



ISLAMIC FINANCIAL SERVICES BOARD

TN-2

**TECHNICAL NOTE ON STRESS TESTING FOR
INSTITUTIONS OFFERING ISLAMIC FINANCIAL
SERVICES (IIFS)**

DECEMBER 2016

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The IFSB is an international standard-setting organisation which was officially inaugurated on 3 November 2002 and started operations on 10 March 2003. The organisation promotes and enhances the soundness and stability of the Islamic financial services industry by issuing global prudential standards and guiding principles for the industry, broadly defined to include banking, capital markets and insurance sectors. The standards prepared by the IFSB follow a lengthy due process as outlined in its Guidelines and Procedures for the Preparation of Standards/Guidelines, which involves, among others, the issuance of exposure drafts, holding of workshops and, where necessary, public hearings. The IFSB also conducts research and coordinates initiatives on industry-related issues, as well as organises roundtables, seminars and conferences for regulators and industry stakeholders. Towards this end, the IFSB works closely with relevant international, regional and national organisations, research/educational institutions and market players.

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ABBREVIATIONS

AQR	Asset quality review
AT1	Additional Tier 1
BCBS	Basel Committee on Banking Supervision
CAR	Capital adequacy ratio
CEBS	Committee of European Banking Supervisors
CET1	Common Equity Tier 1
CMT	Commodity <i>murābahah</i> transactions
CPIFR	Core Principles for Islamic Finance Regulation
DCR	Displaced commercial risk
ECAI	External credit assessment institution
HQLA	High-quality liquid assets
HTM	Held-to-maturity
IAH	Investment account holders
ICAAP	Internal capital adequacy assessment process
ICFA	Implied cash flows analysis
ICIS	Islamic collective investment scheme
IFSB	Islamic Financial Services Board
IFSI	Islamic financial services industry
IIFS	Institutions offering Islamic financial services
IMF	International Monetary Fund
LCR	Liquidity coverage ratio
NPF	Non-performing financings
NSFR	Net stable funding ratio
PSIA	Profit-sharing investment account
RPSIA	Restricted profit-sharing investment account
RRRBB	Rate of return risk in the banking book
RSA	Regulatory and supervisory authority
RWA	Risk-weighted assets
SLOLR	Sharī'ah-compliant lender of last resort
SNCI	Sharī'ah non-compliant income
SNCR	Sharī'ah non-compliance risk
T2	Tier 2
TN	Technical Note on Stress Testing
UIAH	Unrestricted investment account holders
UPSIA	Unrestricted profit-sharing investment account

Section 1: Background

1.1. Introduction

1. Financial institutions across the globe faced significant challenges during the 2007–9 Global Financial Crisis. Declining capital ratios, plummeting equity prices, government takeovers of failing financial institutions, and subsidies by the public sector have been norms rather than special cases in many developed economies. The recent past well illustrated the importance of stress tests not only as a risk management tool and key component of financial stability analysis, but also as a crisis management tool.

2. Stress tests offer a means of trying to discern the impact of a systemic or tail event. They have a number of important benefits as a supervisory tool. From a microprudential perspective, they provide a structured means for institutions offering Islamic financial services (IIFS) and regulatory and supervisory authorities (RSAs) to assess not only whether a particular financial institution holds enough capital, but also whether it is able rapidly and accurately to determine its risk exposures. From a macroprudential perspective, the use of common scenarios allows RSAs to learn how a particular risk, or combination of risks, might affect the banking system as a whole. It provides RSAs with the ability to implement pre-emptive measures before problems assume crisis proportions. The role of stress tests became evident in the US Supervisory Capital Assessment Program, as well as in European stress-test exercises that were used to assess the required level of capital backstops to prevent institutional failures.

3. Stress testing has become a tool widely used by IIFS and RSAs to: (i) identify financial sector vulnerabilities; (ii) influence and support policy decisions affecting the financial system and individual institutions; and (iii) support and guide financial institutions' own risk management. Regulatory stress tests have become a central tool for enhancing the resilience of the banking system.

4. Stress testing is one of the key risk management tools for financial institutions and is an important part of the supervisory assessment under Basel II's Pillar 2. It plays a particularly important role in the following aspects of risk management:

- a. providing *forward-looking* assessments of risk;

- b. overcoming *limitations* of models and historical data, with particular reference to *low-frequency, high-impact events*;
- c. feeding into capital planning procedures, including the *internal capital adequacy assessment process* (ICAAP) and liquidity planning procedures;
- d. facilitating the development of risk mitigation or contingency plans *across a range of stressed conditions*; and
- e. various aspects that concern corporate governance, including:
 - i. informing the setting of an institution's *risk tolerance*; and
 - ii. supporting *internal and external communications* with regard to the above.

5. **From the Islamic financial services industry (IFSI) perspective, stress testing for risk management is an evolving area where much work at all levels, including by supervisory authorities and market players, is required.** Stress tests should be conducted on all material aspects and in relation to extreme but plausible scenarios, with special attention to the position and impact of the investment account holders (IAHs). The asset side of the balance sheet of IIFS also varies from that of the conventional banks in a number of ways, which in turn has a direct impact on how the stress testing must be conducted in IIFS.

6. **The credit, market and operational risk profiles of Islamic financial instruments do not correspond exactly to those of conventional financial instruments.**¹ In addition to these risks, an IIFS is, or may be, exposed to other risks, such as Sharī'ah non-compliance risk, rate of return risk and equity investment risk, which need to be taken into account by an IIFS in its stress testing. In view of an IIFS's limited access (as is currently the case in most jurisdictions) to short-term funding and high-quality liquid assets (HQLA) to streamline with the expectations on liquidity risk management, particularly maintenance of HQLA in GN-6: *Guidance Note on Quantitative Measures for Liquidity Risk Management of IIFS* and establishment of effective contingency funding plan in IFSB-12: *Guiding Principles on Liquidity Risk Management for IIFS*, due consideration must be given to liquidity stress tests.

7. IFSB-13: *Guiding Principles on Stress Testing for Institutions offering Islamic Financial Services* is intended to complement the existing international stress-testing frameworks² (which

¹ See IFSB-1: *Guiding Principles of Risk Management for Institutions (other than Insurance Institutions) offering only Islamic Financial Services (IIFS)*.

² In particular, two seminal documents dealing with stress testing have been published in response to the financial crisis. In May 2009, the Basel Committee on Banking Supervision (BCBS) published its *Principles for Sound Stress Testing Practices and Supervision*; and in August 2010 the Committee of European Banking Supervisors (CEBS) issued its *CEBS Guidelines on Stress Testing*. The BCBS document sets out 15 "principles" for banks and six for supervisors, while the CEBS document contains 17 "guidelines" for banks and five for supervisors.

were developed with conventional banking in mind), by taking into consideration the specificities of IIFS, and to contribute to the soundness and stability of the IFSI and the financial sector as a whole. IFSB-13 followed a principles-based approach and includes guidance on the basic elements that a stress-test framework in IIFS and RSA should incorporate. However, IFSB-13 did not provide technical guidance on how to conduct the stress tests in practice.

8. **During the development of and public consultation on IFSB-13, the need for detailed guidelines on the operationalisation of IFSB-13 was emphasised.** It was agreed to address the technical details of stress testing in due course in a separate IFSB Technical Note.

9. The proposed Technical Note on Stress Testing (TN) was incorporated within the work plan outlined in the Islamic Financial Services Board's (IFSB's) *Strategic Performance Plan 2012–2015*. The IFSB Council approved the development of the TN for IIFS and the forming of a task force for this purpose during its 23rd meeting in Doha, Qatar, on 10 December 2013.

1.2. Objectives

10. The aim of stress tests is for IIFS and RSAs to assess the IIFS' ability to withstand adverse financial and economic shocks, and to enable an RSA to evaluate the potential impact of such a shock on its jurisdiction's financial stability. RSAs also use stress tests as a supervisory tool to encourage IIFS to build and maintain adequate capital and liquidity buffers and put in place risk mitigation plans aimed at a range of adverse conditions. The complexity of stress tests can vary depending on the level of aggregation, including at the portfolio level, institution level and group level, and at the aggregate level for an entire financial system.

11. There are numerous types of stress tests. Different stress tests serve different purposes and are relevant under varying circumstances (see the summary provided in section 2.4). While this TN does not intend to cover all aspects of stress testing, it has been prepared with the following objectives in mind:

- a. to facilitate the design and simulation of solvency and liquidity stress tests for IIFS, including providing guidance on establishing macrofinancial links, running scenarios of various assumptions and stress parameters;
- b. to highlight the specificities of risk exposures in IIFS and how they need to be captured in stress-testing exercises; and

- c. to provide stylised numerical examples of IIFS stress tests under different shock scenarios.

12. **It is intended that the proposed TN would be used by IIFS and RSAs as guidance in developing, conducting and assessing stress testing.** Though the IFSI includes banking, capital market and *takāful* sectors, the scope of this TN is limited to the banking sector only³ and covers both institutional-level (i.e. tests used by institutions to assess their risk tolerance and capital level) and industry-wide⁴ stress tests (i.e. those used by RSAs as a supervisory tool for financial stability analysis stress testing).

13. The TN addresses multiple types of risk and their interrelated effects on the overall financial position and performance of the portfolio, institution, group or system. These risks include credit risk within financing portfolios, equity risk in equity investment portfolios, market risk on assets held, foreign exchange risk, liquidity risk, rate of return risk, and discussions on the aspect of Sharī'ah non-compliance risk.

1.3. Scope of Application

14. **The TN is primarily intended to serve as a benchmark for IIFS and RSAs to conduct stress testing.** RSAs may extend the application of this TN to Islamic “window” operations⁵ that are self-contained, or to other IIFS that fall within their jurisdictions. The scope and application of the TN is subject to the adoption of other applicable IFSB standards and guiding principles – in particular, IFSB-12: *Guiding Principles on Liquidity Risk Management for IIFS*; IFSB-13: *Guiding Principles on Stress Testing for IIFS*; and IFSB-16: *Revised Guidance on Key Elements in the Supervisory Review Process of IIFS*.

15. **The TN also complements IFSB-17: Core Principles for Islamic Finance Regulation (Banking Segment) (CPIFR), which provides a set of core principles – along with the**

³ Other segments such as capital markets and *takāful* should be addressed separately, taking into account their specificities.

⁴ The term “industry-wide” refers to all eligible Islamic banks in a jurisdiction and their data aggregated together for stress-testing purposes. This TN makes use of this term, as opposed to “system-wide”, in relation to stress tests, since most jurisdictions operate a dual banking framework where conventional and Islamic banking systems run parallel to each other. An issue legitimately arising here is whether RSAs need to stress test Islamic banks as an aggregate (*industry-wide and excluding conventional banks*) separately in dual banking jurisdictions. This is further discussed in section 3.6.

⁵ IFSB-16 defines “Islamic windows” as part of a conventional financial institution (which may be a branch or dedicated unit of that institution) that provides both fund management (investment accounts) as well as financing and investment that are Sharī'ah-compliant. Thus, these windows are potentially self-contained in terms of Sharī'ah-compliant financial intermediation, as the funds generated are invested in Sharī'ah-compliant assets.

associated assessment methodology – for the regulation and supervision of the IFSI, taking into consideration the specificities of the IIFS in the banking segment, the lessons learned from the financial crisis, and complementing the existing international standards, principally the *Core Principles for Effective Banking Supervision* issued by the BCBS.

16. In IFSB-17: *Core Principles for Islamic Finance Regulation*, CPIFR 9 (Supervisory Techniques and Tools), Essential Criterion No. 4 mentions review of the outcome of stress tests undertaken by the IIFS as a supervisory tool used to regularly review and assess the safety and soundness of IIFS and the banking system. Essential Criterion No. 5 further adds that the supervisory authority, in conjunction with other relevant authorities, seeks to identify, assess and mitigate any emerging risks across IIFS and to the banking system as a whole, potentially including conducting supervisory stress tests (on individual IIFS or industry-wide).

17. CPIFR 14 (Treatment of Investment Account Holders (IAHs)) states that the supervisory authority requires that stress testing conducted by the IIFS should take account of the risks associated with investment accounts and the position of IAHs as providers of risk-absorbent funds. Similarly, CPIFR 17 (Risk Management Process) states that the supervisory authority requires IIFS to adopt forward-looking stress-testing programmes commensurate with their risk profile and systemic importance, as an integral part of their risk management process.

18. Stress tests are also mentioned in various other core principles (CPIFR 18, CPIFR 19, CPIFR 21, CPIFR 23, CPIFR 24, CPIFR 25, CPIFR 26 and CPIFR 27). In this regard, the TN serves as an important benchmark for both IIFS and RSAs to conduct appropriate stress tests.

Section 2: Basic Requirements for Conducting Stress Tests

19. Stress-testing tools have some basic requirements and important limitations, which should be fully considered when planning a stress-testing regime. These considerations enable stress-testing exercises to become more reliable and more effective. An effective stress-testing framework relies on five elements:

- a. Determination of the objective/s of the stress testing (in general and in relation to the specific exercise in mind), including identification of risk factors (e.g. capital, liquidity, etc.) that need to be stressed and frequency of conducting stress testing on identified risk factors (e.g. monthly, semi-annually, annually or ad hoc).
- b. Selection of meaningful stress scenarios of different levels of impact (e.g. baseline scenario, moderate and/or extreme shock scenarios), which can be hypothetical, or based on historical experience or on simulation of risk factors.
- c. Translation of those stresses as (first-round) impacts on the financial performance income statement and financial position of the IIFS.
- d. Assessment of the stress-testing results and generation of follow-up actions (e.g. capital preservation strategy, reduction of concentrated exposures, etc.).
- e. Taking the results into account in management decision making.

A further refinement would be to take second-round effects into account as well. In addition, stress tests for IIFS require skilled personnel having relevant capabilities and knowledge of specificities of IIFS products and their adequate inclusion and coverage in stress tests.

20. These major elements require a strong governance framework, good-quality economic and financial data, and the adoption of an appropriate methodology within the relevant scope outlined for stress tests.

2.1. Governance Framework of Stress Tests

21. **Strong governance and effective controls are necessary to ensure the stress-testing activities are functioning as intended.** Board and top management commitment to and involvement in stress testing sends the necessary signal that stress testing is taken seriously and is an important management tool. Strong governance and effective controls help the IIFS to

perform stress-testing activities containing core elements, from clearly defined stress-testing objectives to recommended actions. Proper governance and controls over stress testing not only confirm that stress tests are conducted in a rigorous manner, but also help to ensure that those stress tests and their outcomes are subject to an appropriately critical eye.

22. While the form of governance and controls over stress-testing activities will vary across RSAs and IIFS, there are some general principles, expectations and recommendations that RSAs and IIFS can follow. The principles in IFSB-13 must be applied by IIFS and RSAs to ensure strong governance in stress tests.

23. An IIFS must embed stress testing in the organisation and perform such tests as a regular feature of its business. Whenever an IIFS performs stress testing, it must do so to sound stress-testing standards, irrespective of whether it performs it on an ad hoc basis, as part of a particular programme, or as a regular feature of its management of the business. An IIFS must clearly fix responsibility for stress testing, allocate appropriate resources, have an organisational structure focused on stress testing which defines roles and responsibilities and reporting lines, and ensure compliance and hold people accountable for executing the stress-testing policy. An effective management information system will contain time-series and other relevant information; ensure the flow of stress-testing results to senior management, who will review and make interventions as necessary; and, overall, constitute a database for future reference.

24. Senior management, in consultation with the board of directors, should establish a comprehensive, integrated and effective stress-testing exercise that fits into the broader risk management objectives. Senior management should maintain internal summaries of test results, which should be available to the board and RSA, and which document the nature and extent of the IIFS's stress-testing activities and outcomes, as well as proposed follow-up actions.

25. Stress testing can also be used to consider the effectiveness of an IIFS's Sharī'ah-compliant risk mitigation techniques for various risk types over their respective time horizons, such as to explore what could occur if expected mitigation techniques break down during stressful periods. Stress-test results should inform management's analysis and decision making related to business strategies, limits, capital and liquidity, risk profile and other aspects of risk management, consistent with the IIFS's established risk appetite.

26. Senior management should ensure that stress-testing activities are updated in the light of new risks, better understanding of the IIFS's exposures and activities, new stress-testing techniques, updated data sources, and any changes in its operating structure and its internal and

external environments. A stress-testing development should be iterative, with ongoing adjustments and refinements to better calibrate the tests to provide current and relevant information. In addition, management should review stress-testing activities, both on a regular basis and in response to specific changes in economic conditions, to confirm the general appropriateness of, among other things, the validity of the assumptions, the severity of the tests, the robustness of the estimates, the performance of any underlying models, and the stability and reasonability of the results. In addition to conducting formal, routine stress tests, management should ensure that the institution has the flexibility to conduct new or ad hoc stress tests in a timely manner in order to address rapidly emerging risks and vulnerabilities.

27. Outlining stress-testing policies in a documented form is an important part of stress-testing programmes. These policies should:

- a. describe the overall purpose of stress-testing activities;
- b. articulate consistent and sufficiently rigorous stress-testing practices across the entire institution;
- c. indicate roles and responsibilities of various functions, including controls over external resources used for any part of stress testing (such as vendors and data providers);
- d. describe the frequency and priority with which stress-testing activities should be conducted;
- e. outline the process for choosing appropriately stressful conditions for tests, including the manner in which scenarios are designed and selected;
- f. include information about validation and independent review of stress tests;
- g. provide transparency to third parties (and especially the RSA) for their understanding of an IIFS's stress-testing activities;
- h. indicate how stress-test results are used and by whom, and outline instances in which remedial actions should be taken; and
- i. be reviewed and updated as necessary to ensure that stress-testing practices remain appropriate and keep up to date with changes in market conditions, the institution's products and strategies, its risks, exposures and activities, its established risk appetite and industry stress-testing practices.

28. In addition to having clear and comprehensive policies, an IIFS should ensure that its stress tests are documented appropriately, including a description of the types of stress tests and methodologies used, test results, key assumptions, limitations and uncertainties, and suggested actions. In general, documenting stress tests and ensuring their overall robustness with strong governance takes time and effort; hence, IIFS and RSAs should provide appropriate incentives to encourage effective formulation and conducting of stress tests. From the IIFS perspective, such incentives could be introduced by the board of directors for the senior management in the form of, for instance, key performance indicator (KPI) targets.

29. Another key element of governance over stress testing is validation and independent review. Stress-testing governance should incorporate validation or other types of independent review to ensure the integrity of stress-testing processes and results. In general, validation and independent review of stress-testing activities should be conducted on an ongoing basis, not just as a single event.

30. The overall governance framework of stress tests should also encourage IIFS to:

- a. explore more thoroughly the vulnerabilities of their current exposures and future business plans;
- b. make decisions that better integrate their business and capital planning;
- c. improve their contingency planning; and
- d. inform and enhance their existing stress-testing framework.

31. From the RSA's point of view, developing stress-testing capacity is a crucial part of the governance of stress tests. RSAs must develop the appropriate capacity and ability to undertake stress-testing exercises of the Islamic financial system. RSAs should integrate stress testing into their macro- and microprudential analytical work as an additional tool for financial stability analysis and/or as early warning indicators.

