crisis management process to incorporate EWI as the first line of defense against the emergency liquidity crisis
    - Refine escalation management process to incorporate clear communication flow as liquidity crisis develops starting from the reporting team up to the liquidity crisis team who is responsible for invoking CFP, as necessary.

7.4. Mitigating Strategies

Currently the mitigation strategies outlined in the CFP documents are based on three level of crisis matrix and does not consider stress testing framework, which include firm specific, market specific and combined scenarios, in its development of the mitigation plan.

- Consider aligning stress testing framework and the crisis levels to identify and stream line potential list of mitigation strategies relevant under firm specific, market and or combined scenarios.
- Consider aligning funding strategies to stress testing and mitigation plan to clearly outline funding sources for example repos, sale of assets, deposit retention strategies, business dial-down, central bank facilities etc. and quantify funding sources that may be available during a liquidity event.
- Expand the escalation communication to include clear guidance around reporting (balance sheet position, legal entity etc.) and ad-hoc expectations during different levels of crisis.

7.5. Communication Management

Communication should cover outreach to internal and external constituents during liquidity crisis.

- Develop communication plan appropriate for each crisis level and constituents
    - Expand the existing communication outreach to fund providers, rating agencies and fund providers in addition to parent and the regulatory bodies.

- Develop list of top wholesale funds providers, public top borrowers and rating agencies to ensure that in times of crisis the bank can communicate to respective constituents in an efficient and orderly manner.

- Consider having a centralized approach to communication to ensure consistent messaging.

In Jun 2012, SFC published final rule of "Guidance on Disclosure of Inside Information", which provide principles and guidelines over public disclosure of inside information. According to the guideline, following key principles should be followed:

- If the development of liquidity issue/event and the corresponding management actions fit into the criteria of inside information according to Securities and Futures Ordinance (SFO), the Bank, as a listed company, “must, as soon as reasonably practicable after any inside information has come to its knowledge, disclose the information to the public”.

- However, the SFO provides for Safe Harbours which permits a corporation to withhold disclosure of inside information under specified circumstances, e.g.:

  “the information concerns the provision of liquidity support from the Exchange Fund established by the Exchange Fund Ordinance (Cap. 66) or from an institution which performs the functions of a central bank (including such an institution of a place outside Hong Kong) to the corporation or, if the corporation is a member of a group of companies, to any other member of the group.”

  “Where a corporation in financial difficulty and is in negotiations with third parties for funding, the Safe Harbor provides relief from disclosure in respect of the negotiations and the status of progress of those negotiations.”

- The requirements of the Safe Harbor are that the corporation must take reasonable measures to preserve the confidentiality of the information and that the confidentiality of the information is preserved. Where the information has not been kept confidential or there has been a leak, whether intentionally or inadvertently, these conditions will not be fulfilled and any Safe Harbor will no longer apply.

Thus, we suggest that in the Bank’s CFP (or a separate policy over information disclosure which could be referred to), following operational details should be included regarding public disclosure of related information:

- Appropriate and effective systems and procedures to ensure any material information which comes to the knowledge of one or more of its officers be promptly identified,

assessed and escalated for the attention of the Board of directors to decide about the need for disclosure:

  - Establish controls for monitoring business and corporate developments and events so that any potential inside information is promptly identified and escalated;
  - Maintain and regularly review a sensitivity list identifying factors or developments which are likely to give rise to the emergence of inside information;
  - Authorize one or more officer(s) or an internal committee to be notified of any potential inside information and to escalate any such information to the attention of the board;
  - Maintain an audit trail of meetings and discussions concerning the assessment of inside information.
  - Provide regular training to relevant employees to help them understand the corporation's policies and procedures as well as their relevant disclosure duties and obligations.

