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Macroprudential liquidity stress tests using BIS locational banking statistics[1]

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[1] This paper and presentation were prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, IFC, BoP, ECB or the central banks and other institutions represented at the meeting.

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Nikolaos Georgiopoulos, Carnell Lambert[1]

Abstract

This study examines the use of both external and internal positions of Bermuda banks with relevance to the international non-resident sector, i.e. international insurance companies, from the BIS locational banking statistics for macroprudential liquidity stress testing of the Bermuda banking sector. The paper describes the reasons for using locational data in the context of a small open economy with liberalized capital flows. In addition, the paper will describe how locational data and external claims are compiled and validated for use in liquidity stress testing and also present how scenarios are built with this data. Finally, we describe how this data work using an artificial bank example and interactions of liquidity and solvency.

Keywords: stress testing, macroprudential surveillance, foreign assets, international financial data.

JEL classification: C82, C800

Introduction

The scope of this paper is to present to a wider audience the utilization of locational data collected by the Bank of International Settlements (BIS) for macroprudential liquidity stress testing in the context of a small open economy such as that of Bermuda. This paper will introduce the rationale behind the use of locational banking statistics for this purpose, the process of data collection and data quality control and then finally how the stress test is conducted using the data.

Macroprudential liquidity stress testing has been an active area of research although there are no fixed methodologies, rather a collection of methodologies tailored to individual country circumstances. Jobst et al. (2017) have a paper on principles of macroprudential liquidity stress tests as a rather long list of approaches from other countries. For the purposes of this paper we will not go through an exhaustive literature review, rather we will concentrate on methodological aspects relevant to Bermuda. In addition, the Bermuda example may serve as a guide for other small island jurisdictions due to comparable economic and financial systems.

To give some intuition behind our methodology, we will first describe in this section the economics of a small open economy, which is also an international financial center. Bermuda as an open economy trades with the outside world under a regime of largely liberalized financial account. Restrictions in Foreign Direct Investment (FDI) exist for real assets of the domestic economy such as real estate and businesses operating locally. Ownership restrictions restrict acquisition of low-end real estate from foreigners while acquisition of businesses has to follow a 60/40 sharing rule under which a foreign shareholder can hold at most 40% of a business's share capital.

On the other hand, corporations with domicile in Bermuda but with services sold exclusively to overseas (non-Bermuda residents) customers are freely incorporated and capital flows with zero restrictions. Examples of such corporations are Bermuda (re)insurance companies, funds and trusts with clients

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residing and operating outside Bermuda. As these companies transact with the outside world and have a physical presence in Bermuda, they use local Bermuda banks to conduct transactions mostly of operational nature.

Thus, the structure of the balance sheet of Bermuda banks is bifurcated. On the one hand, there is a local economy largely insulated from capital flows and attempts of acquiring ownership from the outside world and an international economy fully liberalized in terms of ownership and capital flows. As a result, Bermuda banks are the de facto managers of capital flows in Bermuda. In addition, Bermuda's currency board is fully operated by the banks without the monetary authority having control over interest rates, except the authority's statutory responsibility to back with foreign reserves all notes and coins in local currency. This feature of the Bermuda economy renders banks operators of monetary policy as well with the goal to maintain the system of fixed exchange rates between the Bermuda dollar (BMD) and the US dollar (USD).

As part of the Bermuda Monetary Authority's (BMA) strategy of enhancing its prudential framework, in 2019 a project was initiated to produce a tool for liquidity stress tests that takes into account the following characteristics of the Bermuda economy.

1. The bifurcated nature of Bermuda banks' funding from the local protected sector and the international liberalized sector.
2. The absence of independent monetary policy.

The final project whose methodology we present in this paper, is the culmination of many years of work, which started from the BMA's participation to the submission of locational bank data to the Bank of International Settlements (BIS) and culminated in an Excel model, which is currently used for stress testing. The importance of BIS locational data stems from the fact that supervisors, both micro and macroprudential, can identify exactly the liabilities of banks stemming from either the liberalized international economy or the local protected economy. Knowing bank exposures to the local and the international economy, allows supervisors to pinpoint vulnerabilities of banks to non-resident capital flows. Given potential vulnerabilities, scenarios can be developed that are tailored to the specific economic and regulatory circumstances of each country.

In the next sections we will describe the process of how the BIS locational data is compiled for usage for the liquidity stress test exercise, how the stress testing model is built according to the compiled BIS data and how the liquidity stress test transmits shocks to the bank balance sheet.

Bermuda Economy and Bermuda Banks

Bermuda is a British Overseas Territory in the Atlantic Ocean. With no natural resources and with a small geographical size, Bermuda developed over the years a very large financial services economy alongside with tourism. Financial services are dominated by large international insurance and reinsurance companies which are domiciled in Bermuda but perform operations overseas. These large international companies are called exempted companies and they are not allowed to sell goods or services to Bermuda residents.

For national accounting purposes, these companies are not included in the GDP and the BoP (Balance of Payments) calculations as they would inflate the GDP numbers and show erroneously that Bermudians have abnormally high per capita incomes. In comparison to GDP, GNI would neither be a correct measure of income, since retained earnings of exempted companies would be included as well as income paid from overseas buyers of insurance. In addition, when insurance losses measured in the several billions increase from events outside Bermuda, the BoP would move in tandem as claims would be recorded in the BoP as income paid to policy holders. These movements would cause unnecessary

volatility in national accounting. For these reasons, the exempted sector is treated as non-resident in Bermuda.

This non-resident international business sector is also responsible as the largest perhaps employer in Bermuda with other sectors providing ancillary services to the exempted sector. Such services can include from legal and accounting to meals and stationery. This sector is responsible for huge imports of hard currency that is used to buy goods from abroad that Bermuda is unable to produce locally.

Banks act as a gateway of Bermuda to the world economy by providing a host of services including payments, accounts for savings and cheques, investments while they operate the fixed exchange rate system which pegs the BMD to the USD at an exchange rate of one to one. Bermuda banks, as gateways to the external world, also manage the capital flows of Bermuda vis-à-vis the rest of the world.

International insurance companies as well as funds and trusts use Bermuda banks to conduct transactions with the outside world. Most deposits of international insurance companies are operational since premium and claims settlements occur overseas. Other foreign financial institutions such as funds and trusts use Bermuda banks to process payments to local accounting, legal firms which provide services to these institutions. Combining all these activities together, we call this side of the economy which is dominated by insurance companies, funds and trusts as the international economy. Parallel to the international economy operates the local economy comprised of residents, Bermudians and foreigners, and local businesses who serve the needs of the local population.

The local economy operates both in USD and BMD. USD salaries are paid from international insurance companies to local residents, while local businesses conduct business with BMD. Local banks provide lending to the local economy in the form of loans, which are denominated both in USD and BMD. Due to ownership laws, Bermudians have priority of ownership of homes and stock of companies, while foreigners are usually barred from owning homes or acquiring more than 40% of stock of a locally incorporated firm with the exception of the international business sector including international insurance companies.