32. RSAs must also have sufficient expertise to provide advice to IIFS in terms of their internal stress-testing exercises, as well as their remedial capital and liquidity adequacy measures, as and when needed based on the stress-test results and assessments conducted by the RSA. The involvement of RSAs in IIFS's stress testing should be proportionate to the size, nature, complexity and sophistication of IIFS's risk profile and business activities. Regardless, IIFS must themselves aim to develop internal expertise in stress testing and generally reduce reliance on RSAs.

33. The governance framework for RSAs must stipulate guidelines on the frequency of stress-testing exercises that are to be conducted throughout a financial year and the reporting channels to be utilised to transmit the results to the concerned authorities/senior management of IIFS. The stipulated frequency of such stress-testing exercises should be commensurate with the purpose and objectives of the stress tests, including the underlying risk profiles; for instance, stress tests for market risks may be done more frequently (e.g. as frequently as daily marking-to-market), while stress tests for liquidity and credit risks may be less frequent (e.g. on a monthly basis for liquidity risks and on an annual basis for credit risks). The governance framework must incorporate the time horizons to be considered in the stress-testing exercises, allowing for a sufficient time frame to enable policymakers to undertake pre-emptive remedial measures to prevent any untoward failures of the Islamic financial system.

34. While RSAs may establish guidelines and an implementation programme for mandatory stress tests incorporating recent regulatory developments (if they have not already done so), IIFS under exceptional and justified circumstances can approach and discuss with the RSAs a certain flexibility in the implementation process. This draws upon the need for a balanced approach to stress testing, as “overreach” can do more harm than good. Particularly when capacity is low, resources are limited, data are lacking or insufficient, and the regulatory framework is inadequate, there is a risk that a stress-testing exercise may cause undue consternation, leading to inappropriate decisions that undermine confidence and credibility.

2.2. Data Needs for Stress Tests

35. The quality of the stress test depends materially upon the scope and quality of available data and the selection of an applicable methodology. The availability of data could influence the assumptions and models used to develop scenarios, estimate the size of the shocks and manipulate the data. Lack of appropriate data too often is a major challenge for Islamic finance-specific stress-testing exercises, and this is particularly so in jurisdictions where IIFS have been established only recently.

36. Premised on the above, **this TN provides a generalised data template** for use by IIFS and RSAs to collect necessary data in order to support their stress-testing exercises (see Appendix A1). **IIFS and RSAs need to formalise, and thereafter regularly update, their data collection** to fill the information gap and enhance their understanding of IIFS risks.

37. For modelling the impact of external shocks on an IIFS's balance sheets in stress tests, reliable macroeconomic and financial data should be used in econometric models to quantify the historical relationship between shocks to selected macroeconomic variables and, for example, non-performing financings (NPFs) in asset portfolios exposed to credit risk.⁶

38. RSAs need to collect the required data from IIFS at regular intervals. While there will always be information asymmetry between RSAs and IIFS, the data collection should be formalised to fill the information gap and to enhance the RSAs' understanding of the risks faced by individual IIFS. In addition, data collection creates strong incentives for an IIFS to develop internal processes that allow for better aggregation across different systems and to provide sufficiently detailed data about its risk profile, business model, and financial position and performance. An IIFS's information technology (IT) resources should be commensurate with its risk profile and systemic importance.

39. **Where data are lacking or insufficient, both IIFS and RSAs need to explore relevant data proxies for stress tests.** The proxies may be derived internally by an IIFS from other assets that possess similar risk characteristics, or externally through industry benchmarking. IIFS must document comprehensively relevant information regarding such proxies, including the characteristics, rationale for the use, source and any known limitations thereof.

40. **When use of proxies is not a meaningful solution, expert judgments concerning the nature and extent of shocks on IIFS' financial statement components may be canvassed.** In addition, when granular data on financing classifications and NPFs of each asset class/portfolio are not available, it may be useful to obtain an expert judgment based on some qualitative criteria to assess the impact of a macroeconomic shock on the specific/aggregate NPFs of the Islamic banks/system as a whole. The process of acquiring expert judgments by RSAs/IIFS may include the following steps:

- a. selecting data indicators for which values are to be derived by the experts;
- b. selecting the experts, which could include internal or external economists, risk management professionals, actuaries, financial/quantitative analysts, etc.;
- c. organising the expert judgment exercise to derive the values needed;
- d. choosing a method for combining multiple expert judgments; and

⁶ Section 3.3 provides guidance on possible econometric techniques for modelling risk impacts from shocks on IIFS' balance sheets.

- e. undertaking a review process by the senior management of the RSAs/IIFS to validate the values of the expert judgments utilised in stress tests and documenting the same for any future reference and regulatory/audit inspections.

2.3. Asset Quality Review

41. An asset quality review (AQR) is a review of the key characteristics of assets, including their underlying collateral. An AQR assesses, among other things, data quality, recoverability, valuation, classification, collateral valuation and provisioning. The detailed financing file review aims to identify data quality problems that need to be resolved prior to use of the data for stress-testing purposes. Where the data quality problems are not satisfactorily resolved prior to use of the data for stress-testing purposes, a decision needs to be made as to whether it is still meaningful to proceed with the particular test despite the problems. Where it is decided to proceed with a stress-testing exercise, notwithstanding such problems, the stress-test results need to be interpreted in the light of the consequent implications and limitations that such problems imply, and adequate disclosure must be made of the relevant issues. An AQR is a highly recommended exercise and typically precedes a stress test. If conducted, AQR-adjusted values should be the point of departure for the stress test; however, the AQR report/findings itself need not necessarily be part of the stress-test results report.

42. AQR is one of a number of important elements that increase the reliability of stress tests. **RSAs conduct AQRs at a business or portfolio level to ensure that IIFS' asset valuations reflect expected asset performance, and to identify risks to asset performance that need to be reflected in IIFS' capital requirements.** More specifically, RSAs use AQRs to ensure that, within the constraints of accounting rules, adequate impairment loss provisions⁷ are held against assets held at amortised costs. IIFS should also ensure data integrity in all areas at all times, including a proper control function to validate the data, such as an internal audit function.

43. The AQR typically comprises three key phases, namely:
- a. **Portfolio selection**, to determine the universe that will be subjected to stress testing and to ensure a comprehensive review of assets, thus avoiding overlooking high-risk assets.

⁷ From a banking perspective, "provisions" are funds set aside by the bank to cover expected and/or recognised assets' impairments on financing portfolios.

- b. **Execution** (the most complex phase), which involves, among other things, data integrity validation, sampling, on-site reviews of files, valuation, collectability assessment, measurement of legal and operational risks, collateral valuation, and the recalculation of provisions and risk-weighted assets (RWAs).
- c. **Collation**, which includes a final consistency exercise to ensure the comparability of results across all portfolios for all IIFS.

There should be a strict process with prescribed guidelines and harmonised definitions in order to achieve consistent results.

44. AQRs should take place regularly as part of both the routine supervisory process and the ICAAP process at an institutional level. Reviews of individual IIFS' assets are conducted periodically and occur at different times for each IIFS, although specifically prior to a stress-testing exercise. Deeper reviews might include discussions with IIFS' management, use of specialist staff, and examinations of individual financing files. The approach taken to an AQR should reflect the level of risk and complexity of the assets concerned. More intense reviews should be conducted on asset portfolios that can materially affect an IIFS's resilience, that are complex and inherently difficult to value, or that appear highly susceptible to losses. Thematic reviews of particular groups of assets are also conducted, often in response to a specific risk or concern, covering multiple IIFS simultaneously.

2.4. Types of Stress Tests

45. Stress tests can be performed at different levels of aggregation of financial data – for instance, **at a portfolio level** within the balance sheet of an IIFS; **at the overall balance sheet level** in a single IIFS; at the (banking or financial) group level; or **at the level of a jurisdiction's entire financial system**, aggregated as a whole. The former are known as micro- or institution-level stress tests, while the latter are termed macro- or system-wide stress tests.

46. **Institution-level stress tests** are designed to assess the resilience of an individual IIFS (or specific portfolios within an IIFS) to adverse shocks in the macroeconomy. The tests are run mainly by an individual IIFS for the purposes of institutional risk management and/or regulatory compliance. An RSA may also undertake institution-level stress tests to identify the weaker IIFS in its jurisdiction in order to initiate necessary remedial measures against flagging institutions to prevent their failure.

47. **System-wide tests** are designed to assess the resilience of an entire financial system as a whole, as opposed to individual institutions only. System-wide stress tests are conducted by RSAs,⁸ as well as by regional and international organisations (e.g. the International Monetary Fund's (IMF's) Financial Sector Assessment Programs, the European Banking Authority's EU stress-testing exercises, and so on). Macro stress-test results enable an RSA pre-emptively to initiate policies in order to prevent the failure of a banking sector should an extreme, yet plausible, macroeconomic shock materialise. In this TN-2, **industry-wide stress tests**⁹ are introduced as an exercise on aggregated values of the Islamic banking sector only. The results enable RSAs to identify any weaknesses or potential vulnerabilities to plausible extreme shocks in the Islamic banking system.

48. Stress tests generally are aimed at assessing the resilience of an individual IIFS (in institution-level tests) or the entire Islamic financial system (in industry-wide stress tests) from a solvency perspective. **Following lessons learned from the Global Financial Crisis, liquidity stress tests and integrated liquidity–solvency stress tests have gained relevance.** The experience of the Global Financial Crisis illustrated that liquidity and funding risks are critical risk factors that can lead to bank insolvency and failure.

49. Reverse stress testing can be conducted by RSAs and IIFS to help them consider scenarios beyond normal business expectations and to challenge common assumptions about performance and risk mitigation strategies. This is a method under which the IIFS assumes a specific adverse outcome, such as suffering losses to cause a breach in regulatory capital ratios, and then deduces the types of events that could lead to such an outcome. Having identified such scenarios, RSAs and IIFS can consider how likely those conditions are, make contingency plans, or take other steps to mitigate the identified risks.

2.5. Scope of Stress Tests

50. Appropriate stress-testing coverage is important, as stress-testing results could give a misplaced sense of comfort if certain portfolios, exposures, liabilities or business-line activities are not included in the exercise. It underscores the need to document clearly each stress test, including what is covered – or not covered – in each test. Effective stress testing should be applied

⁸ Another hybrid type of stress test also exists for RSAs where a specific portfolio of all IIFS, based on its systematic importance or concentration in a particular segment, is chosen for a system-wide stress test – for instance, stress testing the real estate exposure of all IIFS.

⁹ See footnote 4.

at various levels in the institution, including at the business lines level, portfolio level and specific risks level. In addition, it should be applied on an enterprise-wide level. In some cases, stress testing can also be applied to individual exposures or instruments.

51. Stress testing should capture the interplay among different exposures, activities and risks, and their combined effect, although stress testing several types of risks or business lines simultaneously may prove operationally challenging. An IIFS should aim to identify concentrations and common risk drivers across its business lines, customers, types of collateral and assets held, country/regional concentrations, etc., which can affect it adversely – including those not readily apparent during more benign periods.

52. Stress testing should be conducted over various relevant time horizons to adequately capture both those conditions that may materialise in the near term and adverse situations that take longer to develop.

53. **No single stress-testing method or model is perfectly suited for all financial systems or every IIFS.** An important challenge for an IIFS or an RSA is to ensure that appropriate stress tests are applied.

54. The stress-tests framework should require the performance of several activities and exercises, and not rely merely on a single test or type of test. Every stress test has limitations and relies on assumptions. Expert judgment should complement the use of stress-testing models. Policymakers must integrate expert judgment in the stress-testing process to ensure relevance, reasonableness and logic. Where stress tests identify potential vulnerabilities in a particular IIFS or the financial sector, IIFS management and policymakers must follow up with relevant remedial measures to address these vulnerabilities.

2.6. Approaches to Stress Tests

55. **Approaches to stress testing should be expected to vary.** Stress testing adds its greatest value when it is organised, executed and used in ways that take into account the unique characteristics, operating environment and management style of the IIFS.

56. **“Stress testing” refers to many different methods and applications, including transaction stress testing, portfolio stress testing, enterprise-wide stress testing and reverse stress testing.** An IIFS can use a variety of stress-test methods to evaluate financing portfolio risk and the potential impact on earnings and capital based on its unique risk profile.

57. **An IIFS's stress-testing framework should be commensurate with the size, nature, complexity and sophistication of its risk profile and business activities.** In general, a more sophisticated or complex IIFS should use a combination of sensitivity analysis and scenario tests (or any other appropriate concept) to capture all aspects of risks.

58. **IIFS are encouraged to explore, design and develop their own stress test(s) that are most appropriate and effective for their business environment and profile, to be conducted regularly.** There is no single best approach or methodology. However, stress tests need to be sustainable and there needs to be continuity. The RSA should weigh in on the relative strengths and weaknesses of different approaches and methodologies under different circumstances.

Section 3: Solvency Stress Tests

3.1. Introduction

59. Solvency stress tests are designed to assess the **resilience of individual banks, a (banking or financial) group, and/or the banking sector as a whole, to extreme, yet plausible, shocks** in a financial system. In **institution-level stress tests**, the balance sheets of individual IIFS are subjected to stress tests for the primary purpose of gauging the possible impact on solvency (i.e. capital ratios) of extreme shocks in the financial system. The results enable the concerned RSAs to initiate remedial measures against any institution that is at risk of financial distress (going concern) or, in the worst case, insolvency (gone concern).¹⁰ In **system-wide stress tests**, the exercise is on aggregated values across the banking sector **variables**, and the results enable RSAs to identify any weaknesses or potential vulnerabilities to plausible extreme shocks in the financial system. In **industry-wide stress tests**, the exercise is on aggregated values across the Islamic banking sector variables, and the results enable RSAs to identify any weaknesses or potential vulnerabilities to plausible extreme shocks in the Islamic banking system.

60. In general, an effective stress-testing framework should be applied at various levels, including within an individual IIFS, on business lines, portfolios and risk types, as well as on an enterprise-wide, group-wide, system-wide and (possibly) industry-wide basis. In many cases, **stress testing may be more effective at the business line and portfolio levels**, as a higher level of aggregation may cloud or underestimate the potential impact of adverse outcomes on an IIFS's financial condition. Each stress test should be tailored to the relevant level of aggregation, capturing critical risk drivers, internal and external influences, and other key considerations at the relevant level.

61. This TN incorporates *Shari'ah*-compliant contracts' risk specificities when conducting stress tests on an IIFS. The approach involves evaluating the various risk exposures of an IIFS, segregated by the contractual relationships of the balance sheet components. The rationale for such an approach is to account for the specificities of an IIFS's risks arising from the different contracts (elaborated on in section 3.2) and to enable IIFS stress-testing models to capture the interplay among different exposures, activities and specific IIFS risks, and their combined effects.

¹⁰ Total eligible capital for IIFS is the sum of Tier 1 and Tier 2 capital. Tier 1 capital consists of Common Equity Tier 1 (CET1) and Additional Tier 1 (AT1). Together with CET1, AT1 capital is considered as "going concern" capital, which absorbs losses while the IIFS is solvent. T2 capital is considered to be "gone concern" capital, which absorbs further losses in the case of non-viability of the IIFS, and thus helps to protect the current account holders and other creditors, as well as the IAHs, of the IIFS.

62. The proposed template in this TN provides the flexibility of having stress-test results analysed and assessed across three levels in one Excel sheet: at a portfolio level, at an institution-level and at the aggregate industry-wide level. (A similar aggregate approach would be used at the system-wide level.) It is important to capture stress effects across all three levels of financial data aggregation, since relying on one (e.g. only a system-wide stress test) can give a false sense of comfort that the financial sector is resilient, although an institutional-level test may identify an IIFS likely to face financial distress/insolvency.

63. The proposed template provides some initial guidance on stress tests for RSAs and IIFS. Both are encouraged to explore, design and develop their own stress test(s) that are technically more advanced and appropriate for their economic and financial environment and jurisdiction complexity.

64. Furthermore, the proposed template adopts a one-time horizon (i.e. Year 1) to conduct the stress tests and discuss the results. This is indicative only for illustration purposes, and RSAs and IIFS are encouraged to conduct stress tests over multiple time periods and as required by regulations (e.g. a three- to five-year period for ICAAP) to achieve a longer time-period assessment of capital and liquidity adequacy.

3.2. Risk Specificities of IIFS

65. In conducting stress tests, it is important for IIFS to understand and take account of the implications for risk management arising from the differences between their operations and balance sheet structures and those of conventional banks.

66. Islamic financial instruments are exchange-based (*murābahah*, *salam* and *istisnā`*, which are based on the sale or purchase of an asset; and *ijārah*, which is based on selling the usufruct of such an asset), profit- and loss-sharing or profit-sharing and loss-bearing¹¹ by the capital provider (*mushārah* and *muḍārah*), or *sukūk* (securities) and investment portfolios and funds that may be based on the above assets.

67. In the case of the **exchange-based instruments**, the IIFS's gross return is the spread between the cost of the asset to the IIFS and the amount that can be recovered from selling or

¹¹ In the case of *muḍārah*, it is profit-sharing and loss-bearing by the capital provider, as in normal cases only the capital-contributing party bears financial loss while the entrepreneur (*muḍārib*) bears the loss of his/her efforts. However, the entrepreneur (*muḍārib*) is liable to bear part of the financial losses that result due to his/her negligence, misconduct or breach of conditions as stipulated by the capital provider.

leasing it. Such instruments may therefore involve exposure to market (price) risk in respect of the asset, as well as credit risk in respect of the amount due from the counterparty.¹² This is a unique feature in the case of IIFS, as market risk arises together with credit risk in the context of Sharī'ah-compliant financing operations, giving rise to what may be termed "market risk in the banking book".¹³

68. In the case of **profit- and loss-sharing¹⁴ contracts** (*mushārah* and *muḍārah*) used for financing purposes, an IIFS is exposed to the risk of losing part or all of its capital as a result of operating losses suffered by the enterprise or a fall in the value of its assets. Exposure to such a risk of capital impairment on financing assets is a specific type of credit risk that does not involve contractual default. Likewise, such exposures are dealt with under credit risk, except in the case of investments (normally short-term) in assets for trading purposes, which are dealt with under market risk.

69. In addition to the traditional banking risks (such as credit risk, market risk and liquidity risk), **IIFS are also exposed to other specific risks** (e.g. Sharī'ah non-compliance risk, equity investment risk and rate of return risk) as outlined in IFSB-1. The specific risk factors that should be considered by IIFS in their stress-testing programme, depending on their relevance and applicability, include the following: (i) credit risk for *sukūk*, for real estate financing, and for other exposures; (ii) market risk for equities, *sukūk*, real estate investment, foreign exchange and other exposures; (iii) investment risk for *muḍārah* and *mushārah* exposures; (iv) liquidity risk; (v) rate of return risk; and (vi) operational risk, including Sharī'ah non-compliance risk and reputational risk. IIFS also need to be mindful of default and legal risk (i.e. legal risk arising from the interaction between a Sharī'ah contract and civil law, particularly relevant to the issuance of certain *sukūk*). Such specific risks should be well captured, particularly in stress-testing scenarios and in IIFS-wide stress testing as a whole. The IFSI stress scenarios should also include commodity price shocks (e.g. the prices of gold, silver, crude palm oil, etc.) since a number of IIFS also actively use commodities as part of their operations.