- Preservation of confidentiality:
  - Restrict access to inside information to a limited number of employees on a need-to-know basis. Ensure employees who are in possession of inside information are fully conversant with their obligations to preserve confidentiality.
  - Ensure appropriate confidentiality agreements are in place when the corporation enters into significant negotiations.
- Measures to monitor the confidentiality:
  - If a corporation has availed itself of any of the Safe Harbors, it should keep under review whether confidentiality of the information has been maintained.
  - If confidentiality has been lost, the Safe Harbor no longer applies and the corporation must disclose the inside information as soon as reasonably practicable.
  - If there are unexplained changes to the share price of the corporation's securities or if there are comments about the corporation in the media or analysts' reports, this may indicate that confidentiality has been lost. In particular, where media speculation, market rumors or analysts' reports are largely accurate and the

information underlying the speculation, rumors or reports constitutes inside information, it is likely that confidentiality has been lost, thus the Safe Harbor falls away and public disclosure is required.

- The corporation should normally prepare a draft announcement (albeit a holding announcement) to be kept updated ready for publication if it becomes apparent that confidentiality has not been maintained.
- Record briefings and discussions with analysts or the media afterwards to check whether any inside information has been inadvertently disclosed.
- Established Procedures for responding to market rumors, leaks and inadvertent disclosures.
- In addition, the corporation should consider recording the reasons for relying on the Safe Harbor and the steps taken in preserving and monitoring confidentiality.

- Information disclosure process:
  - Necessary steps which the corporation should immediately take prior to the issue of a public announcement may include:
    - Ascertaining sufficient details;
    - Internal assessment of the matter and its likely impact;
    - Seeking professional advice where required; and
    - Verification of the facts.
  - Disseminate inside information via the electronic publication system operated by the Stock Exchange before the information is released via other channels, such as the press, wire services or posting on the corporation"s website. Additional means to disseminate information such as issuing a press release through news or wire services, holding a press conference in Hong Kong and / or posting an announcement on its own website.
  - Procedures to review presentation materials in advance before they are released at analyst's or media briefings.
  - Designate a small number of officers or executives with the appropriate skills and training to speak on behalf of the corporation when communicating with external parties such as the media, analysts or investors.

7.6. Liquidity Funding Strategy

- Consider incorporating a section in the CFP document linking funding strategy to the contingency plan through stress testing results.
- Consider quantifying the capacity and the cost based in-lieu o f the mitigation steps under stress scenarios (acute and chronic). For example, capacity to repo or sale capacity eligible securities to third party, cost to reduce deposit run-offs etc.

7.7. CFP Governance and Testing

Institutions are expected to have processes in place to ensure that CFP document is current and reflects current business situations of an organization.

- Incorporate a section outlining the procedure in place to review and maintain the CFP document. The procedure should consider: a) Frequency of review, b) Maintenance Responsibilities c) Topics to be reviewed for example assumptions and triggers for different crisis level, relevance of existing EWI's and, d) Senior management involvement in the approval, review and implementation processes (as appropriate).
- Consider developing and incorporating a section outlining the procedure to execute 'dry run' of the CFP to validate existing procedures and policies.

7.8. Miscellaneous

- Incorporate a section in the document to describe the process of deactivation of the CFP plan describing the complete process that will be undertaken from the analysis to communication up to the senior management.
- Incorporate a section to align the intraday liquidity management policy to the CFP.

8. Reverse Stress Testing (RST)

RST is defined as circumstances or events that would render the institutions business model unviable, thereby identifying potential business vulnerabilities. The key objective of the RST is to overcome disaster myopia and mitigate the possibility of a false sense of security might arise from the regular stress testing regime.

The primary use of reverse stress testing as a tool is to improve business planning and risk management. A secondary objective is to test the strength and resilience of an institution's capital and liquidity position.