For these reasons, foreign residents' deposits are usually USD deposits that are deemed to be less sticky and are usually moving overseas and vice-versa for operational reasons. In addition to that, the international insurance sector also has less sticky deposits since they are operational in nature and as a sum they comprise less than 1% of their total assets. At the same time, international companies are not invested in physical capital in Bermuda, rather they are invested in human and financial capital which by definition is mobile and not sticky. Overall, we see a structure of two parallel economic systems operating in tandem. An international economy with operational deposits in Bermuda and a local economy with operational and non-operational deposits in Bermuda.

Given this economic structure, the BMA undertook the goal of recognizing and embedding in its macroprudential surveillance function, data that show the extent to which local banks are exposed to these two parallel economic systems. Locational data allow the disaggregation of each sector and allow us to understand the relative sizes of each economic system and how banks are accommodating both from an asset-liability point of view.

In addition, the recognition of the two parallel economic systems allows us to identify potential vulnerabilities given that the international business sector is susceptible to forces and events outside the control of local authorities. In this way, the BIS locational data assist with policy formulation and policymaking.

BIS Locational Data Compilation

The BMA participates in the locational data collection exercise of the BIS since 2002. In 2017, the BMA

made a strategic decision to operationalize this data for macroprudential surveillance and policy purposes. Operationalization of this data required two things. First, reconciliation with prudential fillings of banks since locational data submissions are unaudited and require some form of additional checks for accuracy. Second, compilation into a format that is usable for surveillance, identification of vulnerabilities and policy decisions. In this section, we will analyze both aspects.

Reconciliation

The ability to identify and assess the resilience of the banking sector to liquidity shocks is crucial to the stability of Bermuda's financial sector. Liquidity shocks can adversely affect banks causing the possible destabilization of the financial system. As discussed above, part of the work of the BMA involves analyzing BIS locational and prudential data for macroprudential purposes. The prudential data originates from the Prudential Information Returns (PIRs) which are statistical data reports submitted each quarter by Bermuda banks to the BMA. The reports provide information about the reporting bank's balance sheet exposures on both a consolidated and unconsolidated basis, capturing on-and off-balance sheet assets and liabilities, profitability, capital adequacy, liquidity and other relevant data. Within the PIR there is the capital adequacy report which provides essential data about the bank's capital solvency position in accordance with Basel III standards; incorporating the Risk Asset Ratio (RAR), Common Equity Tier 1 (CET1) capital ratio, Tier 1 ratio and Leverage ratio. The BMA also requires Bermuda banks to submit supplemental reports on both liquidity and funding risk, based on the liquidity coverage ratio (LCR) and net stable funding ratio (NSFR) standards.

In 2017, the BMA conducted a data reconciliation exercise with Bermuda banks, to verify that locational data was correctly populated, consistent with prudential and BIS reporting requirements and to understand any discrepancies between prudential and locational data that may exist. The exercise was done in a two-stage approach. The first stage focused on improving the reporting quality of the BIS template from Bermuda banks, while the second stage involved validating the BIS locational data for internal use including the liquidity stress testing model.

The BMA developed an Excel tool to validate the reliability of the reported values in the BIS template, by capturing the values from the BIS locational data and comparing them with audited unconsolidated prudential data in accordance with balance sheet classifications. In this exercise we used both prudential and BIS reporting guidelines as references to align the two data sets.

To properly match the data sets, only relevant data amounts were required to be included in the Excel template. For instance, BIS locational data only requires financial asset and liability positions to be reported for locational banking statistics. To accommodate this requirement, the prudential data side of the Excel template included financial and non-financial asset balances. Once the non-financial data was identified, it was removed from the prudential total asset balance sheet, so that the two data sets were similar in structure.

The corresponding BIS locational data side contains bank assets (claim) and bank liabilities based on instrument breakdown. The PIR side of the template also factors in the reporting of retained earnings, whereby banks are instructed to only include the retained earnings portion of the shareholders' funds. Another component added to the Excel template was formatting the BIS locational amounts to match the prudential amounts. Amounts reported to BIS are required to be in millions of US dollars (up to three decimal places), to ensure that they are comparable to prudential data (reported in thousands), the BIS locational data was multiplied by a factor of thousand. For example, an amount of $3.435 (in millions) was converted to $3,435 (in thousands). To assist with populating the Excel template, each asset (claim) and liability balance has a direct reference link mapping the data fields to their respected reporting guidelines, thus ensuring that amounts are correctly populated. Thus, there is a fixed infrastructure of Excel spreadsheets that communicate to each other. Once a BIS submission is in place, the reconciliation is automatic without further manual work.

In a first attempt, the BMA populated the Excel template with local and foreign currency balance sheet data using PIR and BIS locational data from a designated quarter. The template was sent to each of the respective Bermuda banks to verify balance sheet amounts, correct any data discrepancies, and provide explanations for differences equal and above the materiality threshold (≥ ±5%).

The BMA performed an extensive review of the received responses from the banks to understand the explanations associated with the identified data gaps. In some cases, the BMA would discuss the data gaps with the bank representative to determine the extent and impact they may have on the overall balance sheet figures. For instance, if amounts included in a particular line item in the BIS locational side where not correctly reported in the corresponding line item in the PIR side of the template, the banks will be asked to resubmit a revised template reflecting the correct classification.

Figure 1 shows an example, based on artificial data, of the Excel template at a particular point in time (quarter-end). The yellow cells are populated with the BIS locational and unconsolidated prudential data, with each asset/liability breakdown separated between Bermuda dollar (BD$) and foreign currency (FX$) amounts. The protected grey cells use formulas to calculate totals for each balance sheet line item and convert the BIS locational data units to match the prudential data unit format. On the PIR side, the non-financial assets are listed to distinguish the non-essential assets not reported per the BIS requirements (financial assets only). In the example in figure 1, the PIR side of the template reflects a simple balance sheet format, while the BIS locational side is designed to mirror the outstanding positions of assets (claims) and liabilities in accordance with the locational banking statistics format.

Since BIS locational data reports financial assets, the PIR side of the template was adjusted to reflect only financial assets to be comparable. In the example, total assets on the PIR side equal $19,000 thousand as reported by the prudential figures submitted by the bank. However, since banks are instructed to report non-financial assets (e.g. "Other tangible assets" of $300 thousand) in the template this will reduce the total asset balance to $18,700 thousand thus closely mirroring the BIS locational side of the template.

On the liabilities side, the "Shareholders' funds" balance equal $1,000 thousand as reported by the bank in the prudential submission. The prudential data includes all components of shareholders' funds, whereas the BIS locational data reports the retained earnings[2]. Therefore, to be comparable to the BIS locational data side, the only component of "Shareholders' funds" reported on the PIR side of the template is retained earnings (e.g. $500 thousand).

We observe in the example, the PIR asset position; cash, deposits, and loans, advances, bills and financial leases totaled $12,700 thousand. The corresponding "Loans and Deposits" amount on the BIS locational asset side totaled $12,000 thousand, resulting in a material difference of 5.83% (or $700 thousand). In general, most of the data captured in the balance sheet line items should match up to each of the respective datasets; however, banks may have reported a particular asset (e.g. intercompany asset) under "Loans, advances, bills and financial leases" for PIR reporting purposes but reported the same asset under "Other instruments" for BIS reporting purposes.