¹² However, in some jurisdictions, IIFS may structure the product with a legally binding purchase undertaking (*wa'd*) issued by the customer that entails a promise to buy the underlying asset at an agreed price at a later date in future. Under such arrangements, the market risk due to price fluctuations is eliminated for the IIFS.

¹³ For instance, in *salam* financing, the IIFS, having paid the purchase price of the subject matter in advance of its delivery, is exposed not just to the credit risk (potential default) of the counterparty but also to the price risk of the subject matter to be delivered.

¹⁴ See footnote 10.

70. An IIFS should also include in its stress-testing programme the specific scenarios to account for the various perspectives of profit-sharing investment accounts (PSIAs).¹⁵ Many IIFS get a significant part of their funding from **unrestricted PSIAs (UPSIAs), which are commingled**¹⁶ with those financed by the IIFS' own funds and current accounts, etc. While, in principle, unrestricted IAHs bear the credit and market risks arising from the assets financed by their funds, shocks to these assets cannot be ignored, as they are likely to have repercussions for the IIFS, such as displaced commercial risk (DCR). In contrast, **restricted PSIAs (RPSIAs) are separately managed funds** that are not commingled with other funds of the IIFS. Shocks to the assets of these funds will generally not have the same repercussions as shocks to those of UPSIAs. This indicates a need for specific stress-testing scenarios to be included in the stress-testing methodologies to account for the various perspectives of PSIAs and their treatment by IIFS in practice.

71. Given the specificities of IIFS, as part of an overall stress-testing programme an IIFS should aim to take account of specific elements in the programme. **Hence, the approach of stress testing to be applied to the IIFS's operations may differ from that applied to conventional banks.** IIFS should perform stress testing on specific portfolios covering, among other things, consumer credit portfolios (i.e. *murābahah* and *ijārah* consumer financing), home purchase financing portfolios (whether by *murābahah*, *ijārah* or diminishing *mushārahah* contracts), real estate (including investment and financing), commodity *murābahah* transactions, and equity investments (i.e. *muḍārahah* and *mushārahah* investments). Consideration should be given to changes in correlations between risks that the IIFS identifies for a given portfolio.

3.3. Stress Designs and Satellite Models

72. The impact on an IIFS's balance sheet on account of macroeconomic stress is assessed by estimating the relationship between macroeconomic variables and the IIFS's risk components. Solvency stress-test models require identification of appropriate risk elements in an IIFS's balance sheet and income statement in order to quantify the potential impact from adverse disturbances in the macroeconomy. The risk components of an IIFS's financial statements are inextricably

¹⁵ While the term "PSIA" is in common use, investment accounts also have features of loss absorbency. Hence, it is more appropriate to refer to *muḍarabah*-based investment accounts as profit-sharing and loss-bearing (by the capital provider) investment accounts, and to *mushārahah*-based investment accounts as profit- and loss-sharing investment accounts.

¹⁶ However, there are other jurisdictions where regulatory requirements require UPSIA to be managed separately from the IIFS' own funds and other deposits.

linked with the performance of the macroeconomy. For instance, balance sheet items at risk from macroeconomic disturbances include held securities, *mushārah/muḍārah*-based project investments, financed assets and real estate assets. On the other hand, income statement items at risk include cost of funds, provisions for non-performing financing, impairments of financing or real estate assets, and so forth.

73. **Macroeconomic stress designs are formulated on the basis of historical data and/or expert judgment on extreme, yet plausible, conditions** in future or may even be established by using externally provided parameters (e.g. stress scenarios given by the European Banking Authority). The time horizon for scenario designs may be between one and three years into the future, describing hypothetical sets of conditions designed to assess the strength of IIFS and their resilience to adverse economic environments. The time horizon needs to be selected by the RSAs, balancing the need to fully capture credit losses that gradually materialise over time with the possibility of larger estimation errors entailed by longer time horizons.

74. While designing macroeconomic shock scenarios, a comprehensive scenario generation process may be followed. This design process should force the stress-testing analyst to think about potential risks in a holistic and consistent manner. Since this is a complex task, it is very helpful to engage in the scenario design process experts from various fields such as macroeconomic forecasting, surveillance, supervision, and statistics and IT. This brings to the table different perspectives on risks and a wide array of expertise. The baseline scenario should aspire to estimate the impact of expected changes in the economy and financial markets on IIFS. Hence, baseline scenarios are designed purely as per the macroeconomic forecasts. The scenario generation process may also benefit from a consultative process on shocks between RSAs and IIFS to achieve more consistent shock scenarios between regulators and market players.

75. The guiding principle for RSAs on extreme, yet plausible, stress scenarios should include high-impact shock events that are in the tail end (e.g. with a probability of occurrence ranging from 5% to as low as 0.1% within a 12-month horizon), or those that are in line with or worse than historical worst, or even taking examples from recent episodes of financial crisis. At times, reverse stress tests may also be conducted that aim to identify the extreme shock scenarios that have the potential to cause a financial system failure in the concerned jurisdiction. In general, RSAs and IIFS must subject portfolios/balance sheets to a series of stress scenarios, which could include past periods during which substantial disturbances occurred, expert judgments on extreme yet plausible conditions in future, and externally provided parameters. IIFS must document

comprehensively relevant information regarding such proxies or externally obtained parameters, including the characteristics, rationale for the use, source and any known limitations thereof.

76. **The relationship between macroeconomic variables in scenario designs and the IIFS's risk components in financial statements is estimated using econometric models,** designed either by the RSAs or by the risk management function of the IIFS. **These econometric models (termed “satellite models”)** estimate the extent of impact (or stress) on the IIFS's financial statement items (e.g. equity investment losses, credit loss provisions, and so on) due to changes in the macroeconomic variables that are included in the shock scenarios designed.

77. The satellite models may be designed to capture the impact on single-risk factors or to incorporate co-movement in multiple risk factors. In a single-risk factor model, the satellite model will capture the impact of a macroeconomic shock scenario on one particular risk. For example, credit risk is the most common risk factor modelled by linking the probability of default (PD) and loss given default (LGD) parameters to macroeconomic variables (or at times to credit ratings frameworks). **This is generally known as sensitivity analysis of risk parameters.** Among the commonly employed techniques used to estimate this relationship are vector auto-regression (VAR), vector error-correction model (VECM), autoregressive distributed lag (ADL) and even ordinary-least-squares (OLS) regressions. Furthermore, panel regression techniques (e.g. dynamic panel modelling with fixed effects) are also widely used.¹⁷

78. On the other hand, **multivariate models may estimate the impact from macroeconomic shock scenarios on multiple risk factors of IIFS financial statements simultaneously** (e.g. credit and market risk parameters) in a process generally termed “**scenario analysis**”. These tests require complex and large structural econometric or dynamic stochastic general equilibrium (DSGE) models.¹⁸

79. All models rely on historical data of the concerned variables and risk components in the IIFS balance sheet to estimate this relationship. In an event where there are imperfections in data (e.g. on account of reliability issues or when the historical time-series of the concerned variables is short), a Bayesian model averaging approach may be used¹⁹ to develop the satellite model equations. Such an approach is particularly useful for modelling banks' risk parameters when

¹⁷ Each econometric technique has its own specific requirements in terms of data quality, modelling structure and programming conduit, while also attracting certain statistical limitations. RSAs need to understand the specific technical needs of each technique and, accordingly, utilise methodologies that best suit their modelling capabilities while also deriving meaningful and statistically significant estimations.

¹⁸ See footnote 14.

¹⁹ As applied in the general top-down satellite model of the European Central Bank.

there are data imperfections, as it allows for more predictor variables (ideally capturing all relevant ones) in explaining the dynamics of a dependent variable and ideally will result in projections that are more robust compared to those of a single equation.²⁰ In other instances, **data proxies or expert judgments are used to account for data imperfections**, as highlighted in section 2.2.

80. The estimated coefficients of the risk parameters, derived from the modelling exercise, may be cross-checked for validity and consistency by comparing with similar historic estimations or peer estimations (either of a peer country or blocs).

81. The **solvency of an IIFS** may be assessed by the use of **the capital adequacy ratio (CAR)**, which is calculated as eligible capital over risk-weighted assets, as well as by the **leverage ratio** introduced in Basel III (Tier 1 capital over total exposures), and as adopted by IFSB-15. The impact on the numerator in each case will be based on credit costs and net losses, subtracted from IIFS capital. The methodology of calculating credit losses may be varied and includes models based on non-performing financing ratios and provisioning rates, or may use the PD and LGD framework to calculate expected losses. Aside from deductions due to specific provisions, the denominator of the CAR consisting of RWA may also be varied should portfolio risk weights be adjusted. For instance, portfolios perceived to be facing higher risks/losses during stress events are likely to require increased risk weights (e.g. due to a ratings downgrade of a counterparty); this has the effect of now requiring a higher capital charge on such portfolios and hence proportionately constituting a higher RWA amount – which, in turn, has the effect of further lowering CAR. A decision on the riskiness of portfolios leading to a shift in risk weights during stress events will be based on sound risk assessment forecasts done by the IIFS for the entire stress-testing time horizon.

82. **The CAR is assessed against the hurdle rate²¹ of the minimum capital requirement of IIFS** in a jurisdiction, which will typically reflect BCBS and IFSB-15 guidelines. For the leverage ratio,²² the minimum value set by both the BCBS and IFSB-15 is 3%.²³ At a minimum, the IIFS's

²⁰ European Central Bank, *A Macro Stress Testing Framework for Assessing Systemic Risks in the Banking Sector*, Occasional Paper Series, No. 152 (2013).

²¹ The hurdle rate is set as the minimum capital requirement to judge the resilience of IIFS and may include total, Tier 1 and Common Equity Tier 1 (CET1) capital ratios. Typically, CET1 hurdle rates range from 4% to 7%, Tier 1 hurdle rates range from 4% to 8%, and total capital hurdle rates range from 8% to 11%. Should an IIFS fall under the category of systemically important bank (SIB) or domestic-systemically important bank (D-SIB), the RSA may require the IIFS to hold additional capital conservation buffers (CCB) or charges, and the hurdle rate for these institutions may accordingly be adjusted upwards.

²² See IFSB-15, paragraph 77, for a detailed leverage ratio definition in Islamic finance.

²³ This value stands true at the time of drafting this TN. However, the value of the leverage ratio (as well as minimum capital requirements) may be revised by both the BCBS and IFSB in line with new developments and studies on this subject matter. Hence, the minimum requirements stated in this TN will accordingly change from time to time, in line

actual CAR must exceed the regulatory minimum set. In the event that this is not the case, the regulator must consider what steps are most effective to regularise or resolve the situation, which may include instructing the senior management and board of directors of the IIFS to raise additional capital. The IIFS itself may assess its overall capital adequacy (as it would usually in an ICAAP), and develop a strategy for maintaining adequate capital levels consistent with its risk profile and taking into account current and anticipated changes in the risk profile. The results of these stress tests should be considered when evaluating the appropriateness of the IIFS's capital plans and internal capital targets, with remedial actions identified to address any potential deficiencies in capital (e.g. review of earnings retention policies to gradually build up additional capital buffers, injection of additional capital by shareholders).

83. In terms of IIFS exposures to be examined in the stress-testing exercise, **the entire financing book, including off-balance sheet items, cross-border financing exposures and consumer exposures**, may be subjected to shocks to examine the impact on regulatory capital from potential losses. Off-balance sheet items under the standardised approach will be converted into **credit exposure equivalents through the use of credit conversion factors (CCF)**. The RSA may undertake to include some exemptions (e.g. overseas financing exposures through subsidiaries) as deemed appropriate.

84. For a capital adequacy framework for IIFS and, specifically, guidelines on RWAs for different IIFS products, off-balance sheet items and so on, RSAs may refer to IFSB-15.²⁴

3.4. Stress-Test Models²⁵

85. In this TN, satellite models are designed to capture solvency stress impact on single-risk factors (credit risk and market risk) from three macroeconomic shock events:

- **Macroeconomic Shock 1:** Recession in the previous year has led to an extremely weakened domestic economic activity – domestic GDP contracts by 2 percentage points.

with new standards and guidelines issued by the relevant international standard-setting bodies. These requirements should therefore be interpreted accordingly.

²⁴ IFSB-15: *Revised Capital Adequacy Standard for IIFS*, December 2013.

²⁵ The stress test models, shocks and scenarios in this TN-2 are not prescriptive; rather, they are suggestive only to offer guidance and are not meant to be exhaustive to cover every aspect and dimension of stress tests. RSAs and IIFS are encouraged to implement principles from this TN-2 into their own appropriate stress test designs with shocks and scenarios built upon historical experiences and expert judgments most appropriate to their economic and financial environment and operational complexity.

- **Macroeconomic Shock 2:** Due to weakened domestic economic activity and internal political turmoil, a prominent external credit assessment institution (ECAI) has cut the country's sovereign rating by two notches (BBB to BB+).
- **Macroeconomic Shock 3:** Expectations of interest rate increases by the US Federal Reserve and tapering in its monthly bond-buying programme – local currency depreciates against a basket of international currencies.

86. The impact from the shocks on the respective credit and market risk portfolios is then transformed as an impact on regulatory capital ratios of five sample IIFS.²⁶ The post-shock regulatory capital ratios are then compared against the minimum total capital hurdle ratio of 8%.²⁷ The respective credit and market risk portfolios and the impact from various shocks are discussed in sections 3.4.1 and 3.4.2.

3.4.1. Credit Risk

Credit Shock 1

87. Macroeconomic Shock 1 is assumed to have produced a **credit shock 1, by *Shari'ah*-compliant contracts, where the unemployment rate in the local economy increases to 25% of the workforce** and causes a substantial increase in the NPFs of IIFS financing portfolios. Satellite models, incorporating focus variables of unemployment of 25% and GDP decline of 2% (in addition to other control macroeconomic variables), derive the results shown in Table 1 for an increase in NPFs across various IIFS portfolios (the dependent variables in the models) segregated by *Shari'ah*-compliant contracts.

Table 1: Modelled Increase in NPFs (%) – Credit Shock 1

<i>Murābahah (collateralised)</i>	25%
<i>Commodity Murābahah (unsecured)</i>	50%
<i>Salam</i>	10%
<i>Ijārah Muntahia Bittamleek (IMB)</i>	20%
<i>Operating Ijārah</i>	30%

²⁶ The dataset is hypothetical.

²⁷ This is an example hurdle rate for the sake of stress tests in TN-2 and is not prescriptive. See footnote 21.

88. The increase in NPFs requires IIFS to undertake **additional provisioning by 30%**²⁸ for each of the portfolios. This increased provisioning **is absorbed by the IIFS, either in its annual profit and loss account (which acts as a first line of defence before losses hit common equity), or, in the case of deficit (i.e. there is insufficient annual profit to absorb the provisions), in part in its common equity (which acts as a second line of defence before a bank is at risk of CET1 insolvency and triggers loss absorption by AT1, and then T2 instruments).**²⁹ During stress events, the likelihood profitability is very low, and hence the ultimate impact from credit losses provisioning is likely to be on regulatory capital.

89. The increased provisions reduce the value of the RWA³⁰ as well as the regulatory capital. This raises the issue of the effect of provisions on the CAR – namely, the regulatory capital in the numerator and the RWA in the denominator. While the increase in provisions **will automatically have a 100% impact on eligible regulatory capital**,³¹ this TN makes a simplifying assumption that **the average risk weight across the whole financing portfolio is at 100%, and hence the reduction in the amount of the RWA (i.e. the denominator of the CAR) due to the increase in provisions is also at 100%.**³²

90. Furthermore, Macroeconomic Shock 1 is also assumed to have produced a **credit shock 1A, where anticipated returns on equity exposures (*mushārah/muḍārabah* investments) and held-to-maturity (HTM) *sukūk* in the banking book are reduced, with increased risk of losses**, and require a substantial increase in the level of provisioning held against such non-payment risks. Satellite models, incorporating a focus variable of GDP decline at 2% (in addition to other control macroeconomic variables), and/or expert judgments based on past trends, produce the results shown in Table 2 for the appropriate level of provision needed to offset risks of non-income flows from banking book exposures.

²⁸ This is an assumed figure for provisioning on the increase in NPFs. Different portfolios should have a different percentage of provisioning, depending upon the underlying mix of assets and their riskiness. For simplicity, here it is assumed that a flat 30% rate of provisions will be applied on the absolute amounts of the respective increase in NPFs.

²⁹ The actual treatment will depend upon the accounting methods/standards as applied in various jurisdictions.

³⁰ Only the specific portfolio provisions reduce the value of RWA; general provisions cannot be deducted from RWA.

³¹ The deductions will be from Tier 1 capital as long as the IIFS remains a “going concern”. However, in the event of a “gone concern”, Tier 2 capital also stands eligible to absorb losses. See footnote 9 for further details.

³² In reality, different Sharī'ah-compliant contracts are likely to have different risk weights ranging from as low as 5% to as high as 400%, depending upon their economic substance, credit ratings (if applicable) and corresponding regulatory treatments. The impact on RWA will also vary should the perceived riskiness of the portfolios change in the light of the stress scenarios and economic shocks (see paragraph 82 of this TN-2). The various assumptions made in the TN (including this 100% impact on RWA) are readily changeable by users by adjusting the numbers in the blue boxes in the respective Excel sheets.

Table 2: Modelled/Estimated Provisioning of Book Value (%) – Credit Shock 1

<i>Equity Position in Banking Book</i>	13%
<i>Sukūk HTM in Banking Book</i>	5%

91. The increase in level of provision required will reduce the value of the RWA as well as the regulatory capital held. This TN makes an assumption that the **increase in provisions will have a 100% impact on regulatory capital, while the impact on RWA based on the risk weights of the respective portfolios in the banking book is as follows: *mushārah/muḍārah* equity exposures at 135%³³ and the HTM *sukūk* portfolio at 100%.**³⁴

92. The post-shock CAR across the Islamic banking system³⁵ and by individual IIFS and specific portfolios (by contracts) can be analysed in the “**Credit Risk**” Excel sheet attached.

Credit Shock 2

93. Macroeconomic Shock 1 is assumed to have produced a **credit shock 2 – by sector**, where the **house price index in the local economy declines by 40%**, causing a substantial increase in the NPFs of IIFS financing by sectors. This exercise allows the stress-testing team to select different shocks to economic sectors and observe how each IIFS would be impacted, depending on the relative size of the banks’ credit exposures to these sectors. Satellite models, incorporating focus variables of house price index declining by 40% and GDP decline at 2% (*in addition to other control macroeconomic variables*), derive the results shown in Table 3 for increase in NPFs across various IIFS portfolios (*the dependent variables in the models*) segregated by sectors.

³³ Based on the Supervisory Slotting Method, where the supervisory category is “Satisfactory”.

³⁴ The various assumptions made in the TN are readily changeable by users by adjusting the numbers in the blue boxes in the respective Excel sheets. These could also be appropriately adjusted to capture the impact across different levels of shock scenarios (e.g. baseline, moderate, extreme).