8.1. HKMA Guidelines on Reverse Stress Testing (RST)

The HKMA supervisory policy manuals, including LM-2 and IC-5, provide AIs the guidance on RST. The following is a summary of the principles:

- Stress tests should feature a range of severities, encompassing the most material business areas across an AI and events that are capable of generating the most damage, whether through financial damage or loss of reputation.
- Reverse stress tests start from a known stress-testing outcome (such as a breach of regulatory capital ratios, illiquidity or insolvency) and then work backwards to identify the events that could lead to such an outcome for an AI.
- There is no single "correct" way for AIs to develop reverse stress scenarios, which may vary depending on AIs' own business models and risk drivers.
- AIs should note that the development of reverse stress scenarios is an iterative process involving a mix of qualitative and quantitative analyses for identifying the causes, consequences and impacts under the various scenarios.
- Reverse stress tests are particularly useful for assessing the risks in certain areas such as (i) business lines where traditional risk management models indicate an exceptionally good risk/return trade-off; (ii) new products and new markets which have not experienced severe strains; and (iii) exposures where there are no liquid two way markets.

The following sections provide a high level framework as a guideline to conduct reverse stress testing.

8.2. Framework for RST

Figure 8.1 outlines the framework for reverse stress testing. Three key stages to design reverse stress tests include:

- Defining 'failure' and identify key risk drivers of failure and corresponding events that could lead to failure
- Test runs based on key risk drivers identified in phase I to confirm if the defined 'failure' point is reached
- Review results based on test runs with businesses and senior management

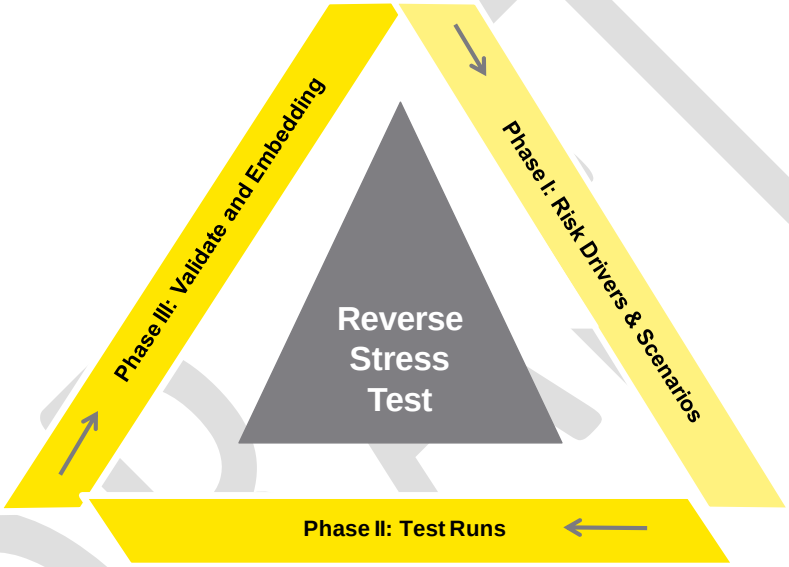


Figure 8.1: Framework for Implementing Reverse Stress Testing

8.2.1. Identify Risk Drivers & Scenarios

The reverse stress design starts with a clear definition of 'Failure'. The failure should focus where it is likely that the counterparties and customers of the firm will cease to trade with it. It is important to take into account both qualitative and quantitative aspects when defining failure. Some examples of definition relevant to BoCHK could include:

- Liquidity ratio violated
- Significant retail and wholesale deposit run-offs
- Credit downgrades
- Impact due to potential operational failure or a fraud event (trading)

- Liquidity < Risk appetite defined by survivability

Section 3.3 above listed the key drivers of liquidity risk for BoCHK. Further stratification of key drivers of liquidity risk is required to identify significant sensitivities and fault lines that could cause significant liquidity constraints for BoCHK. Figure 8.2 shows the schematic of the process of mapping products to various risk factors. Some of the relevant factors to consider include:

- Significant exposures to homogenous cohorts including industry, customer, market, geography, product, distribution channel, currency, etc.
- Exposure to large single name for funding – identify top 20 counterparties and related gross transaction size
- Downgrade - likely effects of a multi notch downgrade on the counterparties, the funding profile, costs and profitability
- Off balance sheet components – understand all areas of the business which are off balance sheet including assessment of contract terms
- Downside risk of New business / products risk which have not experienced stress / down turns or have limited performance history