When observing the liability positions in figure 1, "Other liabilities" under the PIR side totaled $4,000 thousand, compared to the totaled of $4,500 thousand of "Debt securities" and "Other liabilities" under the BIS side, resulting in a material difference of 11.11% (or $500 thousand). In some instances, this could be a result of misclassification, while in other cases the discrepancy may be a result of a non-financial liability (i.e. defined benefit pension liability) recognized only in the PIR liability side in "Other liabilities". To closely map the asset (claim) and liability categories between the prudential and locational data sets, each PIR balance sheet line item was paired against the BIS locational balance sheet line item, by aligning the outstanding positions into the following three categories:

[2] Guidelines for reporting the BIS international banking statistics, pg. 11, "B.3.1.3 Other Instruments"

1. Loans and deposits;
2. Debt securities; and
3. Other instruments.

For instance, PIR balance sheet items like cash, deposit, and loan amounts should also be included in the "Loans and deposits" locational statistics category, since this category comprises of loans, working capital, interbank deposits, deposits with other banks, and other additional financial assets (i.e. repos, financial leases, holding of notes and coins in circulation) [3]. In the investment category of the PIR side of the template, the aggregate is composed of sovereigns, public sector entities (PSEs), banks, securitisation exposures (non-equity tranches), securitisation (equity tranches), investments in subsidiaries and associated companies, investments in the capital of other banks and financial institutions and other investments. When compared to the BIS side of the template, the equivalent assets are "Debt securities" comprising of claims in all negotiable debt instruments and "Other assets (instruments)" comprising of residual claims such as; equity securities and derivative instruments. This same approach was applied to each balance sheet item, so that the prudential and locational amounts are closely matched and correctly categorized.

The BMA recognizes that certain assets/liabilities will either be categorized as "financial assets/liabilities" or "non-financial assets/liabilities", resulting in some differences between the prudential and locational data sets. For example, a non-financial asset (i.e. equity holdings of subsidiaries) would be omitted from "Debt securities" and "Other instruments" for BIS reporting purposes, while on the PIR side the investment would be reported in "Investment in subsidiaries and associated companies". As such, Bermuda banks are instructed to provide an explanation for material discrepancies, factoring in the non-financial asset/liabilities as reported in the template. In certain circumstances, individual balances from the prudential and locational data may not reconcile, yet the aggregate totals may agree. The BMA considers whether the discrepancy between the individual balances has an overall material impact on the aggregate totals. Banks may have reported an asset in one category for BIS reporting purposes with the corresponding asset reported in the PIR side in another asset category, thus creating a disparity between the two individual balances.

The reconciliation exercise continues to be a crucial part of the macroprudential work each quarter, as a tool to help validate and preserve the data integrity and improve data quality for the liquidity stress testing model and other future uses to support macroprudential surveillance and policy work.

[3] Guidelines for reporting the BIS international banking statistics, pg. 8 & 9

Figure 1. Template for Reconciliation

Legend

	Datacells to be completed by bank
	Formula cell

PIR /BIS Financial Analysis

Company Name
BANK OF X

Q2-20XX

MATERIALITY <=5%=>

PIR						BIS									
	ASSETS	Reporting guidance	BD$	FX$	Total (000's)	ASSETS (CLAIMS)	Reporting guidance	BD$		FX$		Total (000's)	Change	% Change	COMMENTS
								Original (as reported in BIS)	(x 1000s to match PIR reporting)	Original (as reported in BIS)	(x 1000s to match PIR reporting)				
	Cash	1	1,000.00	500.00	1,500.00										
	Deposits	2	1,200.00	1,000.00	2,200.00										
	Loans, Advances, Bills and Finance Leases	3	4,000.00	5,000.00	9,000.00										
	Total		6,200.00	6,500.00	12,700.00	Loans and Deposits	1	5.00	5,000.00	7.00	7,000.00	12,000.00	(700.00)	5.83%	
						Debt Securities	2	2.00	2,000.00	3.00	3,000.00	5,000.00			
						Other Assets (instruments)	3	-	-	1.00	1,000.00	1,000.00			
	Investments	4	2,000.00	4,000.00	6,000.00	Total Investments (Debt + Other Assets)		2.00	2,000.00	4.00	4,000.00	6,000.00	-	0.00%	
Exclude non-financial assets (per the BIS guidelines)	Goodwill	5a			-										
	Other intangible assets	5b	300.00		300.00										
	Premises owned and occupied by reporting bank	5c			-										
	Other property /real estate owned by the reporting bank	5d			-										
	Operating leases	5e			-										
	Plant, equipment and other fixed assets	5f			-										
	Other	5g			-										
	Total Non-financial assets		300.00	-	300.00										
	Total Financial Assets		8,200.00	10,500.00	18,700.00	Total Financial Assets (BIS)		7.00	7,000.00	11.00	11,000.00	18,000.00	(700.00)	3.89%	

															Comments
	LIABILITIES	Reporting guidance	BD$	FX$	Total (000's)	LIABILITIES	Reporting guidance	BD$		FX$		Total (000's)	Change	% Change	
								Original (as reported in BIS)	*(x 1000s to match PIR reporting)*	*Original (as reported in BIS)*	*(x 1000s to match PIR reporting)*				
	Deposit liabilities	6	6,000.00	8,000.00	14,000.00	Loans and Deposits	4	5.00	5,000.00	9.00	9,000.00	14,000.00	-	0.00%	
	Savings deposits	6a	1,000.00	3,000.00	4,000.00										
	Demand deposits	6b	3,000.00	2,000.00	5,000.00										
	Time deposits	6c	2,000.00	3,000.00	5,000.00										
						Other Liabilities	5	2.00	2,000.00	2.50	2,500.00	4,500.00			
						Debt Securities	6		-	-	-	-			
	Other Liabilities	7	3,000.00	1,000.00	4,000.00	Total (Debt Securities + Other Liabilities)		2.00	2,000.00	2.50	2,500.00	4,500.00	500.00	-11.11%	
	Shareholders' Funds		1,000.00		1,000.00										
Portion of shareholders' capital excluded from "Shareholders' Funds"	Shareholders' capital		500.00		500.00										
	Shareholders' Funds (Total)		500.00	-	500.00										
	Total Liabilities & Shareholders' Funds (excluding portion of shareholders' capital)		6,500.00	8,000.00	18,500.00	Total Loans and Deposits, Other Liabilities & Debt Securities		7.00	7,000.00	11.50	11,500.00	18,500.00		0.00%	

Source: BMA

Compilation

Compilation of locational data is performed in the so-called balance sheet approach of the International Monetary Fund's (IMF) balance sheet approach to financial crises. For more information on this IMF tool, papers by Allen et al. (2002), Setser et al. (2005), Harutyunyan (2018), describe in detail the rationale behind the use of this model. According to Allen "unlike traditional analysis, which is based on the examination of flow variables (such as current account and fiscal balance), the balance sheet approach focuses on the examination of stock variables in a country's sectoral balance sheets and its aggregate balance sheet (assets and liabilities). From this perspective, a financial crisis occurs when there is a plunge in demand for financial assets of one or more sectors".