³⁵ The Islamic banking system comprises aggregated individual IIFS data within a dual system. In this case, a legitimate question that arises is whether RSAs need to stress test Islamic banks as an aggregate (*industry-wide and excluding conventional banks*) separately in dual banking jurisdictions. This question is discussed further in section 3.6.

Table 3: Modelled Increase in NPFs by Sector (%) – Credit Shock 2

<i>Manufacturing</i>	20%
<i>Home Financing</i>	70%
<i>Infrastructure</i>	15%
<i>Financial</i>	30%
<i>Other</i>	25%

94. The increase in level of provision required will reduce the value of the RWA as well as the regulatory capital held. This TN makes a simplifying assumption that the **full increase in provisions is subtracted from the eligible regulatory capital and that the average risk weight across the whole financing portfolio is at 100%; hence, the reduction in the amount of the RWA due to the increase in provisions is also at 100%.**

95. The post-shock CAR by sector (IIFS industry-wide) and by individual banks and specific portfolios (by sector) can be analysed in the “**Credit Risk**” **Excel sheet** attached.

Credit Shock 3

96. Macroeconomic Shock 1 is also assumed to have produced a **credit shock 3 – financing portfolio funded by unrestricted PSIA**,³⁶ where the **unemployment rate in the local economy increases to 25% of the workforce** and causes a substantial increase in the NPFs of IIFS financing portfolios funded by UPSIA. This exercise allows the stress-testing team to analyse how the credit risks on portfolios funded by UPSIA have an impact on regulatory capital.³⁷ **The**

³⁶ For simplicity, the assumption made here is that portfolios funded by UPSIA are segregated from others that are self-funded by IIFS' own funds and/or current and savings accounts. In practice, UPSIA funds may be commingled with other funds and in such cases the respective shares of such portfolios that are funded by UPSIA and by other funds will need to be taken into account.

³⁷ For instance, in some jurisdictions, unrestricted IAH (UIAH) are treated like investors who bear all the earnings volatility and risks of losses on their investment accounts (absent misconduct or negligence on the part of the IIFS). In such cases, the (credit and market risk-weighted) assets financed by the funds of the IAH are excluded from the denominator of the capital adequacy formula. By contrast, in some jurisdictions IAH are treated like a liability of the IIFS, which therefore bears the risk of the assets funded by IAH “(which in the opinion of the Sharī’ah Board of the IDB group is not Sharī’ah-compliant)”; while in other jurisdictions, IAH are only partially risk absorbent so that the IIFS bears part of the earnings volatility of the assets funded by their investment by providing unconditional smoothing. In such a case, IIFS include a corresponding proportion (known as “alpha” (α)) of the credit and market risk-weighted assets financed by UIAH in the denominator of the capital adequacy formula. Such smoothing practices are not normally employed in the case of restricted IAH (RIAH), but where they are, RIAH should be treated for capital adequacy purposes similarly to UIAH.

jurisdiction in question allows smoothing of profits to UPSIA holders and makes use of an alpha factor of 0.5.^{38,39}

97. Satellite models, incorporating focus variables of unemployment at 25% and GDP decline at 2% (*in addition to other control macroeconomic variables*), produce the results shown in Table 4 for an increase in NPFs across various IIFS portfolios (*the dependent variables in the models*) segregated by Sharī'ah-compliant contracts.

Table 4: Modelled Increase in NPFs (%) – Credit Shock 3

<i>Murābahah (collateralised)</i>	25%
<i>Commodity Murābahah (unsecured)</i>	50%
<i>Salam</i>	10%
<i>IMB</i>	20%
<i>Operating Ijārah</i>	30%

98. The increase in NPFs requires IIFS to undertake **additional provisioning by 30%** for each of the portfolios. The increased provisioning requirements will reduce the value of the RWA as well as the regulatory capital. This TN makes a simplifying assumption that the **full increase in provisions is subtracted** from the **eligible regulatory capital** and that the **average risk weight across the whole financing portfolio is at 100%**; hence the reduction in the amount of the RWAs due to the provisions is also at 100%.

99. **Based on an alpha factor of 0.5, the impact on regulatory capital and RWA due to increased provisioning is 50%.**⁴⁰ The post-shock CAR across the Islamic banking system and

³⁸ Supervisory authorities should assess the extent of risks borne by PSIA and reflect these assessments in the computation of capital adequacy for IIFS in their jurisdiction. The main challenge facing IIFS and their supervisors in this connection is to assess the risk-sharing level between IIFS' own capital (shareholders' funds) and that of the UIAH. The proportion of RWAs that needs to be included in the CAR to cater for the transfer of risk from UIAH to IIFS is denoted by "alpha". The supervisory assessment of how an IIFS manages the risk–return mix of PSIA would determine the alpha factor, with a value of alpha near zero reflecting an investment-like product with the investor bearing the commercial risk, while a value of alpha close to 1 would reflect a deposit-like product with the depositor effectively bearing virtually no commercial risk. PSIA could also be positioned anywhere along a continuum between these two cases, depending upon the extent of investment risks actually borne by the IAH. The IFSB issued GN-4 (*Guidance Note on the Determination of Alpha in the CAR for IIFS*) in March 2011, which outlines a methodology for estimating the value of alpha to be used in the supervisory discretion formula in calculating the CAR of IIFS.

³⁹ It is also important to consider the role of a "Stressed Alpha Factor" in stress tests; that is, under more severe and extreme shock scenarios, the level of regulatory alpha is likely to increase, moving closer towards 1. This has the effect of an IIFS bearing greater commercial risks as compared to the investment account holders in order to manage any arising displaced commercial risks and/or reputational risks during major shock events. The RSAs and IIFSs may also consider conducting a sensitivity analysis of PSIA based on setting different regulatory alpha values in stress tests.

⁴⁰ See IFSB-15, section 3.4.5.

by individual IIFS and specific portfolios (by contracts) can be analysed in the “**Credit Risk**” Excel sheet attached.

3.4.2. Market Risk

Market Shock 1

100. Macroeconomic Shock 1 is assumed to have produced a **market shock 1 – severe deflation in local economy**, where the **producer price index in the local economy declines by 30%** and causes a material decline in the market values of IIFS assets in the trading book, available for sale (AFS) or available for lease (AFL), and *salam* commodities receivable. Satellite models, incorporating focus variables of producer price index – declined by 30% – and GDP – declined by 2% (*in addition to other control macroeconomic variables*), derive the results shown in Table 5 for decrease in market values across the following inventory (*the dependent variables in the models*).

Table 5: Modelled Decrease in Market Prices (%) – Market Shock 1

<i>Murābahah Inventory</i>	15%
<i>Salam Commodities</i>	35%
<i>Ijārah Assets</i>	20%

101. The decrease in market prices of assets in trading book portfolios will require the IIFS to absorb these losses, either in its annual profit and loss account (as a first line of defence) or, in the case of insufficiency, in its common equity (as a second line of defence).⁴¹ During stress events, the likelihood of banking sector profitability is very low and, hence, the ultimate impact from trading book losses is on regulatory capital. This TN makes an assumption that the **change in market values in the trading book will have a 100% impact on regulatory capital, while the impact on RWA based on the risk weights of the respective portfolios in the trading book is as follows: *murābahah* AFS, *ijārah* AFL and *salam* commodities⁴² at 187.5%.**

⁴¹ The actual treatment will depend upon the accounting methods/standards as applied in various jurisdictions.

⁴² As per IFSB-15, under the simplified approach, *salam* exposures without parallel *salam* are accorded a 15% capital charge (187.5% risk weight equivalent) on long position of *salam* exposures.

102. The post-shock CAR across the Islamic banking system and by individual IIFS can be analysed in the “**Market Risk**” Excel sheet attached.

Market Shock 2

103. Macroeconomic Shock 2 is assumed to have produced a **market shock 2 – sukūk risk in trading book**, where the **benchmark rate on five-year ijārah sukūk increases by 100bps** and causes a substantial decline in the market values of IIFS *sukūk* investments held in the trading book. Satellite models, incorporating focus variables of benchmark *sukūk* yield – increased by 100bps – and sovereign ratings downgrade from BBB to BB+ (*in addition to other control macroeconomic variables*), lead to the results shown in Table 6 for a decrease in market values across IIFS *sukūk* and ICIS⁴³ portfolios (*the dependent variables in the models*).

Table 6: Modelled Decrease in Market Values (%) – Market Shock 2

<i>Sukūk</i>	30%
<i>ICIS</i>	15%

104. The decrease in fair/market values requires the IIFS to **absorb these losses**. This TN makes an assumption that the **change in market values in the trading book will have a 100% impact on regulatory capital, while the impact based on the risk weights is as follows: *sukūk* at 50% and ICIS at 150%**.

105. The post-shock CAR across the Islamic banking system and by individual IIFS can be analysed in the “**Market Risk**” Excel sheet attached.

Market Shock 3

106. Macroeconomic Shock 3 is assumed to have produced a **market shock 3 – foreign exchange risk in trading book**, where the **local currency to US dollar depreciates by 40%** and causes a substantial change in local currency terms when analysing the net position of IIFS to foreign currency exposures held in the trading book.

107. A deficit in the net position of the IIFS foreign currency exposure in the trading book will lead to losses in local currency terms and require the IIFS to absorb these losses. This trading book loss will reduce the value of the RWA as well as the regulatory capital. This TN makes an

⁴³ Islamic collective investment schemes (ICIS) are a structured financial scheme where investors have pooled their capital contributions in a fund that is established and managed in accordance with Sharī'ah rules and principles. For more details on the ICIS concept, please refer to IFSB-6.

assumption that the impact from the trading book loss from exchange rate adjustments on both RWA and regulatory capital is at 100%.

108. The post-shock CAR across the Islamic banking system and by individual IIFS can be analysed in the “**Market Risk**” **Excel sheet** attached.

Market Shock 4

109. Macroeconomic Shock 1 is also assumed to have produced a **market shock 4 – assets funded by UPSIA**, where the **benchmark rate on five-year *ijārah sukūk* increases by 100bps** and causes a substantial decline in the market values of IIFS *sukūk* investments. It is assumed for simplicity that the total *sukūk* and ICIS portfolio were funded by UPSIA; in case of commingling of funding for these investments, the respective shares would need to be taken into account. **This exercise allows the stress-testing team to analyse how the market risks on portfolios funded by UPSIA have an impact on regulatory capital.** The jurisdiction in question allows smoothing of profits to UPSIA holders and makes use of an alpha factor of 0.5.

110. Satellite models, incorporating focus variables of benchmark *sukūk* yield – increased by 100bps – and a sovereign ratings downgrade from BBB to B (*in addition to other control macroeconomic variables*), produce the results shown in Table 7 for decrease in market values across IIFS *sukūk* and ICIS portfolios (*the dependent variables in the models*).

Table 7: Modelled Decrease in Market Values (%) – Market Shock 4

<i>Sukūk</i>	30%
ICIS	15%

111. The decrease in fair/market values requires IIFS to **absorb these losses**. Based on an alpha factor of 0.5, the **trading book losses will have a 50%⁴⁴ impact on regulatory capital, while the impact on RWA from *sukūk* is at 25% and from ICIS is at 75%.⁴⁵**

112. The post-shock CAR across the Islamic banking system and by individual IIFS can be analysed in the “**Market Risk**” **Excel sheet** attached.

⁴⁴ Since the other 50% are to be borne by UPSIA holders – based on an alpha factor of 0.5.

⁴⁵ As the IIFS is required to assume 50% of the market risks on the portfolios funded by UPSIA, the market risk weights on these portfolios and the corresponding regulatory capital requirements are also 50% of the original risk weights and minimum capital required should the IIFS be 100% responsible for the risks.

3.4.3. Operational Risk: Sharī'ah Non-Compliance

113. Operational risk is defined by the BCBS as the risk of losses resulting from inadequate or failed processes, people and systems, or from external events. **In the IFSI, operational risk for IIFS has an added scope in the form of the losses resulting from Sharī'ah non-compliance and failure to meet their fiduciary responsibilities.** IFSB-1 categorises operational risk in Islamic banks into three main types: general risks, legal risks and Sharī'ah non-compliance risks. While general and legal risks for Islamic banks are similar but not limited to those of conventional banks, Sharī'ah non-compliance is a unique risk for Islamic banks resulting from non-compliance of the institution with the rules and principles of Sharī'ah in its products and services.

114. The IFSB's standards on capital adequacy (IFSB-2⁴⁶ and IFSB-15,⁴⁷ the latter superseding the former) assign a capital charge similar to the Basel II and Basel III framework, respectively – namely, the basic indicator approach (BIA), (b) standardised approach (TSA), and (c) advanced measurement approach (AMA) – in which strategic and reputational risks were excluded because of the difficulty in measuring them. However, it is mentioned that RSAs can apply an additional capital charge to the IIFS if Sharī'ah non-compliance risk (SNCR) is deemed significant. Similarly, IFSB-16⁴⁸ provides discretion to RSAs to impose additional capital charges for operational risk in order to cater for SNCR.

115. In terms of stress tests for IIFS, a specificity for operational risk would be accounting for such Sharī'ah non-compliance events and their potential impact on the profitability and capital adequacy of the tested institution and/or aggregate Islamic banking sector. However, for any meaningful operational risk stress tests encompassing SNCRs, **it is crucial to be able to identify the worst possible impact on capital adequacy and profitability of an IIFS due to a Sharī'ah non-compliance event.** Furthermore, the event should have been material enough to inflict a sizeable adverse impact on the IIFS's profitability and capital adequacy, thus justifying its consideration in the operational risk stress tests.

⁴⁶ IFSB-2: *Capital Adequacy Standard for Institutions (other than Insurance Institutions) offering only Islamic Financial Services (IIFS)*, December 2005.

⁴⁷ IFSB-15: *Revised Capital Adequacy Standard for Institutions offering Islamic Financial Services [Excluding Islamic Insurance (Takāful) Institutions and Islamic Collective Investment Schemes]*, December 2013.

⁴⁸ IFSB-16: *Revised Guidance on Key Elements in the Supervisory Review Process of Institutions offering Islamic Financial Services [Excluding Islamic Insurance (Takāful) Institutions and Islamic Collective Investment Schemes]*, March 2014.

116. To clarify such considerations, the IFSB Secretariat, in partnership with the International *Shariah* Research Academy for Islamic Finance (ISRA), recently conducted a study⁴⁹ on a sample of Islamic banks across 11 countries to understand the extent of Sharī'ah non-compliant income (SNCI) as compared to an Islamic bank's total assets, total equity and total net income. The findings in this study reveal that **SNCI is not material enough to warrant additional capital requirements, and that current approaches used for calculating operational risk sufficiently cover the wider set of operational risks.** The level of the SNCI is negligible in most cases (as found in this study), and it should be noted that not all SNCR events result in financial loss as most can be rectified or purified without implications for capital adequacy.

117. Hence, premised on the above findings, **IIFS may continue to employ the traditional operational risk stress-testing mechanisms until such time as there are further developments.** In October 2014, the BCBS published its "Consultative Paper on Operational Risk: Revisions to the Simpler Approaches",⁵⁰ which suggests modifications to the existing framework for the calculation of capital charge for operational risk. This consultative paper offers a refinement to the proxy measure, as well as consideration of other factors such as the size and revenue of the bank. Nonetheless, RSAs have discretion to impose additional capital charges for operational risk as the authority deems fit, either collectively as a market or individually at the IIFS level.

118. RSAs and IIFS should ensure that they collect adequate information on material developments in the SNCR, including pertinent information on current and emerging SNCR exposures and vulnerabilities. The main challenge is the quality and comprehensiveness of the SNCR information that an RSA receives or an IIFS provides. In line with the recommendations of IFSB-4, RSAs should provide a detailed and well-rounded set of guidelines for the disclosure requirements on SNCR. It is also crucial to set up key risk indicators for identifying the SNCR inherent in different kinds of Sharī'ah-compliant contracts, and to outline a set of variables that help to estimate the likelihood and severity of SNCR.

119. Furthermore, SNCR may also lead to reputational risk, which is excluded from the definition of operational risk for capital charge under Basel III – Pillar 1. It is possible for IIFS to become insolvent because of the reputational risk that is triggered by the SNCR. Therefore, the

⁴⁹ IFSB-ISRA Joint Research Paper, "Sharī'ah Non-compliance Risk in the Banking Sector: Impact on Capital Adequacy Framework of Islamic Banks", [www.ifsb.org/docs/2016-03-30%20SNCR%20Paper%20\(WP-05\)%20\(Final\).pdf](http://www.ifsb.org/docs/2016-03-30%20SNCR%20Paper%20(WP-05)%20(Final).pdf).

⁵⁰ BCBS, "Operational Risk: Revisions to the Simpler Approaches", Consultative Paper, www.bis.org/publ/bcbs291.pdf, October 2014.

SNCR can be evaluated under Pillar 2 (Supervisory Review Process) by the RSAs. Pillar 2 provides a more effective tool for RSAs to use in dealing with this subject, as outlined in IFSB-16.

120. Apart from purely technical considerations of capital adequacy calculations, it is important to consider SNCR as one of the main risks that the RSAs and IIFS must take into account as part of their enterprise-level risk evaluation. IIFS should be aware of the implications of SNCR for the overall enterprise when Sharī'ah requirements and rulings are not effectively communicated, translated into internal policies, or observed by the institution across different businesses and functional units.

3.4.4. Rate of Return Risk (Banking Book)

121. Rate of return risk in the banking book (RRRBB) of an IIFS⁵¹ is analogous to interest rate risk in the banking book in conventional banks, which is defined by the BCBS as current or prospective risk to the bank's capital and earnings arising from adverse movements in interest rates that affect the bank's banking book positions.⁵² **In the IFSI, RRRBB of an IIFS arises from the possible impact on the IIFS's capital and net income arising from changes in market rates and, more specifically, relevant benchmark rates,⁵³ by way of their impact on the actual returns on assets⁵⁴ and payable on funding.⁵⁵** One major source of this risk is re-pricing mismatches between assets (with longer maturities) and liabilities or UPSIA (with shorter maturities), as a result of which increases in the cost of funding are not matched (whether in extent and/or timing) by increases in the rates of return on assets. Specific to the case of assets funded by PSIA, RRRBB leads to displaced commercial risk if the IIFS absorbs all or part of any shortfall in the returns payable to IAH⁵⁶ by reducing its *muḍārib* share or by donation from the shareholders' share of income (see IFSB-1 and IFSB-12 for details).

⁵¹ It should be noted that rate-sensitive assets held in the trading book of an IIFS are treated under market risks and, hence, are covered under market risk stress tests.

⁵² BCBS Standards, *Interest Rate Risk in the Banking Book* (April 2016).

⁵³ Benchmark rates may include non-interest rate measures (e.g. commodity prices, inflation rates, etc.).

⁵⁴ Rate-sensitive assets – that is, financing and investments held in the banking book.