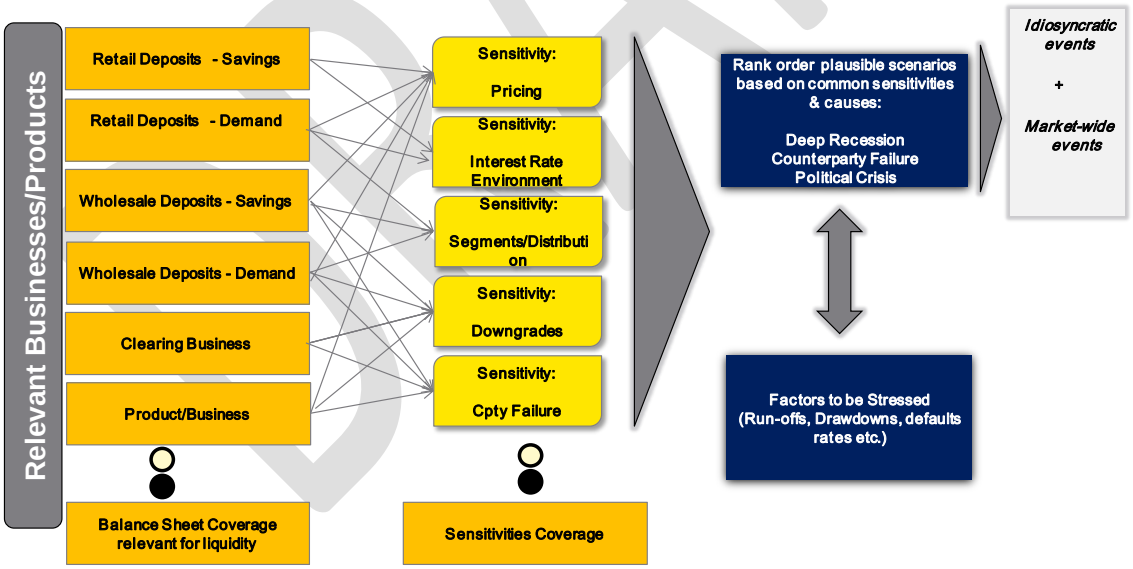


Figure 8.2: Stratification of key product and businesses to identify fault lines

All in all, the failure definition and analysis should lead back to event(s)/scenarios which could be systemic, idiosyncratic or a combination in nature to conduct RST and quantify the input factors (like run-off rates, draw-down on commitments etc.) to run the test.

8.2.2. RST Execution Methodology

Given the size of BoCHK balance sheet and its standing as a major institution in Hong Kong, it is unlikely that a single scenario would cause a debilitating liquidity crisis at BoCHK. Instead, a range of interlinked low probability, high impact events, identified through the process described in the above section has more likelihood of materializing and potentially harming BoCHK's liquidity position.

Figure 8.3 illustrates the schematic of the process to run the RST. The methodology is to run test by combining various stress scenarios and sensitivities that could elevate liquidity risk and cross check the impact against the predefined 'Failure' point defined by the management. For example, in the case of BoCHK, the chain of events could be the impact of multiple notch downgrades on the run-off rates of interbank and wholesale deposits coupled with the impact of a default on payment due to failure of a large counterparty

Given that RST look for events that could render an organization unviable to operate, the starting point for the testing can be one of the base case stress scenario and on which the quantified inputs can be applied.