Under the IMF balance sheet approach, balance sheets of the government, banks, corporations and households are split in a cross-like schematic form for visual easiness for policy makers. In addition, the IMF balance sheet approach splits the exposures in assets and liabilities by residency (domestic and foreign), currency and duration. If the entire balance sheet table is filled, what is being reproduced is the International Investment Position (IIP) of a country and the domestic cross-sectorial exposures.

Table 1 shows with empty numbers how the BMA balance sheets are created. In the first column are the economic actors within and outside the local economy. We observe that these are the government, commercial banks, non-bank financial institutions, non-bank and non-financial institutions dubbed as corporates, households and the rest of the world. We are only interested in the assets and liabilities of banks while we currently do not have a comprehensive household wealth survey to see assets and liabilities of households outside those that are held in local Bermuda banks.

BIS Locational data are used to fill the bank exposures. We have automated the process by connecting the locational templates with table 1, after all the data validation and reconciliation have taken place. Table 1 is produced not only in the cross section but also in time series. Each quarter the entries of table 1 are recorded and we produce a time series of exposures in order to identify trends.

Table 1 rows denote liabilities, while columns denote assets. For example, under domestic issuer of security we have a set of institutions from General Government to Non-Bank households. These institutions are the issuers of liabilities. In our case where we are interested only in banks. Thus, we use only the rows for commercial banks for holders of bank liabilities. In the columns for holders of securities i.e. assets we are only interest in assets held by domestic commercial banks.

For interbank liabilities these are recorded in the rows shaded with light green on table 1. For interbank assets there would a supposition on liabilities and for that reason we record them in a separate table. For Bermuda, interbank assets are not significant in value and we nonetheless record them but they do not alter significantly the stress testing results. Moreover, for visual convenience for the scope of this paper we do not show the breakdown of foreign issuers of securities, even though we have a breakdown of the rest of the world issuers of securities in order to record column-wise the assets that Bermuda banks own vis-à-vis foreign issuers.

Table 1. Aggregate Balance Sheets(In US$ millions)

	Holders of Securities												
Domestic Issuer of Security	Domestic	Domestic	Domestic	Domestic	Domestic	Foreign	Foreign	Foreign	Foreign	Foreign			
General Government and Central Bank	General Government and Central Bank	Commercial Banks	Non-Bank Financial	Non-Bank Corporate	Non-Bank-Household	General Government and Central Bank	Commercial Banks	Non-Bank Financial	Non-Bank Corporate	Non-Bank-Household	Total Domestic	Total Foreign	Total
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency		50											
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Commercial Banks													
Short Term Liabilities (totals)													
in foreign currency			100										100
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													
Non-Bank Financial													
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													
Non-Bank-Corporate													
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													
Non-Bank-Household													
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													
Foreign													
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													

Source: BMA

For expositional purposes we populated two fields in table 1. For example, the number 100 in red font color is 100 monetary units in foreign currency of a liability held by a domestic non-bank financial institution. In other words, the number 100 is a deposit of 100 monetary units of a domestic non-bank financial institution to a local bank. Another example is the number 50. It represents the holding of 50 monetary units by a local bank of assets, which represent a liability of the local government in domestic currency. In other words, the local bank holds a long term sovereign bond of the local government.

Up to now, the BIS template does not refer to liquidity and maturity profiles of assets and liabilities. We split locational data to maturity brackets by making common sense assumptions. For example, all deposit liabilities of banks to other institutions are short term. If we see a loan and deposit asset of a local bank as a liability of a non-bank financial institution, we will classify it as long term since most Bermuda non-bank financial institutions are insurance companies and most likely have issued some bond with maturity longer than one year. When in doubt about the liquidity classification of an asset or liability, we will prefer to classify an asset as a long term asset and a liability as a short term liability to err on the conservative side.

When this table is fully populated we have a complete picture of the internal and external assets and liabilities of the banking system in aggregate and in isolation. We compile table 1 for each individual bank and then for the aggregate banking system. With this information in table 1, we can build liquidity stress scenarios by assuming withdrawals from sectors which are either more volatile or whose size is large enough to cause disruptions. The stresses are designed under the assumption of being extreme but plausible. In the next section we will describe how the scenarios for liquidity stresses are determined.

What the locational data allows us to do is to pinpoint exactly the potential source of vulnerabilities and the size of vulnerable positions. This is the area where stress scenarios can be developed. In this paper we are focused on liquidity stresses but also credit stresses, FX stresses etc. which can also be developed with this information. As part of the exercise we also compile a set of vulnerability indicators for the banking system. These indicators can be found on table 2.

Table 2. Selected Vulnerability Indicators

FX Liabilities/Total Liabilities
External Liabilities/Total Liabilities
Short Term Liabilities/Total Liabilities
Short Term Assets/Short Term Liabilities
External Short Term Liabilities/Total Liabilities

Source: BMA

These indicators show the reliance of the local banking system to foreign currency and non-resident deposits in particular with issues of how these liabilities are structured vis-à-vis currency and duration.

Scenario Design

Scenario design in liquidity stress tests is a very subjective exercise since liquidity runs depend on a varied set of behavioral and economic variables. In the classic paper of Diamond and Dubvig (1983), financial intermediation in the form of banks exists only if there is the chance of a bank run which can occur as a sunspot equilibrium phenomenon without specific reason. There are no agreed methodologies on liquidity stress scenarios and individual authorities tailor their stress tests and stress scenarios according to country experience and supervisory necessity.

For Bermuda banks, scenarios are constructed in order to reflect risks specific to international financial centers with a large international economy sector, human and financial capital intensive. International financial centers are receivers of capital flows and direct investment. In Bermuda, capital flows are not

speculative and short term, which have the tendency to be unstable (hot money) but long term in nature. In addition, ownership restrictions and a shallow capital market for domestically-issued securities precludes speculative attacks.

As a place for international insurance and reinsurance, international insurers place significant operational deposits in the local banks. Funds and trusts are also active in Bermuda with capital flows and operational deposits for these entities also managed by Bermuda banks. These flows are denominated in USD and other foreign exchange. On the other hand, the local economy is characterized by residents and local businesses that transact mainly in Bermuda dollars.

Thus, we tend to believe that the international economy is far more mobile than the local economy and more prone to capital reversals than the local economy, which is also tied to Bermuda dollar. But the capital reversals are not from speculative hot money, rather from structural events that influence the conduct of business in an international financial center. Therefore, the scenarios are based on a set of circumstances that can influence the life of an international financial center and for the case of Bermuda, circumstances that affect the international insurance and reinsurance industry. Such circumstances can be:

- Global economic and regulatory developments in insurance markets that increase the cost of doing business in Bermuda. Such developments can include protectionism, trade barriers, punitive treatment of provision of foreign-based insurance services etc.
- A natural catastrophe that could decimate Bermuda's infrastructure and render conduct of business in Bermuda impossible. Destruction of property and /or loss of life of key employees as well as destruction of physical premises of international insurance firms that would render their operations here, non-viable for an extended period of time.
- A bank-specific idiosyncratic shock accompanied with loss of confidence in other banks that can trigger massive outflows from institutional investors.
- An international shock that could create severe losses in banks' asset portfolios and trigger runs from loss of confidence.