⁵⁵ Although, contractually, no returns are to be paid on *qarḍ* and *wadī'ah*-based current and savings accounts, these may be rate-sensitive liabilities on account of displaced commercial risks to the IIFS – that is, the risk of sudden withdrawal of these funds by depositors due to expectations of higher rates of *hibah*, leading to substantial adverse impacts to the liquidity of the IIFS. Note that the practice of providing *hibah* to *qarḍ* and *wadī'ah*-based current and savings accounts is not in line with Sharī'ah rules and principles according to the opinion of the Sharī'ah Board of the IDB group. However, there is diversity in practice among jurisdictions, as some Sharī'ah boards have no objection to the payment of *hibah* on the above accounts provided the payment is voluntary and fully at the discretion of the Islamic bank.

⁵⁶ Contractually, IAH should accept any return decided on the basis of a pre-agreed profit-sharing ratio, which may be higher or lower than their initial expectation. Similarly, IAH are also expected to bear any losses on the assets funded from their investment, provided there is no negligence, fraud, misconduct or breach of contracted terms by the IIFS.

122. **Excessive RRRBB can pose a significant threat to IIFSs' current capital base and/or future earnings (solvency issues) if not managed appropriately. It can also lead to liquidity issues if a sudden withdrawal of funds is initiated by IIFS depositors/IAHs.**⁵⁷ Accordingly, an effective risk management process encompassing RRRBB is essential to the safety and soundness of IIFS.

123. Sound RRRBB risk management involves the application of four basic elements in the management of assets and liabilities:

- a. appropriate board of directors and senior management oversight;
- b. adequate risk management policies and procedures;
- c. appropriate risk measurement, monitoring and control functions; and
- d. comprehensive internal controls and independent audits.

The specific manner in which an IIFS applies these elements in managing its RRRBB risk will depend upon the complexity and nature of its activities, as well as on the level of RRRBB risk exposure.

124. There are two complementary methods of measuring the potential impact of RRRBB:

- a. changes in expected earnings (earnings-based measures); and
- b. changes in economic value (EV, or EVE when measuring the change in value relative to equity).

The two methods are complementary in that both measures reflect the impact of changing cash flows arising from changing benchmark rates; and the change in expected earnings is reflected in the change in economic value, while both are also affected by common assumptions.

125. Both measures of RRRBB are significantly impacted by assumptions made for the purposes of risk quantification; for instance, the range of shocks to the possible changes in the level, slope and shape of benchmark rate yield curves that are required to produce an RRRBB effect on EV or earnings and the economic stress scenarios that would be consistent with these shocks.

Despite these contractual features, many IIFS consider at least their UPSIA as behaving like conventional depositors, who might withdraw their funds in the case of lower-than-expected profit rates, posing a liquidity risk for the IIFS. To mitigate this risk, many IIFS smooth the profits payout to their IAH, particularly UPSIA. The IIFS should fully take into account its practices, regulatory requirements, if any, and accounting conventions related to smoothing, especially the establishment of profit equalisation reserve (PER) and investment risk reserve (IRR), while analysing the interaction of liquidity risk with RRRBB and displaced commercial risk.

⁵⁷ Aspects related to sudden withdrawal of funds by depositors/IAH are covered in liquidity stress tests in Section 4.

126. Measurement of RRRBB should be based on outcomes arising from a wide and appropriate range of shock and stress scenarios affecting the benchmark rates of return. The identification of relevant shock and stress scenarios for RRRBB, the application of sound modelling approaches and the appropriate use of the stress-testing results require the collaboration of different experts within an IIFS (e.g. treasury department, finance, risk management and risk control, and/or the IIFS's economists).

127. A stress-testing programme for RRRBB should ensure that the opinions of the experts are taken into account. Modelling assumptions should be conceptually sound and reasonable, and consistent with historical experience while also forward-looking to capture emerging risks in the upcoming 6–12 months. The assumptions should include parallel and non-parallel rate movement, re-pricing risk, yield curve risk, basis risk and option risk under both severe and plausible stress scenarios. IIFS must also carefully consider how the exercise of the behavioural optionality (e.g. prepayments, exercising of options, etc.) will vary under the benchmark rate shock and stress scenario.

128. It is essential that IIFS have RRRBB risk measurement systems. A number of generally accepted techniques (such as gap analysis, duration gap analysis, and static and dynamic simulation techniques) are available for measuring the RRRBB risk exposure of both earnings and economic value. Regardless of the measurement system, IIFS should note that the usefulness of each technique depends on the validity of the underlying assumptions and the accuracy of the basic methodologies used to model RRRBB risk exposure. The IIFSs' risk management system must also be robust to be able to identify and quantify the major sources of RRRBB exposure, ranging from simple calculations based on static simulations using current holdings to more sophisticated dynamic modelling techniques.

129. Supervisory authorities should obtain from IIFS sufficient and timely information with which to evaluate their level of RRRBB risk. This information should take appropriate account of the range of maturities and currencies in each IIFS's portfolio, including off-balance sheet items, as well as other relevant factors, such as the distinction between fixed rate and variable rate Sharī'ah-compliant contracts. Supervisory authorities may want to collect additional information from IIFS on those positions where the behavioural maturity is different from the contractual maturity.

130. Supervisory authorities should particularly assess whether:

- a. the internal measurement systems of IIFS adequately capture the RRRBB risks in their banking book – in particular, that they are capable of measuring risk using both an earnings and an economic value approach; and
- b. the standardised benchmark rates shock (expressed in percentage terms reflecting a stressful rate environment) has been properly incorporated into the systems if this was determined by the respective supervisory authority. In the case where the standardised benchmark rates shock was based on the assessment and analysis of IIFS themselves, the supervisory authority must assess its appropriateness.

131. If supervisory authorities determine that an IIFS has insufficient capital to support its RRRBB, they should consider remedial action, requiring the IIFS either to make a reduction in the risk or to hold a specific additional amount of capital, or a combination of both. Supervisory authorities should be particularly attentive to the capital sufficiency of “outlier IIFS” – as a minimum criterion, outlier IIFS are those whose RRRBB risk in the banking book leads to an economic value decline of 15% of the Tier 1 capital following a standardised benchmark rate shock or its equivalent.⁵⁸

132. Accompanying this TN is a basic stress template for RSAs and IIFS for measuring RRRBB from an earnings-based measure using gap analysis between rate-sensitive assets and rate-sensitive liabilities (see Excel Sheet “2.4 Rate of Return Risk”). Both RSAs and IIFS are encouraged to explore, design and develop their own stress test(s) that are technically more advanced and appropriate for their economic and financial environment and jurisdiction complexity.

133. For the sake of simplicity, the accompanying “Rate of Return” Excel template uses a single time horizon (i.e. Year 1) to conduct the stress tests and discuss the results. RSAs and IIFS are encouraged to conduct stress tests over multiple time periods and as required by regulations (e.g. a period of three to five years for ICAAP) to achieve a longer time-period assessment of capital adequacy. The normal focus is on the short/medium-term horizon (typically one to three years, no more than five years), to limit the cumulative impact of underlying assumptions and the complexity of the calculations.

134. The rate-sensitivity characteristics of assets and liabilities/UPSIA may well vary between jurisdictions, and also between IIFS within a jurisdiction. The assets typically likely to be rate-

⁵⁸ The minimum criterion of outlier IIFS stipulated in TN-2 reflects the revised standard adopted by the BCBS in its April 2016 document. The criterion previously stipulated by BCBS (July 2004) and by IFSB-16 (March 2014) was comparatively less stringent at “an economic value decline of more than 20% of the sum of Tier 1 and Tier 2 capital”.

sensitive will include financing based on variable rates – for example, *ijārah* contracts where the rental rate of return is benchmarked to some varying measure, and *ijārah sukūk* instruments held in the banking book with returns benchmarked to a varying indicator and to be re-priced at set durations (e.g. three months, six months, etc.). On the liabilities side, and as discussed earlier, it will include deposits and investment accounts that are deemed to face withdrawal risks should returns serviced on them not conform to customer expectations based on changing market benchmark rates.

135. An IIFS is expected to evaluate its assets and liabilities portfolios appropriately to identify all those facing potential RRRBB exposures. RSAs may also wish to provide more clarity and details to standardise the calculations by IIFS – for instance, how to classify exposures that have no-maturity into maturity buckets, how to classify off-balance sheet items, and so on. Both RSAs and IIFS should understand the risk profile of the assets and liabilities relevant in their own jurisdiction and reflect that accordingly in the stress test – for example, a restricted PSIA that totally mitigates RRRBB may be excluded from its stress test. Similarly, deposits that do not offer any returns/*hibah*⁵⁹ may also be treated differently.

136. The net impact on the income of an IIFS due to a shift in benchmark rates will depend upon the gap between rate-sensitive assets and rate-sensitive liabilities. For example, in a scenario of an increase in benchmark rates with a pre-existing negative gap (with rate-sensitive liabilities exceeding rate-sensitive assets) the outcome will be a negative impact in the income of an IIFS. Ideally, the RRRBB stress-test template should match the different sets of benchmark rates to their corresponding portfolios (based on different maturities and risk profiles – e.g. A1 (rating): 6 months (duration); AAA: 1.5 years, etc.) and stress test them separately. However, the accompanying “Rate of Return Risk” Excel template is a basic stress-test template. Although it segregates rate-sensitive assets and liabilities by different maturity buckets, it exposes the cumulative gap between all rate-sensitive assets and liabilities to a single stress-test variable – that is, the shifting benchmark rate of return. This is a simplifying assumption where a shift in a single benchmark rate of return indicator is assumed to capture the impact on returns, on average, across all assets and liabilities exposed to RRRBB.

137. In the initial scenario, as encapsulated in the accompanying “Rate of Return Risk” Excel template, of a negative rate-sensitive assets and liabilities gap, a potential 2.5%⁶⁰ upward shift in

⁵⁹ See footnote 55.

⁶⁰ This value is a variable that the person performing the stress test can change – see the blue cell in the accompanying “**Rate of Return Risk**” Excel template.

benchmark rates will result in a net increase in the total amount needed to pay the IIFSS' fund providers.⁶¹ This increased amount **is absorbed by the IIFS in its annual profit and loss account, or, in the case of deficit (i.e. there is insufficient annual profit to absorb the increased returns payable to fund providers), in part in its common equity.**⁶² During stress events, the likelihood of profitability is low, and hence, the ultimate impact from increased returns to fund providers is likely to be on regulatory capital.

138. The template is based on the assumption that 100% of the impact on net income arising from the shock due to the RRRBB stress event is deducted from the regulatory capital.⁶³ The post-shock CAR across the Islamic banking system and by individual IIFS can be analysed in the “**Rate of Return Risk**” Excel sheet attached.

3.5. Review and Analysis of the Results

3.5.1. Sensitivity Analysis

139. The sensitivity stress tests conducted in section 3.4 highlight some interesting results (summarised in Table 8 below).

⁶¹ Assuming that the IIFS will also willingly and at its own discretion pay, on average, an increased 2.5% return to the fund providers.

⁶² The actual treatment will depend upon the accounting methods/standards as applied in various jurisdictions. Furthermore, regulatory capital would be reduced only if the rate of return mismatch resulted in a loss to be borne by the IIFS willingly and at its own discretion.

⁶³ This is based on the further assumption that there are zero profits prior to the shock, and that the impact of reduction in net income, arising from the shock, is transferred as a loss to be absorbed by the regulatory capital. The person performing the stress test can change this assumption. Note that current-period profits constitute the first buffer to losses arising from a shock.

Table 8: Summary of IIFS Capital Adequacy (%) Post Credit and Market Shocks

Shocks	All IIFS (Industry-wide)	IIFS 1	IIFS 2	IIFS 3	IIFS 4	IIFS 5
Credit Shocks 1 & 1A	7.7	7.6	7.6	7.7	8.1	7.4
Credit Shock 2	8.0	8.0	7.9	7.9	8.4	7.7
Credit Shock 3	8.2	8.3	8.1	8.2	8.6	8.0
Market Shock 1	8.2	8.3	8.0	8.1	8.6	8.0
Market Shock 2	7.5	7.8	7.3	6.4	8.2	7.4
Market Shock 3	8.3	8.3	8.1	8.3	8.7	8.2
Market Shock 4	8.0	8.1	7.8	7.4	8.5	7.8

Note: Hurdle rate = 8% total capital. Figures in red indicate CAR below the hurdle rate.

140. From an **industry-wide perspective**, the **Islamic banking sector as an aggregate is able to withstand credit shocks 2 and 3**, while the total capital adequacy falls **below the hurdle rate in an event of credit shocks 1 and 1A**. In particular, credit shock 3, which was stress-tested upon segregated assets funded by UPSIA, highlights how the **loss-absorbency features of investment accounts help to sustain better capital adequacy** for Islamic banks as compared to the conventional banks. Credit shocks 1 and 3 are identical in their macroeconomic magnitude. They differ to the extent that credit shock 1 was applied to portfolios assuming no risk bearing by UPSIA, while credit shock 3 was applied assuming an alpha factor of 0.5 in relation to risk exposures of UPSIA.

141. **From a market shock perspective, the Islamic banking sector also appears resilient.** In three instances (market shocks 1, 3 and 4), the industry-wide capital adequacy survives above the hurdle rate. **Only in market shock 2**, when stress hits the *sukūk* market, does the Islamic banking sector **capital adequacy fall below the hurdle rate. Reinforcing the loss-absorbency features of UPSIA, market shock 4 in fact survives the stress test**; market shock 4 is identical to market shock 2 and differs only to the extent that market shock 2 was applied on portfolios

assuming no risk bearing by UPSIA, while market shock 4 was applied assuming an alpha factor of 0.5 in relation to risk exposures of UPSIA.

142. When analysing results from an **institutional-level perspective**, a weak IIFS with capital adequacy falling below the hurdle rate is identified in more instances, **even when the Islamic banking sector as an aggregate is identified as surviving the stress tests**. This enables RSAs to identify specific institutions that are financially vulnerable to macroeconomic adversities. In particular, **IIFS 2, 3 and 5 are the more vulnerable institutions as they fail capital adequacy stress tests in four out of seven shock events**. On the other hand, **IIFS 4 is identified as being most resilient, as it does not fail any shock event**.

143. From a **portfolio perspective**, by *Shari'ah*-compliant contracts, **operating *Ijārah* and commodity *murābahah* transactions appear to experience the highest rates of NPFs** and expose the respective IIFS to higher proportionate amounts of provisioning. These are mainly due to the **uncollateralised nature** of both these contracts. Commodity *murābahah* is used by the IIFS to structure unsecured financing products for clients; hence, in a stress event, these products face higher instances of non-performance. Similarly, in an operating *ijārah*, the lessee leases the underlying asset without an intention to buy the asset. As such, the lessee is more likely to default on lease payments during stress events since it is not the owner and not at risk of losing the underlying asset.

144. From a sector-exposure perspective, **home financing appears to experience the highest rate of NPF** and exposes respective IIFS to higher proportionate amounts of provisioning. In contrast, **the infrastructure sector had the least comparative amount of NPF, mainly since the exposure is usually to the public sector/government** as the ultimate servicer of the financing facility.

145. In general, often single-risk factor sensitivity stress tests are criticised for not being “stringent enough” or “sufficiently extreme” to predict financial-sector meltdown should macroeconomic turmoil events occur. It is argued that in the macroeconomic context, changes in several risk factors are typically interrelated. In this regard, **scenario analysis that combines various risk factors into a single scenario is utilised**. The following section reviews stress-test results from a simplistic scenario analysis that **proportionately consolidates impact on regulatory capital** from both credit risks and market risks simultaneously.

3.5.2. Scenario Analysis

146. The main reason for using scenarios rather than single-factor shocks is that, in the macroeconomic context, changes in several risk factors are typically interrelated. The “**Scenario Analysis**” Excel sheet⁶⁴ attached provides a simplistic template of how a common macroeconomic shock impacts on both credit and market risks, and of the resulting impact on regulatory capital and capital adequacy of the institutions and the aggregate financial sector. The data and conditions in this analysis are the same as previously explored individually in the credit risk and market risk sections.

147. The scenario stress tests shown in Table 9 highlight some interesting results when compared to the results explored in the previous section.

Table 9: Summary of IIFS Capital Adequacy (%) Post Macroeconomic Shocks

Shocks	All IIFS (Industry-wide)	IIFS 1	IIFS 2	IIFS 3	IIFS 4	IIFS 5
Macroeconomic Shock 1 Credit Shocks 1 & 1A Market Shock 1	7.5	7.4	7.3	7.4	7.9	7.2
Macroeconomic Shock 2 Credit Shock 2 Market Shock 2	6.0	6.2	5.8	4.9	6.9	5.8

Note: Hurdle rate = 8% total capital. Figures in red indicate CAR below the hurdle rate.

148. When the impact of each macroeconomic shock on credit and market risks is considered simultaneously, **there is a substantial capital reduction causing the aggregate Islamic banking sector’s capital adequacy to fall below the established hurdle rate.** Macroeconomic

⁶⁴ For simplicity of presentation, the “Scenario Analysis” Excel sheet contains only formulas linked to the other sheets – namely, “Credit Risk” for credit risk and “Market Risk” for market risk. In addition, it is assumed that credit and market risks are having an impact on regulatory capital in equal proportions in the common shock scenario. However, realistically, scenario analysis should accord appropriate weights to the different types of risks; studies in conventional finance indicate that credit risks account for as much as 80% of a bank’s total risk; followed by operational risk at 15% and market risk at 5%. RSAs and IIFS are expected to identify the appropriate risk weights for different types of risks applicable to the IFSI in their jurisdictions and which can go towards conducting robust scenario stress-test analysis. Intuitively, IFSI may have a higher proportion of market risk element as compared to that witnessed in the conventional finance sector.

Shock 2, where a prominent ECAI has cut the country's sovereign rating by two notches (BBB to BB+), is the more severe shock for the country's Islamic banking sector.

149. Among individual institutions, **all IIFS fail the stress tests**. IIFS 3 is severely affected by Macroeconomic Shock 2, as its capital adequacy falls below 5%, while IIFS 5 is the most impacted in Macroeconomic Shock 1.

150. The **impact from macroeconomic shocks varies from IIFS to IIFS**, which enables each IIFS (and RSA) to identify its specific vulnerabilities and where it needs to be aware and/or take remedial action.

151. Overall, the scenario analysis highlights that **common macroeconomic shocks have the propensity to impact multiple risk factors simultaneously**, which has critical implications for the capital adequacy of individual IIFS and the aggregate financial sector.

3.6. Role of RSAs and Critical Considerations

152. **Stress tests are complementary to other tools for financial stability analysis**. Results from stress tests do not automatically trigger any action. The process is intended to help an IIFS in identifying key sources of vulnerability and in taking corrective actions to enhance its resilience to shocks.

153. **Supervisory authorities need to undertake immediate remedial action to ensure that vulnerable IIFS are better capitalised in relation to their risk exposures**. This would also involve enhanced vigilance of flagged institutions along with necessary follow-up actions and reporting, as has been discussed in Section 2. These actions may also include placing limits on IIFS portfolio evolutions over time and/or gradual downsizing of risk exposures in specific portfolios that are identified to be vulnerable going forward. The IIFS itself may propose to the RSA collective management actions and strategies it will undertake for maintaining adequate capital levels consistent with its risk profile and taking into account current and anticipated changes in the risk profile. The RSA may use this proposed strategy as an input to determine any potential policy action arising from stressed conditions. The IIFS's proposed management actions and strategies must be realistic, approved by its board of directors and aligned with the approved risk appetite, while also remaining within the constraints imposed by legislation, regulation and the RSA.