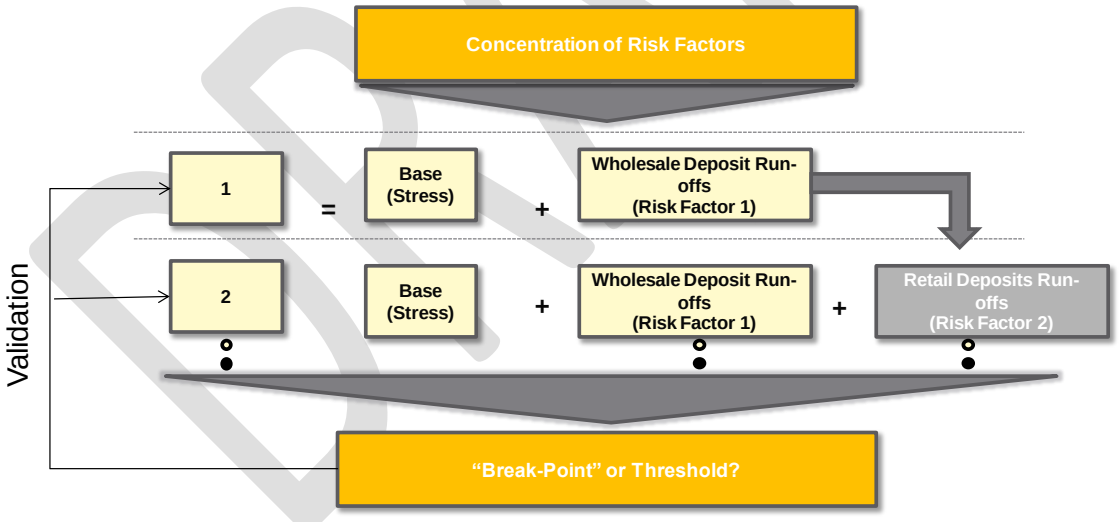


Figure 8.3: Step by step process to run Reverse Stress Test

For example, if " liquidity ratio < 25%" was defined as "failure' point, the reverse stress testing process could be generally described as follows:

1) List out all factors could affect the liquidity ratio;

2) Identify key factors could possible cause the decrease of liquidity ratio through sensitivity analysis;

3) For each key factors identified, establish the threshold that might lead to the liquidity ratio < 25%, e.g. The amount of marketable securities decrease by XX billion; or one-month liabilities increase by XX billion;

4) Try combination effect of more than one factors, e.g. marketable securities value decrease by XX together with the increase of one-month liabilities by XX.

5) A series of scenarios could be worked out through repeating process of 3) and 4).

6) Review and discuss the scenarios identified, and find the 1-2 scenarios most relevant to the bank according to bank's business strategy, i.e. plausible events most likely to cause the business model of the bank to fail.

9. Liquidity Stress Testing Policy Enhancement

9.1. Recommendations on "Liquidity Stress Testing Guideline"

We understand that currently, BOCHK has not established a separate policy for liquidity risk stress testing. The "Liquidity Risk Management Policy" authorized by the Board only provide high level requirements over liquidity risk stress testing including related risk appetite (expressed in minimum survival period), and detailed requirements in the current version of "Liquidity Risk Management Rule" is not comprehensive enough and can't meet the requirement of LM-2.

Set below provide our high level recommendation over the structure and main contents of BOCHK's "Liquidity Risk Stress Testing Guideline"

9.1.1. Purpose

Based on regulatory requirements of HKMA Supervisory Policy Manual LM-2 "Sound Systems and Controls for Liquidity Risk Management", the "Liquidity Risk Management Policy of BOC(HK) Group" , and "Liquidity Risk Management Rule of BOC(HK) Group", the guideline be developed to provide guidance over the application of stress-testing in liquidity risk management, which include a framework for conducting cash-flow projections, based on "what if" scenarios on the Bank's liquidity positions to:

- Identify sources of potential liquidity strain;
- Ensure that current liquidity risk exposures remain in accordance with the established liquidity risk tolerance; and
- Analyze any possible impact of future liquidity stresses on the bank's cash flows, liquidity position, profitability and solvency.

9.1.2. Application scope

The guideline should be applicable to entities including BOCHK, NYB and CYB, as well as liquidity risk stress-testing at consolidate level.

9.1.3. Roles and responsibilities

Roles and responsibilities of the Board, ALCO and different departments in liquidity risk stress-testing have been generally included in the Bank's Liquidity Risk Management Policy".