These economic circumstances are evaluated and scenarios are produced with a determined outcome of deposit outflows. The Financial Stability Department (FSD) at the BMA, monitors sectorial developments in international insurance and participates in relevant standard setting bodies such as the International Association of Insurance Supervisors (IAIS), thus the FSD has a good picture of scenarios or instances where international insurance on Bermuda can be threatened. Banking supervision have their own views about banking risk as microprudential supervisors.

Locational data are used to distinguish the type of deposits that are part of the international business economy. Given location, type of activity and duration we are to pinpoint exactly where we think that an extreme but plausible scenario could be realized based on economic circumstances such as the ones that we discussed above.

In the Bermuda case of particular importance are liabilities of banks from non-bank financial institutions, which are broadly international insurance companies, funds and trusts. For BIS locational purposes these deposits are reported as resident deposits since the place of domicile, Bermuda in this case, defines also the residence. However, from an economic point of view these companies are very internationalized and we treat their deposits as more volatile in the design of scenarios. In addition, we allow the deposit run to develop in up to five periods which could be either, weeks, months or even days depending on the scenario design in order to simulate the progression of outflows in a staged fashion and not abrupt and immediate situations.

Liquidation Waterfalls

When deposits are withdrawn, assets need to be sold to cover for the withdrawals. However, according to accounting rules some assets are recorded as Available for Sale (AFS) and other assets as Held to Maturity (HTM). In addition, some assets are liquid, while others are not. Therefore, as HTM and non-liquid assets are liquidated they incur capital losses. Capital losses stem from bid-ask spreads in illiquid markets or from realizing revaluation profits or losses of an HTM asset sold and marked-to-market.

Thus, the assumption that we make in liquidity stress tests is that banks will tend to liquidate first their AFS liquid assets, then their HTM liquid assets and lastly a stock of illiquid assets. AFS assets will be sold immediately without capital losses, while HTM assets will suffer mark-to-market revaluation. Illiquid assets will suffer from bid-ask spread price differentials. In this way, liquidity stresses can become capital stresses through the comprehensive income statement.

Locational data provide us the types of assets that are most likely to be liquidated and they supplement prudential fillings which also have a breakdown of assets. In particular, locational data can help us in identifying potential assets that cannot be liquidated if they are in different countries and are encumbered.

Care has to be taken to do the proper accounting of capital losses and how much assets are available for liquidation if they have to be revalued during a sale. In this section we will provide the accounting formulas which calculate the available assets for sale given haircuts and revaluations and the cumulative losses suffered by the bank during the sale of these assets. Before we proceed we introduce the following notation table.

Table 3. Notation

A_t	AFS assets at time t
B_t	HTM assets at time t
Γ_t	Illiquid assets at time t
C_t	Outflow at time t
$1-H$	Haircut for each asset (%)

When an HTM or illiquid asset needs to be liquidated due to an outflow at a haircut loss, $1-H<1$, the accounting is identical to having the asset without a haircut but with an outflow raised by the amount of the haircut. There is a formal proof for this result according to the following lemma.

Lemma 1. Assume an asset with value B_t which has to be liquidated up to an amount C_t with $C_t < B_t$. The value of the remaining asset B_{t+1} after the liquidation at a haircut $1-H<1$, is:

$$B_{t+1} = B_t - \frac{C_t}{H} \quad (1)$$

Proof

When confronted with liquidation to the amount of C_t, the bank splits the available assets B_t into C_t and $B_t - C_t$. C_t is the amount of assets that will be used for liquidation for the outflow C_t and $B_t - C_t$ the remainder. To cover outflow of C_t, the available assets are HC_t because of mark to market losses. The bank now has to find an additional $HC_t - C_t = C_t(H-1) < 0$ from $B_t - C_t$ since $H<1$. Thus there is going to be a further liquidation:

$$-C_t(H-1)H + C_t(H-1) = -C_t(H-1)^2 < 0$$

Again a new liquidation is needed for the deficit $-C_t(H-1)^2$. This equals:

$$C_t(H-1)^2H - C_t(H-1)^2 = C_t(H-1)^3 < 0$$

Doing this calculation ad infinitum and taking care of the changing signs we have that the remainder is:

$$B_{t+1} = B_t - C_t + C_t(H-1) - C_t(H-1)^2 + C_t(H-1)^3 - \cdots = B_t + C_t \sum_{i=0}^{\infty} (-1)^{i+1}(H-1)^i =$$

$$= B_t - C_t \sum_{i=0}^{\infty} (1-H)^i = B_t - \frac{C_t}{1-1+H} = B_t - \frac{C_t}{H} \blacksquare$$

One can see that $B_t - \frac{C_t}{H}$ can become negative. This means that all HTM assets B_t have been depleted and the bank needs to liquidate other less liquid assets. For the waterfall of assets, we have the following formulas which describe the value of assets after liquidation:

$$A_{t+1} = \max(A_t - C_t) \quad (2)$$

$$B_{t+1} = \begin{cases} \max(B_t H - (C_t - A_t), 0), & |A_t - C_t| < B_t \\ \max\left(B_t + \frac{A_t - C_t}{H}, 0\right), & \text{otherwise} \end{cases} \quad (3)$$

$$\Gamma_{t+1} = \begin{cases} \min(\Gamma_t H - (C_t - A_t - B_t H), \Gamma_\tau), & |A_t + B_t - C_t| \geq \Gamma_t \\ \Gamma_t + \min\left(B_t - \frac{C_t - A_t}{H}, 0\right), & \text{otherwise} \end{cases} \quad (4)$$

These formulas are neither particularly appealing, nor do they have a formal proof. They are results from multiple trial and errors in order to replicate the correct amounts. Equation (2) describes the amount of AFS assets after a cash flow C_t. If the outflow C_t is larger than all AFS assets A_t, then these are depleted and take value equal to zero and HTM assets have to liquidated.

Equation (3) describes the value of HTM assets once AFS assets have been depleted. The equation is split into two parts. The condition $|A_t - C_t| < B_t$ means that the outflow after the liquidation of AFS assets is large enough to deplete all HTM assets completely. In this case, the amount of available assets to liquidate are $B_t H - (C_t - A_t)$ which are negative and the max function caps them at zero. In the case where the outflow will not deplete all HTM assets we need to employ equation (1) which raises the value of the outflow by the haircut H to account for the mark to market losses when HTM assets are liquidated. The same logic pertains to equation (4), therefore we will not repeat its logic in detail.

Note that if $B_t = C_t$ one cannot retrieve formula (1). There is a discontinuity at that point. The reason is that for total liquidation the sharing mechanism between the assets that need to be liquidated and those assets that are not liquidated that produces formula (1) is not present any more. At the point at which $C_t = HB_t$ we will have $B_{t+1} = 0$ and for every $C_t \geq HB_t$ we will have $B_{t+1} = 0$. What it will change is the loss carried forward for Γ_{t+1} since for $C_t = HB_t$ up to $C_t = B_t - \varepsilon, \varepsilon > 0$ there is partial liquidation of B_t ,while at $C_t = B_t$ there is full liquidation and different formulas are used in equation (3).