154. When considering system-wide stress tests (the entire banking system) in dual-banking jurisdictions, a question legitimately arising is whether RSAs need to stress test Islamic banks as an aggregate (*industry-wide and excluding conventional banks*) separately. In most countries, Islamic banks are only part of the overall banking system, which also consists of conventional counterparts. Often, the Islamic banking sector constitutes the smaller market share of the overall banking system. Under these conditions, **how should the RSA conduct a system-wide stress test: (1) separately for IIFS and conventional banks; or (2) as a combined exercise consisting of the top and major IIFS and conventional banks?**

155. When considering a combined exercise, a problem arises in that the stress tests for IIFS differ in some technical respects from those used for conventional banks. As a result, would a conventional stress test on the entire banking sector (including IIFS) be appropriate and sufficient for RSAs to gauge the health of the financial system? Similarly, an RSA may not be able to stress test the entire banking sector (Islamic plus conventional banks) using the IIFS stress-testing templates, since these require specific IIFS data that are obviously not available for conventional banks. Even, for instance, if a jurisdiction comprises a 75% market share for Islamic banks and 25% for conventional ones, an RSA would not be able to accurately stress test conventional banks using IIFS templates as the cohort of conventional banks will not be able to meet the data requirements of the IIFS templates.

156. The question that begs deliberation, therefore, is whether RSAs need to combine or segregate these two banking systems when it comes to system-wide stress tests. If a combined exercise is preferred, how would the methodology of stress tests be designed to cover effectively both types of banking institution? An important consideration is the respective proportions of the overall dual system represented by the two systems – Islamic and conventional.

157. A possible approach in this regard could be to conduct industry-wide stress tests of IIFS (excluding conventional banks) as a separate exercise, and to consider including only the industry-wide (all IIFS) stress test results as a single and aggregated Islamic banking component alongside conventional banks in the broader system-wide stress-testing framework.

158. The advantages of such a method are three-pronged: (1) all IIFS are individually subjected to appropriate stress tests, enabling the RSAs to identify problem banks (if any); (2) it provides the RSAs with an outlook on the aggregated performance and resilience of the Islamic banking sector under stressed conditions; and (3) by inserting an aggregated Islamic banking component in the broader stress-testing framework alongside conventional banks, the RSA can gain an indication of joint (conventional and Islamic) system-wide banking sector vulnerabilities under

stressed conditions (if any). By inserting only an aggregated component of IIFS, the numbers need to be adjusted only once for the IIFS results to fit into the conventional system-wide framework.

159. This method rests particularly well in dual-banking system jurisdictions where the Islamic banking sector is small. However, in the case where a jurisdiction has an IIFS that has achieved a sizeable and material market share of the domestic banking sector, this IIFS could be added as a separate component in the system-wide stress-testing framework, in addition to the other aggregated data on Islamic banks and conventional banks. The final decision on the inclusion of either all or some Islamic banks in the industry-wide and/or system-wide stress test rests with the local RSA, which will take an appropriate decision depending upon several considerations – for example, the market share of Islamic banks in the domestic banking system, the systemic importance of one or more Islamic banks in the system, the profitability and interconnectedness of Islamic banks in the system, and so on.

160. An additional critical consideration for stress tests relates to groups with conventional parent banks that operate either Islamic subsidiaries or Islamic window operations.⁶⁵ In the first case where a conventional parent operates an Islamic subsidiary, in general, Islamic subsidiaries are to stress test their balance sheets separately using methodologies suited to account for the specificities of the IFSI. This may include an additional set of customised shock designs and scenarios, separate from those at the group level, which are more applicable and relevant to the Islamic subsidiary's business.⁶⁶ A logical challenge arising from such an approach would be the consolidation of stress test results at the group level at a later stage. Here, the approach proposed in paragraphs 157–159 for the system-wide stress test could also be applied in group-wide stress tests in order to address this challenge of consolidation.

161. In the second case where a conventional parent bank operates Islamic window operations, ideally, the window's operations should be stress tested separately with customised stress test shocks and designs as discussed for subsidiaries in paragraph 160⁶⁷.

⁶⁵ See footnote 5.

⁶⁶ These may include different types of risk exposures, different sets of clients and risk concentrations, vulnerabilities to the real sector and commodity shocks, etc. See the discussion in section 3.2 on risk specificities of IIFS' business.

⁶⁷ The stress testing exercise should in no way violate the principle of separation of funds of the two businesses. However the RSA and conventional bank may wish to assess factors that might lead them in some cases to waive separate stress tests for the windows and parent bank for assessing the same types of risks, in view of the substantial costs and complex formulation of assumptions required for separate stress tests and in the light of materiality of risks posed by window operations to the parent.

162. In both cases highlighted in paragraphs 160 and 161, the final decision on the choice of the appropriate stress test rests with the local RSA, which will take a decision depending upon the type and nature of businesses and risk exposures that IIFS subsidiaries/windows are permitted to undertake in the jurisdiction.

Section 4: Liquidity Stress Tests

4.1. Introduction

163. Liquidity risk plays an important role in managing the soundness and stability of the financial system, as evidenced during the turmoil faced by the global financial sector in 2007–9. The financial crisis highlighted a pre-crisis lack of sound liquidity risk management in financial institutions. An idiosyncratic liquidity risk in a bank became systemic through direct and/or indirect linkages within the financial system in a very short period of time, resulting in the whole global financial system coming to a halt. An important prudential tool developed since the crisis to help in the effective management of liquidity risks, and to protect the financial system against similar negative liquidity events, is the liquidity stress test, which helps financial institutions and RSAs to identify liquidity risk with extreme, yet plausible, idiosyncratic and market-wide liquidity stress scenarios.

164. Relatively less attention was paid before the financial crisis by standard-setting bodies, RSAs and banks, including IIFS, to the analysis of liquidity and its components, cash flow and maturity mismatch, compared to analysis of banks' capital. When the banks were hit by severe idiosyncratic funding shocks, the banking sector was affected by a liquidity crisis, with some central banks having to take unconventional measures to provide funding to solvent but illiquid banks. The crisis soon illustrated the importance of liquidity risk within stress-testing frameworks.

165. As expected, liquidity stress tests are not currently as well developed as credit and market risk stress tests, although there is now increased interest in the threats posed by liquidity risks as a result of the financial crisis and it is now assumed to be one of the main risks for the banking sector, including IIFS. The IIFS and RSAs have realised the importance of liquidity risk management, and have incorporated the formal stress-testing programme into their liquidity risk management frameworks.

166. The main reasons for the comparatively low level of development in the area of liquidity stress testing are: (a) liquidity crises are very low-frequency/high-impact events; (b) liquidity risk management was underestimated before the 2007–9 crisis; and (c) all liquidity crises are somehow different, making it difficult to standardise stress assumptions.

167. The RSAs and IIFS are endeavouring to be more alert to the liquidity position of IIFS and to manage this risk. It is important for RSAs and IIFS to have information about the liquidity position of IIFS in order to understand the risks IIFS take and how best to mitigate those risks.

4.2. Liquidity Risk of IIFS

168. Liquidity risk is the potential loss to IIFS arising from their inability either to meet their obligations or to fund increases in assets as they fall due without incurring unacceptable costs or losses. It has two aspects: (a) funding liquidity risk, and (b) market liquidity risk. Funding liquidity risk arises from expected and unexpected current and future cash flow and collateral needs. Market liquidity risk arises when an IIFS cannot easily offset or eliminate a position at the market price because of inadequate market depth or market disruption.

169. It is important to have a good understanding of the key drivers of liquidity of IIFS in order to be able to identify issues affecting sound liquidity stress-testing design. Additionally, IIFS often have additional challenges for sound liquidity risk management as compared to the conventional banks. The two main sources of fund generation for liquidity purposes used by conventional banks are not applicable to IIFS: (a) interest-based financing from the interbank market; and (b) in most jurisdictions, transfer of debt assets, other than at their face value or in exchange for a commodity.

170. The shortage or unavailability of Sharī'ah-compliant securities/*sukūk* in many jurisdictions adds to these problems. IIFS therefore tend to hold and maintain high levels of cash and non-earning liquid assets compared to the conventional banks. Overall, the inability to quickly raise alternative funding due to an absence of established Sharī'ah-compliant money markets exposes an IIFS to substantial liquidity risks.

171. From a market perspective, the unavailability of an active Sharī'ah-compliant trading or repurchase (repo) market remains an ongoing problem. In addition, most jurisdictions lack any form of a *Sharī'ah*-compliant lender-of-last-resort (SLOLR) scheme to protect the soundness and stability of IIFS in situations of serious liquidity stress.

172. From the perspective of liabilities, IIFS generally have two types of income-generating accounts: unrestricted and restricted PSIA, the latter being normally accounted for “off balance sheet” and so not actually appearing on the liabilities side. There is also an increasing use of commodity *murābahah* transactions- (CMT-) based term deposits. In principle, the profit- and loss-sharing (PLS) nature of IIFS has reduced liquidity risk problems, since if the investment account holder does not have the right to make withdrawals at short notice, liquidity stress events affecting PSIA concern the IAHs and not the IIFS itself. However, because of the common practice in the market, unrestricted IAH commonly have withdrawal rights at short notice before maturity, which leads to unexpected cash outflows in times of stress as in conventional banks. (See the treatment of “run-off” in the IFSB’s GN-6 on liquidity risk.) If liquidity risk problems emerge, Islamic

banks have limited options to employ Islamic money market instruments or requests to the central bank for an emergency liquidity facility on a Sharī'ah-compliant basis. Moreover, deposits and PSIA generated by the IIFS are not covered by a reliable Sharī'ah-compliant deposit insurance scheme in most jurisdictions. In addition, CMT-based term deposits tend to have short tenors and run-off on maturity; they require a specific decision from the depositor to be rolled over.

173. From the perspective of difficulties and restrictions faced by IIFS even in normal times, the liquidity stress-test scenarios and assumptions for IIFS should be carefully analysed by both IIFS and RSAs. In particular, determining the liquidity characteristics of assets of IIFS, including Sharī'ah-compliant securities/*sukūk* for the purpose of a fire sale in the event of liquidity shocks, is one of the key aspects of these tests.

174. By taking into account the peculiarities and impediments of IIFS in terms of liquidity risk, this TN endeavours to provide IIFS and RSAs with an Excel template for conducting a liquidity stress test. The template for IIFS is derived from Martin Cihak's stress-test template⁶⁸ and Schiemeder et al.'s next-generation stress tester.⁶⁹ The parameters of the liquidity coverage ratio (LCR) and net stable funding ratio (NSFR) (quantitative requirements under Basel III) in the template are based on GN-6, which built upon Basel III, with a number of additions and adjustments to meet the specificities of IIFS.

175. The template includes four different modules for analysing the liquidity position of IIFS and/or the Islamic banking system under stress scenarios:

- a. Implied cash flows analysis (ICFA) (five days and 30 days), which is a tool to simulate IIFS-run type scenarios while accounting for fire sales of liquid assets and/or established *Sharī'ah*-compliant central bank liquidity provisions subject to eligible collateral and haircuts under different stress assumptions.
- b. LCR is a stress test based on a scenario that entails a combination of idiosyncratic and market-wide shocks that includes anything from the run-off of a portion of funding to a three-notches downgrade in its credit rating and unscheduled draws on committed but unused credit and liquidity facilities.

⁶⁸ M. Čihák, "Introduction to Applied Stress Testing", IMF Working Paper No. 59 (2007).

⁶⁹ C. Schiemeder, H. Hesse, B. Neudorfer, C. Puhr and S.W. Schmitz, "Next Generation System-Wide Liquidity Stress Testing", IMF Working Paper No. 12/3 (2012).

- c. Maturity mismatch analysis is a liquidity gap analysis assessing risks arising from Sharī'ah-compliant maturity transformations of IIFS; it simulates liquidity shortfalls in IIFS for different maturity buckets under both normal and stressed conditions.
- d. The NSFR intends to promote more stable funding of the assets and activities of banks over a one-year period under market-wide stress conditions.

176. The Excel-based template is an easy-to-use balance sheet-type liquidity stress-testing tool for IIFS that allows bottom-up tests to be run for many IIFS. For illustration, only five IIFS are included in the template, and data from these five IIFS are hypothetical. An IIFS can run liquidity stress tests for risk management purposes on an individual basis, and RSAs can also run the system-wide or industry-wide test for both micro- and macroprudential purposes. The decision on which modules are necessary to be applied by IIFS for liquidity stress tests depends upon the local regulations; for example, LCR and NSFR have begun to be implemented in some jurisdictions that have already adopted Basel III/IFSB-15/GN-6.

177. The template uses IIFS balance sheet data to perform the stress tests on an IIFS-by-IIFS level. The needed data for ICFA are mainly from the balance sheet of IIFS, with more granular data on both the asset and liability sides using haircuts on different kinds of assets and withdrawal rates of different categories of deposits/PSIA based on stress scenarios. It is also possible for IIFS and RSA to modify the template based on their more granular data (different categories of assets and liabilities of IIFS based on their liquidity characteristics).

178. The template calculates LCR and NSFR ratios based on GN-6: *Guidance Note on Quantitative Measures for Liquidity Risk Management in IIFS*.⁷⁰ The assumptions in this template incorporate the same parameters for LCR and NSFR as in GN-6, which calibrates the rates for IIFS (see GN-6 for details). The template also allows RSAs and IIFS to simulate different kinds of scenarios and regulatory liquidity requirements (LCR and NSFR) based on the different data availability. The template for LCR and NSFR follows the data-reporting requirement for IIFS based on GN-6.⁷¹

179. Maturity mismatch analysis is used intensively in liquidity management to visualise cash flows. It shows the capacity of an IIFS bank to deal with maturity mismatches. It plots cash flows across time. The template for maturity mismatch analysis can be used for analysing actual maturity mismatch under normal rollover conditions and under defined stress conditions in which

⁷⁰ IFSB, GN-6: *Guidance Note on Quantitative Measures for Liquidity Risk Management in IIFS* (April 2015).

⁷¹ See Appendix 1: "Illustrative Summary of the LCR for IIFS" and Appendix 2: "Illustrative Summary of the NSFR for IIFS" of the GN-6.

different rollover rates can be used based on the severity of the stress scenarios. The maturity structure under both normal and stress conditions reveals maturity and volume mismatches between financing and deposits/PSIA.

180. The template for liquidity risk provides run-off rates as examples for benchmark scenarios. These scenarios and behavioural assumptions used in the template of liquidity tests are based on Martin Cihak's stress-test template and Schmieder et al.'s next-generation stress tester. RSAs and IIFS should use their own scenarios and behavioural assumptions based on historical or experimental studies of the behavioural characteristics of assets and liabilities of IIFS, or rely on expert judgment if there is no such study, to reflect the IIFS- and country-specific circumstances. For example, in Schmieder et al.'s next-generation stress tester, assumptions or run-off factors were benchmarked to the Lehman Brothers case. Although the Lehman Brothers calibration may not be appropriate for small jurisdictions and Islamic banks, there is no study as yet to benchmark in the template for small jurisdictions or IIFS. It is a simple matter for the stress tester to modify the assumptions based on institution- or country-specific circumstances.

181. The template can also be used for monitoring purposes, along with an individual liquidity stress test for IIFS and an industry-wide liquidity stress test for RSAs, within a relatively short period of time.

4.3. Liquidity Stress Scenarios

182. It is valuable to gain a better understanding of the key drivers of liquidity risk in order to identify issues through sound liquidity stress-testing design. Past experiences faced by different jurisdictions have generated a number of insights that can be used to better evaluate the liquidity stress test, whether conducted by IIFS or by RSAs.

183. Designing a liquidity stress-testing framework appears to be crucial, for the following reasons:

- a. IIFS have limited access to Sharī'ah-compliant funding in the current market (i.e. limited access to Sharī'ah-compliant facilities from central banks, interbank facilities, cross-border liquidity facilities, etc.), and there is a lack of an organised money market infrastructure.
- b. Liquidity stress tests for an IIFS need to take into account the specificities of its balance sheet structure.

- c. An IIFS has a dual role, with respect to liquidity, in meeting the withdrawal rights of its current account holders and the liquidity expectations of its unrestricted IAHs. (See Principle 4 of IFSB-12: *Guiding Principles on Liquidity Risk Management for IIFS* for further details.)
- d. Investment accounts are prone to create liquidity risks for the IIFS during stress events. An IIFS may have to inject its own capital to support underlying assets of the investment accounts – for example, through provision of liquidity support and sponsoring role, particularly when the assets are tied in long-term financing and the IIFS is unable to quickly raise sufficient alternative funding to replace the investment account withdrawals.

184. IIFS and RSAs should consider idiosyncratic and market-wide stress scenarios, including short- and long-term considerations in their liquidity stress testing. It is valuable to be more conservative while transforming the scenarios into assumptions. Based on the type and severity of the scenario, IIFS and RSAs need to consider the appropriateness of a number of assumptions or factors, potentially including:

- a. predominant element in the IIFS's funding (e.g. PSIA, or CMT-based deposits⁷² or current accounts) and its volatility;
- b. degree of maturity mismatches between assets and liabilities by different currencies, geographical location or any other constraints in the flow of liquidity;
- c. the correlation between assets while stressing multiple scenarios;
- d. breadth and depth of market liquidity;
- e. potential liquidity requirement during stressed environment as a result of market-making activities, for an IIFS that acts as an active market maker (e.g. principal dealer of *sukūk*);
- f. potential liquidity support for an IIFS with cross-border operations;

⁷² "Commodity *murābahah* transactions" means a *murābahah*-based purchase and sale transaction of Sharī'ah-compliant commodities, based on the stipulation of purchasing on a deferred basis and sale on a cash basis. Some IIFS offer deposits based on CMT in which the IIFS purchases a commodity from a customer (depositor) through a reverse *murābahah* transaction on a deferred payment basis and then sells it for cash. See IFSB, GN-2: *Guidance Note in Connection with the Risk Management and Capital Adequacy Standards: Commodity Murābahah Transactions* (December 2010).

- g. potential vulnerability from a particular large funding provider or a group of funding providers, or a sector, due to unprecedented market news or development;
- h. interaction of liquidity risk, asset and liability management, and funding strategy;
- i. relationship between liquidity and credit and asset prices, taking account of amplification feedback loops;
- j. possible Sharī'ah-compliant funding arrangements with the central bank (i.e. assuming that central funding will be available in the event of a market crunch) and other Sharī'ah-compliant facilities available for meeting liquidity shortages;
- k. the run-off or withdrawal risk of IAHS and refinancing risk of CMT-based deposits;
- l. a simultaneous drying up of market liquidity in several markets, and linkages between reductions in market liquidity and constraints on funding liquidity;
- m. the impact of credit-rating triggers;
- n. severe constraints in accessing secured and unsecured *Sharī'ah*-compliant funding;
- o. restrictions on currency convertibility;
- p. contingent claims and, more specifically, potential draws on committed lines extended to third parties or the bank's subsidiaries, branches or head office;
- q. the ability to transfer liquidity across entities, sectors and borders, taking into account legal, regulatory, operational, and time zone restrictions and constraints;
- r. liquidity reserves, regulatory required ratios and specific liquidity ratios; and
- s. IIFS with cross-border operations to consider a combination of both idiosyncratic and market-wide stress scenarios in their liquidity stress testing.