9.1.4. Principle for liquidity risk stress testing

General principles, as required in LM-2, include:

- Stress tests should enable the Bank to assess its ability to generate sufficient liquidity from both sides of the balance sheet to meet funding needs under adverse conditions. Potential sources of demand for liquidity arising from off-balance sheet commitments and other contingent liabilities should also be addressed;
- Stress tests should consider the implications of the stress scenarios across different time horizons, including on an intraday basis;
- Stress tests should be performed for all currencies in aggregate and separately for positions in the Hong Kong dollar and individual foreign currencies in which the Bank have significant positions;
- The stress testing frequency (monthly) has been specified in the "Liquidity Risk Policy";
- When conducting stress tests on liquidity position, the Bank should also consider the insights and results of stress tests performed for other risks, including possible interaction with these other risks.

9.1.5. Scenario Design

The minimum scenarios should be covered (institution-specific, market-wide and combined) and related minimum survival periods have been specified in the "Liquidity Risk Policy".

Scenario design and underlying assumptions should be developed based on comprehensive understanding and analysis of the behavioral characteristics of the Bank's assets and liabilities as well as off-balance sheet commitments and other contingent liabilities, and how these items may contribute to, or place demands on, the Bank's liquidity under stress scenarios. (LM-2, 5.3.1)

Stress scenarios and underlying assumptions should be properly defined in the guideline (LM-2, 5.4.8)

The scenario design and underlying assumptions used should be subject to regular review and approval by the Board and senior management to ensure that the nature and severity of the tested scenarios remain appropriate and relevant to the Bank. (LM-2, 5.4.7)

9.1.6. Utilization of stress-testing result

The stress-testing results should be integrated into the Bank's strategic business planning process as well as its liquidity risk management strategies and practices, including the setting of internal liquidity risk limits and the assessment of, and planning for, related potential funding shortfalls in contingency funding plan. (LM-2, 5.5.2)

9.1.7. Management reporting

Item	Specification
Report Name	Liquidity Risk Stress Testing Report
Preparer	MRD
Distribution	ALM, IMD, Head of Risk, Head of Finance, CRO, CFO, ALCO
Frequency	Monthly or ad hoc
Scenario	Institution Specific Crisis; Market Crisis; Combined
Entity	► Solo: BOCHK, NCB, CYB ► Consolidated: BOCHK Group
Currency	► By currency: HKD and significant foreign currency (RMB, USD) ► All currency in HKD
Key Information	► Net and Cumulative cash flow gap by time buckets; ► Comparison with size of liquidity buffer; ► Management actions (CFP) and liquidity gap after management actions; ► Minimum Survival Period.
Format	Excel
Template Maintained By	IT
Report filing	1 Year

Please refer to Appendix IV for a sample stress testing report.

9.1.8. System and data

Please refer to our deliverable of "System and Data Governance Report"

9.1.9. Appendix

- Management reporting template:

  Please refer to our deliverable of reporting template.

- Operational manual

  Please refer to our deliverable of user manual.

9.2. Recommendations on Liquidity Cushion Management

9.2.1. Defination of liquidity cushion assets

The current definition of liquidity cushion assets, as used in MCO calculation and limits monitoring, is different with the definition specified in LM-2 (which is generally aligned with "High Quality Liquidity Asset" in Basel III LCR). The current definition used by the bank is generally narrower that LM-2 requirement without consideration of most assets might be included as Tier 2 assets according to LM-2 definition. This might lead to un-necessary confusion in both internal management reporting and communication with regulator, and other related management measures including limit setting and monitoring, liquidity cost measurement and allocation, etc.

Hence, we suggest that the definition of liquidity cushion assets should be updated according to LM-2 requirement when updating related liquidity risk management policy. The related reporting rules and data specification in MIS system and user tools should also be updated accordingly.

9.2.2. Management of liquidity cushion assets

We understand that currently, the liquidity cushion assets of the bank are managed by front office together with other investment portfolio, which is not in line with the regulatory requirement and expectation.