Having established the values of assets post liquidation, we now calculate the loss from revaluation and haircuts of HTM and illiquid assets. The losses for each asset type, ${L^B}_{t+1}$ for HTM and ${L^\Gamma}_{t+1}$ for non-liquid assets are given by the following equations:

$${L^B}_{t+1} = \begin{cases} B_t - (C_t - A_t) - B_{t+1}, & B_{t+1} \geq 0 \\ B_t(H-1), & \text{otherwise} \end{cases} \quad (5)$$

$$L^{\Gamma}{}_{t+1} = \begin{cases} \Gamma_t H - (C_t - A_t - B_t) - \Gamma_{t+1}, & \Gamma_{t+1} \geq 0 \\ \Gamma_t (H-1), & \text{otherwise} \end{cases} \quad (6)$$

Equations (5) and (6) describe the losses from revaluation and are both split into two branches. In equation (5) if there is anything left after the liquidation i.e. $B_{t+1} \geq 0$, then the loss is the haircut suffered in the entire value of HTM assets. The same logic applies for non-liquid assets in equation (6). Running the stress test forward for five periods, we calculate the losses from asset sales for each period. Then, the total losses for the all five periods of the test are:

$$\sum_{j=1}^{5} L^{B}{}_{t+j} + \sum_{j=1}^{5} L^{\Gamma}{}_{t+j}$$

Example of Waterfall

In this example, we show how the calculations work using formulas (1)-(6) in an Excel spreadsheet. We assume that we have \$100 of AFS, \$100 of HTM and \$100 of illiquid assets. The haircut is assumed to be 10% or $H = 90\%$. Moreover, we assumed that the outflow is \$250. We will do the calculations on what assets are left and the losses incurred step-by-step.

1. AFS assets are first to be liquidated, thus $\$100 - \$250 = -\$150$ of deficit and there is zero left of AFS.
2. HTM are second to be liquidated but at a haircut. Since there is \$100 of HTM and \$150 to be liquidated, then the amount available for sale for HTM is: $\$100 \times 0.9 - \$150 = -\$60$.
3. Now the \$60 that needs to be liquidated has to be sold from the illiquid assets which themselves need to suffer a haircut. Therefore the amount left is: $\$100 - \$60/0.9 = \$33.333$.

If there were no valuation haircuts for both HTM and illiquid assets, the HTM assets deficit would be \$50 instead of \$60 and the remaining illiquid would be \$50 instead of \$33.333. The losses that eat up capital are first from HTM revaluation and second from illiquid asset sales. These are calculated as follows:

1. If there were no haircut for HTM assets, the value of the deficit would have been \$50 instead of \$60, thus the loss equals \$10.
2. If there were no haircut for illiquid assets, the value of the outflows would be \$60, now instead is \$60/0.9, thus the loss is $\$60 \times (1 - 1/0.9) = \$6.667$.
3. Cumulatively the losses are $\$10 + \$6.667 = \$16.667$.

The losses affect the capital position of the bank by first eating out equity and then changing the definition of risk-weighted assets as sales of assets reduce the stock of high quality liquid assets with low risk weights and instead increase the share of assets with higher risk weights.

Numerical Example

In this section we will provide a numerical example based on artificial numbers on how the liquidity stress test can be conducted. In table 4 we provide the numbers for assets and liabilities of a model bank for the purposes of this paper.

Table 4. Model Bank Balance Sheet (In US$)

Assets		Liabilities	
Cash and T-bills (AFS)	1,000,000	Foreign corporate deposits	2,000,000
Long-term corporate bonds (HTM)	2,000,000	Domestic corporate deposits	2,000,000
Real estate (Illiquid)	2,000,000	Foreign households	2,000,000
Loans (Unable to liquidate)	5,000,000	Domestic households	2,000,000
Other assets	0	Equity	2,000,000
Total	10,000,000	Total	10,000,000

Source: Artificial data

The liability structure is compiled by break-ups according to BIS locational data. Corporate deposits can be either the sum of bank and non-bank financial institutions including non-financial corporations. These are typical BIS categories and can be easily aggregated into broader categorizations such as foreign and domestic corporates. Likewise, households and NPISH are relevant BIS categories and can again be broadly aggregated into domestic and foreign sub-categories.

In this example, we will assume that 99% of foreign deposits will flee within five time periods. The total amount to flee is 99% of $4,000,000. At each period $100 \times \left(1 - (0.01)^{1/5}\right) = 60.2\%$ of each deposit category flees the bank. A scenario could be that foreign depositors/investors lose trust in the local government due to concerns in sovereign rating or some other geopolitical factors. As foreign depositors tend to be yield-seeking they are assumed to be more sophisticated and react faster to bad news. Once foreign depositors start fleeing, the central bank imposes capital controls and forbids any withdrawals from domestic depositors.

A rationale for such differentiated treatment of foreign vs. domestic depositors is that the government may not want to get bogged down into international litigation with foreign investors who would see their money trapped in the domestic banking system. Or, by being more sophisticated, foreigners are faster to withdraw especially if they have demand deposits instead of term deposits. In any event the scenario can take into account various variations around the thematic of foreign capital fleeing a country.

We assume that HTM and illiquid assets suffer a 10% haircut if they are liquidated, or in our notation $H = 0.9$. Table 5 shows the results of the stress test for the first and final time period of the stress test.

Table 5. Liquidity Flows and Results

Time Period 1			
	Flows of Assets/Liabilities	Losses of Portfolio Revaluation	
Deposit Outflow	2,407,571	HTM Asset Losses	46,603
Cash and T-bills (AFS)	0	Illiquid Asset Losses	0
Long-Term Corporate Bonds (HTM)	436,031		
Real Estate (Illiquid)	2,000,000	Total Losses Period 1	46,603
Time Period 5			
	Flows of Assets/Liabilities	Losses of Portfolio Revaluation	
Deposit Outflow	60,475	HTM Asset Losses	0
Cash and T-bills (AFS)	0	Illiquid Asset Losses	71,111
Long-Term Corporate Bonds (HTM)	0	Total Losses Period 5	71,111
Real Estate (Illiquid)	711,111	Total Period Losses	424,360

Source: Artificial data

We observe that at the end of the period AFS and HTM assets are completely depleted and there is only some real estate left that has been liquidated. From table 4 we assumed that 99% of international depositors will flee implying a departure of $3,960,000, thus we expect to have left from $5,000,000 of assets that can be sold, around $1,040,000. Yet we have $711,111 left. This is due to capital losses as more assets are required to be sold since HTM and illiquid assets are subject to haircuts.

The losses are calculated separately and in total they are of the amount of $424,360. Losses accumulate from sequential sales of assets which are recorded as HTM or are illiquid. HTM assets suffer losses since they are recorded at book value and at liquidation they are sold at market value, thus the capital loss will move through the comprehensive income statement to the capital and surplus. Illiquid assets are revaluated due to bid-ask spreads in illiquid markets, which may not have a readily quotable price. In any event, these revaluations translate liquidity runs into solvency deterioration if the bank matches most of its liquid liabilities with less liquid assets.