185. The liquidity stress scenario is merely a conjecture on the potential future developments of the economy. In designing a test, it is important to determine whether such conjectures should be based on historical events, assuming that past shocks may happen again, or on hypothetical shocks – that is, on extreme but plausible changes in the external environment regardless of the historical experience. While historical scenarios are easier to implement and somewhat more tangible, hypothetical scenarios may be the only available option because it is demonstrated that each liquidity shock has its own dynamics and makes the past history no longer informative.

186. The Excel template simulates both IIFS-run-type scenarios for five and 30 days with the benchmark rates given in Schmieder et al.'s next-generation stress tester (2012) while accounting for fire sales of liquid assets, maturity mismatch analysis and Basel III liquidity ratios (LCR and NSFR).

Type	Rationale	Liability side	Asset side
Implied cash flows analysis (ICFA) – for five and 30 days	Modification of liquidity test based on Cihak (2007) and Schmieder et al.'s (2012) next-generation stress tester, taking into account the peculiarities of IIFS (higher granularity, particularly on the assets side, use of haircuts).	Substantial (sudden) outflow of funding, including RPSIA. ⁷³	Fire sale of unencumbered liquid assets.
Liquidity coverage ratio	The liquidity coverage test (LCR) is similar to ICFA. It was calibrated to IIFS through GN-6 by IFSB.	Calculation of net cash outflow.	Haircuts for different types of assets based on their characteristics (levels 1, 2A and 2B).
Maturity mismatch analysis	Comparison of the maturity structure of assets and liabilities of IIFS to identify liquidity gaps under different scenarios.	Simulation of funding subject to rollover. For example, 20% of UPSIA/term deposits maturing during the next 12 months cannot be rolled over.	Simulation of compensation of loss of funding by liquid assets under specific assumptions.
Net stable funding ratio	The net stable funding ratio is part of the liquidity test to be introduced as part of Basel III and assesses the stability of an IIFS's funding sources in more structural terms. The test was adopted according to the GN-6.	Calculation of stable funding.	Calculation of required stable funding resulting from business activities.

187. The objective of the LCR is to promote the short-term resilience of the liquidity risk profile of banks, including IIFS. It does this by ensuring that banks have an adequate stock of unencumbered high-quality liquid assets (HQLA) to meet their liquidity needs for a 30-calendar day liquidity stress scenario. The LCR is calibrated for IIFS in GN-6: *Guidance Note on*

⁷³ Refer to paragraph 53 of GN-6 for the treatment of RPSIA for liquidity purposes.

Quantitative Measures for Liquidity Risk Management in IIFS (April 2015). (For details of stress scenarios of LCR for IIFS, see paragraph 23 of GN-6.) The LCR helps to absorb the shocks arising from financial and economic stress, thus reducing the risk of spillover from the financial sector to the real economy.

188. Maturity mismatch analysis indicates the gaps between the contractual liquidity inflows and outflows for selected time bands. These gaps signify potential liquidity needs of an IIFS that need to be raised in respective time bands if all outflows occurred at the earliest possible date.

189. NSFR is seen as a complement to the LCR and is designed to provide incentives for banks and IIFS to seek more stable forms of funding. Again, it is based on a stress scenario that covers an extended firm-specific stress scenario. (For details of stress scenarios for IIFS, see paragraph 90 of GN-6.)

190. The scenarios may involve adverse conditions in line with historical maximum funding withdrawal rates. The stress scenarios should be designed based on the jurisdiction's special characteristics and some cases in the international area. For example, if a jurisdiction's IIFS liability structure is characterised by a comparably high share of wholesale funding, which makes the IIFS vulnerable to a sudden and substantial funding withdrawal, the stress scenarios could be amplified further in the structural shortage of wholesale funding.

Box 1: Treatment of PSIA under GN-6

PSIA, commonly referred to as "investment accounts", are offered by IIFS for raising funds. Whether retail or wholesale, PSIA are categorised as either unrestricted PSIA (UPSIA) or restricted PSIA (RPSIA), as in most cases their underlying contract is either the *mudārabah* or *wakālah*⁷⁴ principle or CMT-based deposit accounts with various maturities. The applicable run-off factor for PSIA depends on the withdrawal rights of the IAH and whether they are retail or wholesale accounts under GN-6. The reporting of PSIA, whether on- or off-balance sheet, is not relevant.

⁷⁴ In fact, the *wakālah* model, strictly speaking, is not a true PSIA since it is built on the earning of specific fees by the *wakil* (agent) regardless of profit or loss from the underlying activity, and the entire profit will be attributed to the *wakil* (capital provider). However, some jurisdictions consider it as PSIA, which is contradictory to the essence of *wakālah* from the Shari'ah perspective. However, the reason for considering it as PSIA is due to the fact that the *wakil* might receive part of the profit as a performance-related incentive if the realised profit exceeds a certain level. In such cases, the *wakil* will share part of the profit with the investors, which is in reality considered a *hibah* or a commitment to pay it.

For RPSIA, IAH may have no withdrawal rights prior to maturity, or IAH may have withdrawal rights subject to giving at least 30 days' notice. The IIFS managing the RPSIA is not exposed to run-off for LCR purposes, unless the contract maturity date falls within the next 30 days. Only in the case of RPSIA from which the IAH may withdraw funds at less than 30 days' notice without any "significant reduction of profit" is the IIFS exposed to run-off for LCR purposes.⁷⁵ Where an IIFS offers such RPSIA, it would be expected to retain a proportion of HQLA in the relevant RPSIA fund in order to meet withdrawals, in which case the HQLA would be netted off the amount of the run-off in calculating the total net cash outflows. The run-off factor applied to the RPSIA is based on the minimum ratios in GN-6, or on historical or experimental studies of the behavioural characteristics of RPSIA. Where the funds of RPSIA are invested in assets with a liquid secondary market, such that under normal conditions the assets may be monetised rapidly in time to meet a demand for withdrawal, there is a risk that under stressed conditions it may not be possible to monetise the assets so readily. Hence, there is a potential exposure to a (net) run-off for LCR purposes. The amount of the run-off for LCR purposes should therefore be reduced only in respect of cash and HQLA held in the RPSIA fund.

For UPSIA, in some cases withdrawals will be permitted either on demand or at less than 30 days' notice, and the supervisory authority will need to apply the appropriate run-off factor as mentioned in the GN-6 or based on historical or experimental studies of the behavioural characteristics of UPSIA. (Run-off factors for different categories of PSIA are shown in the "Liquidity Stress Test" Excel template.)

In some jurisdictions, PSIA may be offered on a *wakālah* basis. Run-off rates for *wakālah*-based PSIA are again based on the contractual withdrawal rights of the IAH, as indicated above.

191. When designing a scenario for IIFS, the following dimensions should be taken into account: (a) on the asset side, the availability of liquid assets (i.e. market liquidity), taking into account an adverse market risk scenario (i.e. changes in interest rates and foreign exchange rates); and (b) on the liability side, (i) the run-off rates of different types of funding, including PSIA (i.e. wholesale funding is assumed to be more volatile than retail funding); (ii) concentration of

⁷⁵ To be "significant", a reduction of profit must be considerably more than a mere loss of accrued income. In the Basel document, the term "significant penalty" is used to refer to any amount charged to the customer that is materially greater than the loss of interest in case of early withdrawal. In the case of RPSIA, premature withdrawal of funds by an RPSIA holder is likely to require the IIFS to realise assets at less than their carrying value. Any losses and other costs of so doing, properly determined, would be borne by the RPSIA holder in addition to loss of accrued income.

funding, which is simulated to have a negative impact on run-off rates; and (iii) the historical volatility or behaviour profile of deposits/PSIA at each IIFS.

192. There are some sources of stress that are common in most scenarios:

- a. reduction in asset prices;
- b. increased collateral and margin calls;
- c. reduced access to funding markets;
- d. increased deposits/PSIA withdrawals;
- e. non-rollover of term deposits/PSIA; and
- f. utilisation of credit lines previously approved.

193. Generally, there is a lack of assumptions based on models because of the fact that modelling liquidity risks is more complex. Liquidity stress tests therefore mainly use the assumptions on the current Basel III or GN-6 liquidity regulatory requirements (LCR and NSFR). New liquidity stress tests by some jurisdictions, however, rely on other economic measures in setting hurdle rates.

194. RSAs have a critical role to play in conducting system-wide liquidity stress tests, as banks generally lack the data needed to calibrate a liquidity stress test and often employ diverse assumptions and scenarios that can make it difficult for supervisors to assess the relative liquidity risk of different institutions.

195. Special attention should be given by RSAs and IIFS to the connection between liquidity risk and reputational risk. The IIFS's reputation is important, especially in times of financial stress. Any event that undermines confidence in an IIFS can easily generate liquidity and intraday risk. An IIFS's reputation for operating in a safe and sound manner is essential in attracting funds at a reasonable cost, as well as for retaining funds during a crisis. Liquidity stress tests should take into account the reputation risk potentially associated with the possibility of extraordinary withdrawals from IIFS.

196. Reputational considerations, which featured prominently in the crisis, need to be built into the scenario assumptions, particularly if the host jurisdiction of the IIFS has been at the centre of an economic event. Additionally, stress testers need to take into account contingent liabilities such as committed credit/liquidity lines to customers. This risk is particularly high under market-wide funding dislocations.

4.4. Liquidity Stress-Test Models⁷⁶

197. Testing for liquidity risks is less common than testing for risks to solvency because of the fact that modelling of liquidity risks is more complex. First, to properly model liquidity fluctuations in IIFS, one needs to have very detailed, high-frequency data that are typically used by IIFS themselves in their liquidity management models. Second, to model the impact of large liquidity shocks, one needs to consider the broader liquidity management framework.

198. Given the lack of empirical evidence, as noted previously, the calculation of satellite models (i.e. econometric models) that link the outflow of deposits/PSIA to macroeconomic conditions is not yet feasible. Such models can be used to determine the haircuts for assets under stress (i.e. market liquidity risk). In addition, satellite models can be used to link banks' solvency under stress (e.g. capital ratios or banks' default probabilities) to funding costs.

199. Most IIFS forecast their cash flows by means of assumptions about the impact on inflows and outflows. These assumptions are mostly based on historical evidence and expert judgments. With the new Basel III liquidity requirement that was calibrated by GN-6 for IIFS, the IIFS and RSAs may start to set assumptions based on the run-off factors and haircuts as stipulated in GN-6. While the majority of the RSAs judge the liquidity conditions of an IIFS based on current or prospective (Basel III) regulatory requirements, some also rely on other economic measures.

200. The calibration of liquidity stress tests is an important issue for IIFS and RSAs. The country's own experience is the most frequently used source in establishing liquidity stress parameters. In establishing liability run-off rate assumptions, alternative approaches include using IIFS' own estimates, reviews by supervisors, expert judgment or regulatory guidance. The liquidity stress scenarios also include haircuts on liquid assets. To establish the extent of the assumed haircuts, in addition to the country's own history, stress-testing teams rely on international experience, expert judgment, IIFS' own estimate, arbitrary shocks, or the haircuts applied by the central bank for its refinancing operations.

201. In the liquidity stress test, a model should consider: (a) the situation where there are different withdrawal rates for different types of deposits/PSIAs; (b) what variables can be used to approximate depositors'/IAHs' perceptions of an IIFS's safety; (c) the situation where an increase

⁷⁶ The stress-test models, shocks and scenarios in this TN-2 are not prescriptive; rather, they are suggestive only to offer guidance and are not meant to be exhaustive in covering every aspect and dimension of stress tests. RSAs and IIFS are encouraged to implement principles from this TN-2 into their own appropriate stress-test designs with shocks and scenarios built upon historical experiences and expert judgments most appropriate to their economic and financial environment and operational complexity. Particularly for further guidance on LCR and NSFR for IIFS, reference should be made to IFSB's GN-6: *Guidance Note on Quantitative Measures for Liquidity Risk Management in IIFS*.

in market volatilities impacts the quality of collateral; and (d) what other liquidity outflows may affect the liquidity position of IIFS, including unscheduled draws on committed but unused credit and liquidity facilities that the IIFS has provided to its clients.

202. The liquidity stress-test template contains basic examples of liquidity tests based on implied cash flow, maturity mismatch and regulatory liquidity requirements (LCR and NSFR). After inputting the basic data and assumptions based on the stress scenarios of IIFS or RSAs, the results of the tests for the default values can be followed in the spreadsheet. The template models a liquidity drain that affects all IIFS in the system, depending on the different run-off factors of different types of deposits/PSIAs. The template allows the IIFS and RSAs to change assumptions about the percentage of different kinds of deposits/PSIAs that get withdrawn each day, and about the percentage of liquid and other assets that IIFS can convert to cash each day.

203. The resulting spreadsheet summarises the ICFA, showing for each bank the number of days it would be able to survive a liquidity drain without resorting to liquidity from outside (i.e. from other IIFS or the central bank). It may also be possible to add to the template a feature for central bank funding and contingent liabilities, as well as the required reserved held at the central bank by IIFS, which should be readily available to IIFS.

204. The key variables that a liquidity model must incorporate are:

- a. cash flows;
- b. funding capacity;
- c. funding spread (distribution of profit between IIFS and IAH); and
- d. haircut.

205. RSAs and IIFS can model the cash flow, including behavioural components of the counterparties. They can also distinguish among deposits/PSIAs based on their behavioural characteristics. With respect to contingent cash flows, the IIFS should analyse their triggers. Common triggers entail changes in economic variables, credit rating downgrades, country risk and specific market disruptions.

206. In short, a cash-flow model should:

- a. model cash flows from all products;
- b. incorporate future business;
- c. distinguish sub-products within a product category; and

- d. incorporate a behavioural element.

207. There is no publicly available model of liquidity risk that has been commonly agreed between RSAs and banks, including IIFS. Therefore, it seems viable to estimate and forecast the liquidity risk drivers. However, data on liquidity crises are scarce, and in stress situations correlations may differ from past experience. Data gaps in general are an issue for liquidity stress testing.

208. RSAs and IIFS should calibrate models provided for liquidity stress testing based on the country-specific and/or institution-specific circumstances, taking account of the funding structure, level of competition, development of the market and any other relevant factors.

4.5. Review and Analysis of the Results

209. Adequately designed and properly implemented liquidity stress tests can generate valuable information on an IIFS's liquidity profile that cannot be generated from a limited set of standardised liquidity metrics. Liquidity stress tests should help inform IIFS' tolerance towards liquidity risk. The implementation of risk tolerance in liquidity risk management differs among IIFS, however, and RSAs still observe shortcomings with the integration of liquidity risk stress tests into IIFS' total risk management.

210. An example of the added value of stress testing beyond reliance on a single metric can be found in the LCR's 30-day horizon, which does not preclude intra-30-day timing mismatches. In a stress test, shorter and longer horizons can be explored to assess to what extent an IIFS's outcomes are sensitive. In addition to the results, in their evaluations IIFS and RSAs should look at the other aspects relevant to an IIFS's liquidity that can have a material impact, including the level of consolidation, the currency composition of exposures, and the composition of the liquidity buffer.

211. Liquidity stress testing results should be evaluated in line with an IIFS's overall strategy and annual planning cycles; results should be refreshed in the event of major strategic decisions, or other decisions that can materially impact capital or liquidity.

212. The results should be used as an input for adjusting and improving liquidity risk management. IIFS and/or RSAs should consider using the results of stress testing in the following areas:

- a. to identify and quantify sources of potential liquidity strain;

- b. to analyse possible impacts on the IIFS's cash-flow position, profitability and solvency;
- c. to ensure that current exposures are consistent with the IIFS's established liquidity risk tolerance;
- d. to take remedial or mitigating actions, and to set various types of internal limits, including concentration limits on the IIFS's liquidity exposures;
- e. to decide the level of liquidity cushion/buffer needed;
- f. to ensure that intraday secured and unsecured Sharī'ah-compliant funding will be available in order to make payment and settlement system requirements;
- g. to find the level of unencumbered, high-quality liquid assets that can be sold or pledged to obtain *Sharī'ah*-compliant funds in a range of stress scenarios; and
- h. to shape the IIFS's contingency planning and help in determining the strategy and tactics to deal with events of liquidity stress.

213. The results of liquidity tests based on the top-down approach provide information for RSAs in these areas:

- a. They show the counterbalancing ability of IIFS (and their specific limits in the case of reverse stress tests) to remain liquid.
- b. They allow a peer comparison – that is, the relative performance of banks under liquidity stress.
- c. They can provide a link between the joint resistance to liquidity and solvency risks if the feedback between solvency and liquidity risks is modelled.

214. From a system-wide perspective, considering the present market conditions and the liquidity infrastructure, results of stress tests may not give the actual conditions. RSAs have an important role in solving the infrastructural problems of the Islamic financial services industry, which will require improvements in the provision of Sharī'ah-compliant deposit insurance and lender-of-last-resort schemes, as well as a sufficient and regular supply of high-quality liquid assets.

215. An example of the results of the liquidity stress test template is given in Figure 1. RSAs and IIFS should review and analyse the results based on the aforementioned points. The summary of the results gives a concrete picture of the liquidity position of IIFS and/or a system

based on the defined scenarios and assumptions. The output of the liquidity tests in the Excel template provides failure and pass rates (in terms of the number of IIFS and total assets, respectively), and the estimated funding shortfalls for each IIFS as well as at the system level (or group of IIFS tested). For the LCR and the NSFR, the tests show those banks that are likely to be below the regulatory threshold.