"The stock of high-quality liquid assets should be unencumbered, managed by AIs with the clear and sole intent for use as a source of contingency funding, and segregated from those assets held within, or used to hedge, trading positions." (LM-2, 8.5.2)

More specific requirement is required in Basel III liquidity standard:

"The stock of liquid assets should not be co-mingled with or used as hedges on trading positions, … and should be managed with the clear and sole intent for use as a source of contingent funds."

We suggest the requirements above be reflected in updated liquidity risk management policy.

In addition, when setting risk limits, separate limits could be considered for "Tier 1" assets (which aims to meet the liquidity needs in the initial phase of the liquidity stress, e.g. the first one to two weeks in the case of a one-month scenario) and "Tier 2" assets (which is used to cater for the longer end of the stress period). Also, separate limits could also be consider for RMB assets % in liquidity cushion assets considering the liquidity needs of BOCHK as the only clearing bank of off-shore RMB business in HK.

Appendix I – Balance Sheet Profile

Appendix I - Balance Sheet Pro

Appendix II - Historical Volatility and Statistics of Deposit and Commitment

Appendix II - Historical Volati

Appendix III – Assumptions of Stress Scenarios


Appendix III - Calculation of In


Appendix III - Assumptions of St

Appendix IV – Stress Testing Result

[Please refer to stress testing report send out sperately]

Appendix V – Sensitivity Analysis

Sensitivity analysis is performed under the Combined Scenario for each entity (BOCHK, NCB, and CYB) with all currency consolidated in HKD equivalent. By change the value of each following factor by +/- 1% while keeping others constant, the sensitivity of the Liquidity Gap/Surplus (defined as the maximum gap during the stress horizon) to the factor is calculated. Please see the attached file for the detailed results.

- Run-off rate of retail deposit;
- Run-off rate of wholesale deposits;
- Run-off rate of interbank deposits;
- Drawdown rate of commitments;
- Haircuts applied to marketable securities

Summary - Sensitivity Analy

As the analysis shows, the retail deposit has the highest sensitivity to the run-off rates/haircut, followed by the wholesale deposit, interbank deposit, and liquidity buffer successively for BOCHK. Given it has a liquidity surplus of 31,903 million (see Appendix IV – Stress Test Results) under the Combined Scenario, it is expected that there would be a liquidity gap for the Bank when the run-off rate of the retail deposit increases by about 7%.

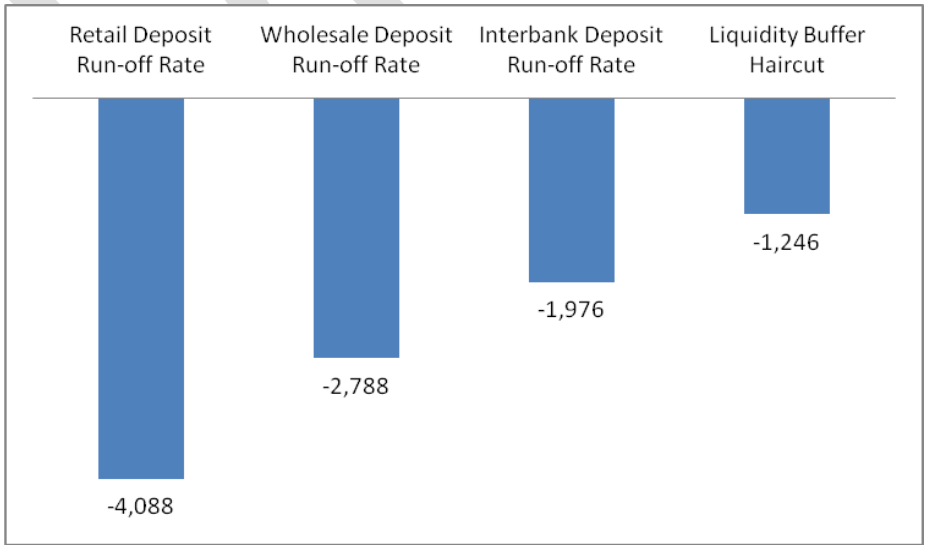


Table V-1: Sensitivity of liquidity gap of BOCHK