In this example, the BIS categorization of deposits is crucial for the design of the scenarios. An overarching scenario of 99% withdrawal of deposits is extreme and implausible if the drivers of the withdrawal are not sufficiently understood. However, knowing deposits by sector and location we can articulate plausible scenarios and tie them into a coherent macroeconomic scenario. The usefulness of BIS locational data is that they allow the stress test to have an internal consistency on the stresses and also stress the bank with relevant economic shocks.

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Macroprudential Liquidity Stress Tests Using BIS Locational Banking Statistics

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Carnell Lambert. Senior Analyst.

Bermuda Economy and Bermuda Banks

- Bermuda is a British Overseas Territory located in the Atlantic Ocean. Population: 60,000. Area: 53.2 km^2.
- No natural resources, inability to create local capital intensive industries.
- Instead Bermuda developed tourism and financial services (insurance and reinsurance).
- (Re)Insurance and tourism account for the majority of FX receipts.
- Banks act as gateways between Bermuda legal entities and individuals and the rest the world.
- Bermuda banks serve the local economy and the international business economy under unified entities, but local economy and international business economy are exposed to different shocks.

Bermuda Economy and Bermuda Banks

- International insurance companies are exposed to the international underwriting cycle, tax and regulatory effects. These are largely overseas shocks with the Bermuda Government unable to intervene.
- Local economy is driven by domestic supply and demand factors which are also affected by employment and FX receipts from international insurance and tourism.
- Banks have a bifurcated balance sheet for the local economy and the international economy.
- International sector has operational deposits, the domestic sector has deposits for savings, lending and operational purposes.
- BMA wanted to understand the dynamics of this bifurcated nature for policy purposes especially in banking supervision at a microprudential level, recovery & resolution planning and macroprudential surveillance.

BIS Locational Statistics and Bermuda Banks

- Starting point: BIS locational statistics.
- Location, currency and duration are essential to understand the bifurcated nature of Bermuda bank balance sheets.
- Project: A comprehensive liquidity stress test for Bermuda banks to inform BMA about potential vulnerabilities from the bank balance sheets.

BIS Locational Statistics and Liquidity Stress Tests - Milestones.

- BIS data is unaudited. There was a need for comprehensive validation of the data. Achieved in 2017 after one year of back testing past submissions using a special template BMA created for validation.
- There was a need to present the data in a convenient form. We used the IMF Balance Sheet Approach (Allen et al. 2002) and we linked to the IMF-like balance sheets the submissions. Achieved in 2018.
- Validation and data compilation are almost fully automated processes done quarterly.
- Liquidity stress testing model uses the BIS submissions as inputs, together with prudential data. Final operational model created in October 2019.

	Holders of Securities												
Domestic Issuer of Security	Domestic	Domestic	Domestic	Domestic	Domestic	Foreign	Foreign	Foreign	Foreign	Foreign			
General Government and Central Bank	General Government and Central Bank	Commercial Banks	Non-Bank Financial	Non-Bank Corporate	Non-Bank-Household	General Government and Central Bank	Commercial Banks	Non-Bank Financial	Non-Bank Corporate	Non-Bank-Household	Total Domestic	Total Foreign	Total
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency		50											
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Commercial Banks													
Short Term Liabilities (totals)													
in foreign currency			100										100
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													
Non-Bank Financial													
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													
Non-Bank-Corporate													
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													
Non-Bank-Household													
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													
Foreign													
Short Term Liabilities (totals)													
in foreign currency													
in domestic currency													
Medium and Long Term (totals)													
in foreign currency													
in domestic currency													
Equity (Capital)													

Scenario Design of Liquidity Stress Test

- Once we have the BIS submissions we combine them with prudential submissions in the stress testing model.
- Liquidity stress scenarios are not produced according to an econometric method, but using a "story-telling" approach.
- Financial stability department devises scenarios in the form of *"Bermuda banks are hit by this shock emanating from this sectorial imbalance or macroeconomic development"*. Then we devise a space of possible withdrawals of deposits according to the scenario for each BIS reported sector, currency and duration of liabilities/assets.
- We assume a waterfall of asset liquidations. AFS assets are first to be sold, HTM second and illiquid assets are the last resort. Based on the scenario outflow, we know exactly which assets are going to be sold and we assume haircuts to the valuation of HTM and illiquid assets.

Scenario Design of Liquidity Stress Test

- All these features are blended together to provide us with post-stress LCR, Tier 1/RWA and final amount of assets and liabilities.
- The stress test can be conducted in reverse, i.e. which outflow can generate a specified LCR, Tier 1/RWA or other indicator.
- For LCR calculation purposes, assets and liabilities are matched between prudential, BIS and LCR templates. This is a tedious process and we literally go line by line per broad asset categories to match three separate databases/calculation methods.
- There are some discrepancies when we try to match the data but we make sure that the matching calibrates the current LCR within reasonable accuracy. We allow around 5 percentage points difference between actual and calibrated LCR if the actual LCR is way above 100%.

Sample of Liquidity Stress Test based on Artificial Data

Assets		Liabilities	
Cash and T-bills (AFS)	1,000,000	Foreign corporate deposits	2,000,000
Long-term corporate bonds (HTM)	2,000,000	Domestic corporate deposits	2,000,000
Real estate (Illiquid)	2,000,000	Foreign households	2,000,000
Loans (Unable to liquidate)	5,000,000	Domestic households	2,000,000
Other assets	0	Equity	2,000,000
Total	10,000,000	Total	10,000,000

Prudential fillings taxonomy

BIS locational taxonomy

Sample of Liquidity Stress Test based on Artificial Data

Assumptions: 10% of value haircut due to sale of HTM, illiquid assets, five-period liquidity stress test, 99% of international deposits flee.

Time Period 1			
	Flows of Assets/Liabilities	Losses of Portfolio Revaluation	
Deposit Outflow	2,407,571	HTM Asset Losses	46,603
Cash and T-bills (AFS)	0	Illiquid Asset Losses	0
Long-Term Corporate Bonds (HTM)	436,031		
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Time Period 5			
	Flows of Assets/Liabilities	Losses of Portfolio Revaluation	
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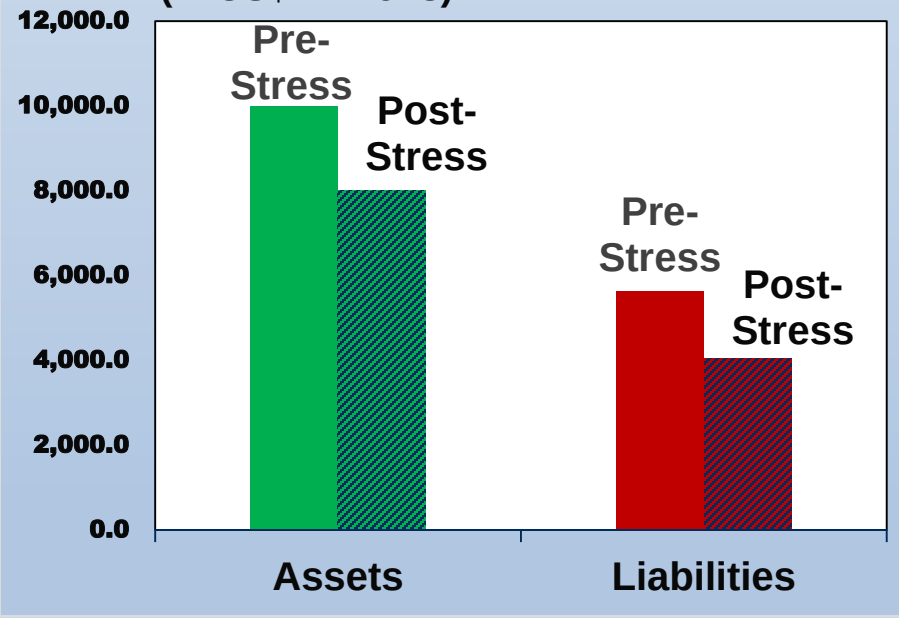
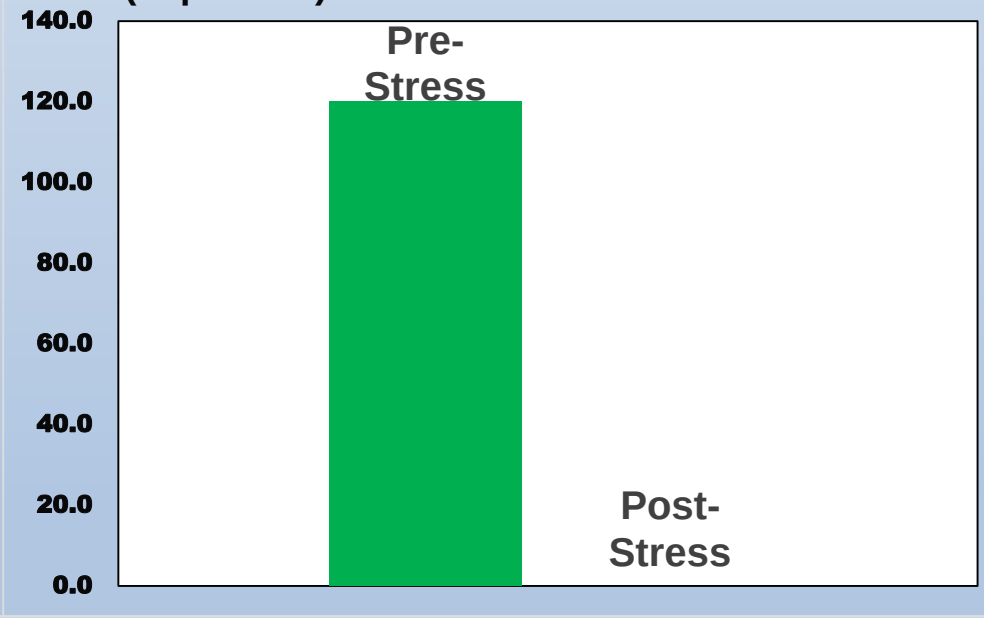
Long-Term Corporate Bonds (HTM)	0	Total Losses Period 5	71,111
Real Estate (Illiquid)	711,111	Total Period Losses	424,360

All numbers and figures are based on artificial data

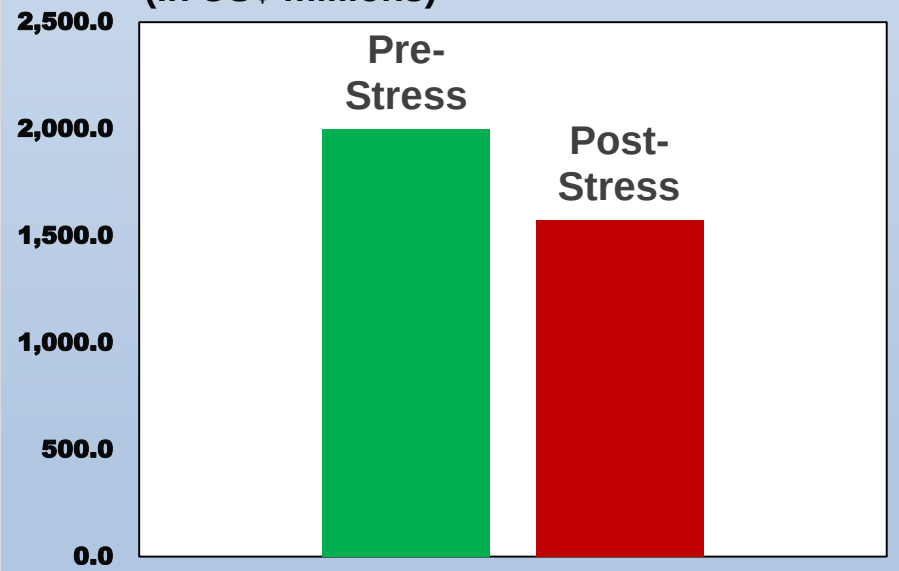
Assets and Liabilities Pre/Post Stress (In US$ millions)



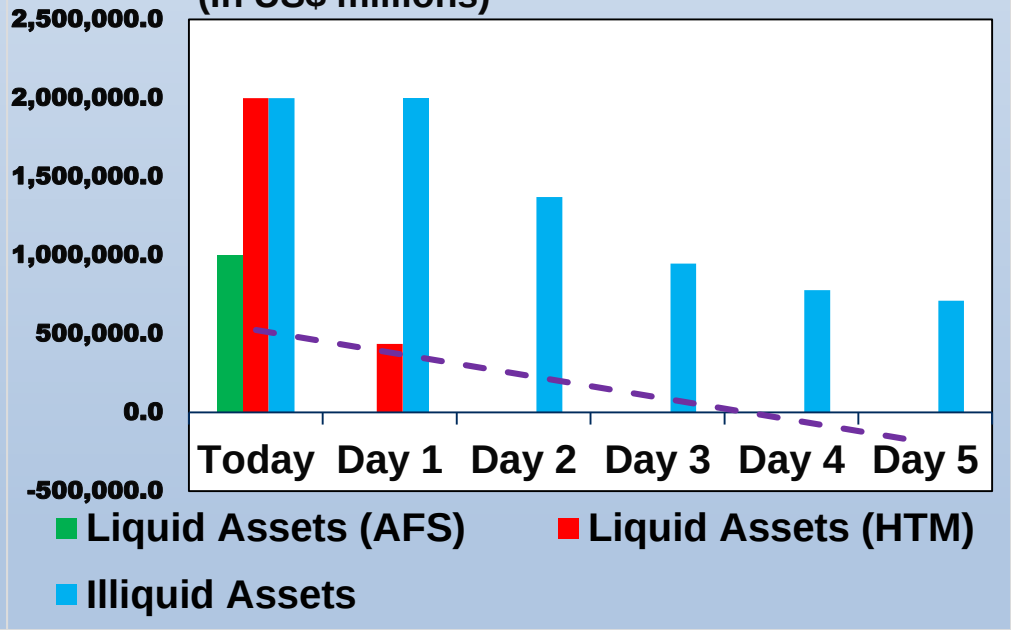
Pre and Post-Stress LCR (In percent)



Pre and Post-Stress Capital and Surplus (In US$ millions)



Asset Run-Off from Liquidations (In US$ millions)



Thank you for your attention

Any Questions

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