Figure 1: Summary of Liquidity Analysis

System-level Result							
Total Number of Banks Tested	5						
Test 1-a: Implied Cash Flow Test (5 Days)							
	Cumulative Withdrawal of Deposits/RPSIA (% of Total, Assumptions for Test)	Cumulative Loss of Short Term Funding (% of Total, Assumptions for Test)	Cumulative Total Loss of RPSIA (% of Total, Assumptions for Test)	Cumulative Total Loss of Funding (% of Total, Assumptions for Test)	Minimum Number of Periods of Survival	Number of Banks Illiquid	Survival - % of IIFS
Day 1	0.0%	0.0%	0.0%	0.0%	0	0	100.0%
Day 2	5.4%	0.0%	0.0%	3.7%	1	0	100.0%
Day 3	10.4%	0.0%	0.0%	7.4%	2	0	100.0%
Day 4	15.0%	0.0%	0.0%	10.7%	3	0	100.0%
Day 5	19.4%	0.0%	0.0%	13.5%	4	0	100.0%
	23.5%	0.0%	0.0%	16.4%	5	1	80.0%
Number of IIFS passing test through period 5	4						
Liquidity shortfall	-264,038						
Liquidity shortfall as % of total assets	-0.3%						
Test 1-b: Implied Cash Flow Test (30 Days)							
Cumulative Withdrawal of Deposits (% of Total)	Cumulative Loss of Short-Term Funding (% of Total)	Cumulative Total Loss of Funding (% of Total)	Survival	Number of Banks	% of Banks	% of Assets	
7.2%	0.0%	5.0%	No	0	0.0%		
			Yes	5	100.0%		
Number of IIFS failing the test	0						
Liquidity shortfall	0						
% of total Assets	0.0%						

Test 2: Liquidity Coverage Ratio

Assets)	31.0%		Liquidity Coverage Ratio	Number of Banks	% of Banks	% of Assets
Other cash inflow (% of Assets)	1.2%	"Not Passed"	<0.25	0	0.0%	0.0%
Total cash inflow (% of Assets)	32.2%	"Not Passed"	0.25-0.5	0	0.0%	0.0%
Total cash outflow (% of Assets)	8.2%	"Not Passed"	0.5-0.75	0	0.0%	0.0%
		"Not Passed"	0.75-1	0	0.0%	0.0%
Average LCR (weighted-average)	4.48	"Passed"	>1	5	100.0%	100.0%
Median LCR	4.89					
Number of banks failing the test	0					
Liquidity shortfall	0					
% of total assets	0.0%					

Test 3: Maturity Mismatch Analysis

Bucket	Cumulative no. of IIFS with	Shortfall (% of total				
0	0	0.0%				
Less than 3 months	0	0.0%				
3 to 12 months	2	40.6%				
1 to 5 years	5	100.0%				
More than 5 years	5	100.0%				
Not assigned						

Test 4: Net Stable Funding Ratio (NSFR)

Available stable funding (% of Assets)	18.2%		Net Stable Funding Ratio	Number of Banks	% of Banks	% of Assets
Required stable funding (% of Assets)	4.4%	"Not Passed"	<0.25	0	0.0%	0.0%
		"Not Passed"	0.25-0.5	0.00	0.0%	0.0%
Average NSFR	4.09	"Not Passed"	0.5-0.75	0.00	0.0%	0.0%
Median NSFR	3.87	"Not Passed"	0.75-1	0.00	0.0%	0.0%
Number of banks failing the test	0	"Passed"	>1	5.00	100.0%	100.0%
Liquidity shortfall	0					
% of total funding liabilities	0.0%					

Section 5: Recent Developments in Stress Tests

5.1. Integrated Liquidity and Solvency Tests

216. Liquidity risks typically cannot be isolated from other risks, such as solvency and contagion risks. Solvency issues are relevant for liquidity stress testing because quickly liquidating assets will come at a cost, which can hurt solvency buffers. Especially during stress periods, market participants with sound solvency profiles can experience liquidity strains. Recent experience has also shown that reputational contagion in particular can spread quickly. Integrated analysis should take into account the interconnectedness of liquidity, solvency and contagion risks.

217. The Global Financial Crisis also clearly showed the need to assess risks from a systemic perspective, taking into account the possible interlinkages between different risk factors and contagion risks within the financial system, as well as risk transmission between conventional banks and IIFS.

218. Solvency stress tests generally do not include those risk transmissions and systemic effects, such as the collapse of the interbank money market and other wholesale markets and the importance of feedback effects between market liquidity and funding liquidity risks of IIFS. General application is to conduct solvency and liquidity stress tests independently. As the 2007–9 global market turmoil highlighted the crucial importance of the linkages between different kinds of risks, especially credit, market and funding liquidity risk, the stress-tests framework that integrates solvency and liquidity stress tests through different satellite models provides a more structural approach to simulate feedback effects within the financial system.

219. As integrated models for solvency and liquidity stress tests are complex and need deep expertise to implement, these models potentially provide a more complete picture of the possible impacts of tail events. These models should take into account multiple transmission channels (risk transmission between conventional banks and IIFS) and feedback effects.

220. The current models that attempt to simulate how a macrofinancial shock reinforced by idiosyncratic liquidity stress at the institutional level affects solvency are very limited. The following are some examples of the models also used by RSAs:

- a. Aikman et al. (2009)⁷⁷ can be regarded as the most comprehensive approach to endogenising liquidity risk stress tests in a modelling framework.
- b. Barnhill and Schumacher (2011)⁷⁸ developed an empirical model linking solvency and liquidity risks, similar to work done by van den End (2010)⁷⁹ and Wong and Hui (2009).⁸⁰
- c. Chan-Lau (2010)⁸¹ and Barnhill and Schumacher (2011) used network models to capture the link between solvency and liquidity.

221. Liquidity and solvency risks are sometimes interlinked but frequently are treated separately, especially in supervisory stress tests. A more integrated exercise might recognise that IIFS could also incur capital losses from the liquidation of assets necessitated by funding run-off in times of stress. Integrated liquidity and solvency tests help to simulate the impact of changes in solvency, rating downgrades and concentration risk on funding costs. Specifically for IIFS, PSIA that allow redemptions on demand or prior to maturity of the underlying assets, there are potential impacts to solvency of the IIFS due to exposure to the underlying assets in providing liquidity support to meet these redemption requests. In the case that underlying assets are illiquid (e.g. financing) or of lower quality (may incur too low a fire-sale value during a crisis), IIFS may need to purchase the underlying assets from the PSIA.⁸² Furthermore, the impact of reputational risk, such as due to Sharī'ah non-compliance, applies to both solvency and liquidity positions.

222. RSAs and IIFS should be able to integrate, effectively and meaningfully, all the risks and business areas in the stress-testing programme to deliver a complete picture of industry-wide and IIFS-wide risks. This development currently is a work in progress.

⁷⁷ D. Aikman, P. Alessandri, B. Eklund, P. Gai, S. Kapadia, E. Martin, N. Mora, G. Sterne and M. Willison, "Funding Liquidity Risk in a Quantitative Model of Systemic Stability", Working Paper No. 372, Bank of England (2009).

⁷⁸ T. Barnhill and L. Schumacher, "Modeling Correlated Systemic Liquidity and Solvency Risks in a Financial Environment with Incomplete Information", WP/11/263, IMF Working Paper Series (2011).

⁷⁹ J. Van den End, "Liquidity Stress-Tester: Do Basel III and Unconventional Monetary Policy Work?", DNB Working Paper No. 269 (2010).

⁸⁰ E. Wong and C. Hui, "A Liquidity Risk Stress-Testing Framework with Interaction between Market and Credit Risks", HKMA Working Paper No. 06/2009 (2009).

⁸¹ J. Chan-Lau, "Balance Sheet Network Analysis of Too-Connected-to-Fail Risk in Global and Domestic Banking Systems", WP/10/107, IMF Working Paper Series (2010).

⁸² The IIFS is permitted to purchase the underlying assets from the investment pool at any price (which may be higher or lower than the market price) provided that no prior undertaking to this effect was given.

5.2. Network Contagion and Second-Round Effect Analysis

223. While most stress-testing models focus on solvency risk, the 2007–9 financial crisis demonstrated that, in times of stress, liquidity risk and network spillover effects associated with interconnections among banks (both conventional and IIFS) can also be significant. The recent crisis also clearly showed the need to assess risks from a systemic perspective, taking into account the possible interlinkages between different risk factors and contagion risks within the financial system as well as risk transmission between the conventional financial system and the Islamic financial system.

224. Liquidity stress tests can be a more useful macroprudential instrument when they include network and feedback effects in the scenarios across institutions and system-wide. Network and feedback effects are rarely modelled in liquidity stress tests. Although liquidity stress tests that include network contagion and feedback effects are not early warning devices, they can unveil sources of systemic risk and vulnerability through regular system-wide monitoring. These tests can complement other tools and processes and foster communication about financial stability risks.

225. RSAs and IIFS tend to develop stress tests that do not account for second-round or contagion effects; that is, such tests assume that the IIFS's actions have no impact on the market and that there are no other IIFS seeking to undertake similar actions.

226. One of the challenges of financial stability analysis and stress testing is establishing scenarios with meaningful macrofinancial linkages – that is, taking into account network contagion and spillover effects.

227. The impact of both idiosyncratic and market-wide scenarios takes place in three logically interlinked phases:

- a. the formation of a balance-sheet liquidity shortfall as the first-round effect of shocks;
- b. the reaction by IIFS and/or banks; and
- c. the feedback effects of shocks, including reputational and systemic risks.

With each step, re-counting of the liquidity buffer is needed and the buffer should be examined to test that IIFS hold a sufficiently large amount of liquid assets to be able to survive the liquidity tension in their balance sheets.

228. Modelling contagion effects and their impact typically constitutes a challenge. By definition, spillover effects and dynamic contagion effects are implicitly captured in past data, but not necessarily if one uses structural econometric models – usually perceived as being “best practice”. Even if potential spillover events are captured in past data, such data might not be representative for a future scenario if, for example, linkages between economies and IIFS have become gradually more intense over time.

229. There are two main steps that need to be carried out when analysing contagion:⁸³ (a) determining the bilateral exposures between involved IIFS; and (b) developing a simulation of how a stress event at one IIFS is propagated through the system along the paths of bilateral exposures.

230. RSAs and IIFS should apply both bottom-up and top-down approaches in conducting stress tests to capture second-round and systemic effects. Furthermore, if applicable, RSAs and IIFS could consider evaluating:

- a. an IIFS’s liquidity position on a currency-by-currency basis for those currencies in which it is most active; and
- b. IIFS’ group structure (i.e. legal entities subject to different regulatory regimes vs. consolidated).

231. The use of network analysis to perform stress tests is rare, although work is under way at several institutions. Some recent examples are provided in Box 2. These approaches endeavour to integrate balance sheet-based models of liquidity stress tests with a network model in a way that allows for the feedback effect of asset sales. The main scenario for network models is that contagion can occur after bank/IIFS failure due to confidence contagion, default in the network of interbank exposures (counterparty risk), or fire sales that are assumed to depress asset prices at the point of default. The scenarios can also include behavioural reactions, such as liquidity hoarding or pre-default fire sales.

232. While preparing methodologies and models for jointly modelling liquidity and credit stress, including second-round or “feedback” effects, RSAs and IIFS need to be more cautious in assessing the interactions between major risk factors (especially the interaction between credit risk and liquidity risk) and allowing for an assessment of profit-and-loss effects and second-round

⁸³ The balance sheet-based network analysis can be used as a baseline methodology in determining interconnectedness of IIFS. It should be noted, however, that the balance sheet-based network analysis is not forward looking, but is based on past data.

effects of specific stress events. Here, a major challenge is to have homogeneous data from IIFS and on the connections between their different balance sheets; this, however, can be addressed by collecting data using a standardised supervisory data collection template.

Box 2: Some Examples for Modelling Network Contagion Risk in a Stress-Testing Framework

One of the earliest integrated stress-testing models is the Systemic Risk Monitor of the Central Bank of Austria, which integrates satellite models of credit and market risk with a network model to evaluate the probability of bank default. In the model, shocks to credit and market risk exposures may trigger bank defaults, leading to interbank contagion effects in a network model that is built on a matrix of bilateral interbank exposures.

The Bank of England's RAMSI stress-testing framework uses models to estimate resilience in a stress scenario. The models simulate macroeconomic scenarios through satellite models for credit and market risk and net interest income, an interbank network model and an asset price function to simulate fire sales of assets (market liquidity risk). RAMSI has been extended to include feedback effects resulting from liquidity risks. This is the interaction mechanism between market liquidity shock and funding liquidity shock within RAMSI.

The Bank of Canada's Macro-Financial Risk Assessment Framework (MFRAF) identifies systemic risks by estimating interbank spillover effects at major Canadian banks under a stress scenario. The framework links solvency, market and funding liquidity risks. Funding liquidity risk is generated by banks' solvency risk and the potential for asset fire sales. Uncertainty about a bank's asset quality gives rise to solvency risk concerns, and lenders may stop rolling over their short-term deposits.

The difference between the results obtained in the bottom-up stress test and those obtained with a model-based stress-testing framework that integrates solvency risk, funding liquidity risk and market risk stems from the marginal impact of liquidity risk and network spillover effects. A striking finding of this model is that when liquidity and network spillover effects are considered together with credit losses for a given shock, the aggregate capital position of banks declines by an additional 20%. Liquidity risk and network effects lead to an additional 40-basis-point decline in the aggregate CET1 ratio beyond the effect of solvency risk. Liquidity risk explains 65% of this additional decline, and network effects account for the remaining 35%. The above findings underscore the importance of considering these risks jointly. These results illustrate

the importance of liquidity risk and network spillover effects in times of stress: they add almost 20% to the estimated impact of this stress scenario on banks. It is therefore important for authorities to account for these effects when assessing the potential impact of stress scenarios on the banking system.⁸⁴

5.3. Cross-Border Macro Stress Testing

233. Most banking systems include some foreign-owned IIFS, so it is valuable for IIFS and RSAs to analyse the cross-border exposure and cross-border contagion because of the various barriers to the cross-border flows of liquidity that impede IIFS' liquidity management.

234. The IIFS should perform liquidity stress tests both at the group and entity level. However, IIFS do not always include potential barriers to the cross-border flow of liquidity in their stress tests, even though these can be particularly prevalent in crisis situations. In the face of potential barriers to the cross-border flow of liquidity and collateral, it is important for IIFS and RSAs to conduct stress tests at both the group and entity level, and to account for these potential cross-border barriers in liquidity stress tests.

235. In terms of cross-border linkages across banking sectors, two main channels for credit risk can be distinguished:

- a. common exposures to the same (or systemic) sources of risk; and
- b. balance sheet linkages between institutions.

236. Common credit risk exposures can be a source of contagion across national banking sectors if widespread or systemic shocks affect IIFS in a number of different countries simultaneously, or if individual IIFS have exposures in multiple countries. Balance sheet linkages can be a source of contagion across national banking sectors, both for systemic and idiosyncratic shocks. With such linkages, shocks can be, and often are, propagated between financial institutions located in different countries through the *Shari'ah*-compliant interbank money and repo markets (where these exist).

237. Modelling the cross-border issues in stress testing faces impediments for RSAs and IIFS because of the lack of data on cross-border transactions or intragroup exposures, which makes it impossible to quantify the impact of cross-border contagion. A common way of modelling cross-

⁸⁴ K. Anand, C. Gauthier and M. Souissi, "Quantifying Contagion Risk in Funding Markets: A Model-Based Stress-Testing Approach", Bank of Canada Working Paper 2015-32 (August 2015).

border stress is to use some relatively homogeneous variable that characterises the evolution of the credit quality of the financing either at a single bank or single country level. The cyclical dynamics of these variables can then be explained using a set of macrofinancial risk factors, which can also be subjected to various stress scenarios.

238. Although interconnectedness creates a strong case for conducting macro stress tests that take account of cross-border dimensions, cross-border exposures and cross-border contagion, different restrictions exist on intragroup cross-border transfers imposed by the host or home-country regulators (henceforth referred to as “ring-fencing”).

239. Although this interconnectedness creates a strong case for conducting macro stress tests that take account of cross-border dimensions, progress in this area has been relatively slow for at least two main reasons:

- a. *Practical*: there is a lack of harmonised data across countries with sufficient time spans to allow for quantitative assessment of the relevant sources of risk and exposures.
- b. *Institutional*: the national RSAs are not keen to share information across institutions and on a cross-border basis, and this may also be limited by national practices and legal restrictions.

5.4. Summary

240. Stress testing is an important supervisory tool available to authorities to assess risks to the financial system. However, it is important to highlight that, despite recent significant progress in the development of stress-testing models, stress testing remains challenging because it attempts to capture the effects of tail events.

241. In most stress tests, solvency risk explains a large share of the deterioration in the capital ratios of banks during periods of severe stress. As demonstrated by the recent financial crisis, however, liquidity risk and network spillover effects can generate substantial additional losses for banks. These are even further extended into a multi-jurisdictional and cross-border context. Hence, it is important to take them into account when assessing risks.

APPENDICES

A.1. Supervisory Data Collection Template

242. The proposed data collection template is a guiding example and can be modified as necessary to suit each RSA's specific data needs.

243. Stress designs include diverse macroeconomic variables that define economic developments within the RSA's jurisdiction, as well as external economic and financial factors that have potential to influence economic developments in the local jurisdiction.

244. The domestic macroeconomic variables that may be part of stress designs include:

- a. measures of economic activity and prices (e.g. changes in real/nominal GDP, unemployment rate, real/nominal disposable incomes, Consumer Price Index, and so on);
- b. measures of asset prices or financial conditions (e.g. changes in house price index, equity prices, stock market volatility, and so on); and
- c. measures of cost of funds (e.g. changes in base financing rates, three-month *sukūk* yields issued by the central bank, five-year *sukūk* instruments, rates of return on ten-year corporate *sukūk* instruments of different ratings, and so on).

245. The relevant external economic and financial factors that have the potential to stress the financial sector may include measures of changes in macroeconomic factors (e.g. real GDP, unemployment, asset prices, cost of funds/interest rates) of a foreign country or regional bloc (e.g. EU, ASEAN, GCC, and so on) that exert significant influence on the domestic economy through economic and financial linkages. The foreign currency exchange rate is a particularly important risk transmission channel.

Proposed Data Requirements for Islamic Banking System's Stress Tests⁸⁵

Table 10: Macroeconomic Variables	
Measures of Economic Activity and Prices	• Real GDP • Nominal GDP • Unemployment rate • Real income • Disposable income • Consumer Price Index • Commodity prices (e.g. crude oil, natural gas) • Any other variables significant for Islamic banks
Measures of Asset Prices and Financial Conditions	• House price index • Benchmark equity indices • Stock market volatility • Average banking sector NPF • Indices of key industries with significant concentration in IIFS financings (e.g. real estate, oil sector, infrastructure, and so on)
Measures of Cost of Funds	• Base financing rates/central bank policy rates • Central bank <i>sukūk</i> yields • Islamic interbank benchmark rates • Sovereign <i>sukūk</i> rates of return • Corporate <i>sukūk</i> rates of return • Any other costs of funds significant for Islamic banks
External Economic and Financial Conditions*	• Changes in external region/bloc/country economic activity and prices • Changes in external region/bloc/country asset prices and financial conditions • Changes in external region/bloc/country cost of funds • Currency exchange rates • Any other variables significant for Islamic banks

****Note: An external country or regional bloc (e.g. EU, ASEAN, GCC, and so on) that exerts significant influence in the local domestic economy through economic and financial linkages.***

⁸⁵ This list is not exhaustive and can be modified as necessary to suit each RSA's specific data needs.

Table 11: Islamic Bank Specific Variables Related to Financings and Investments

Financings Portfolio	• <i>Murābahah</i> financing • <i>Salam</i> financing • <i>Istisna`</i> financing • <i>Ijārah</i> financing • <i>Ijārah muntahia bittamleek</i> financing (IMB) • <i>Muḍārabah</i> financing • <i>Mushārah</i> financing • Diminishing <i>mushārah</i> financing • Other Islamic modes (if any)
Investments Portfolio – Trading Book	• Equity securities • Islamic collective investment schemes • Investment properties • <i>Sukūk</i> • <i>Murābahah</i> inventory – available for sale • <i>Salam</i> commodities • <i>Ijārah</i> assets – available for lease • <i>Mushārah/muḍārabah</i> investments at cost – for trading, shares and commodities • Net foreign exchange position

Table 12: Additional Information on Variables Related to Financings and Investments

Financings/Investments Portfolio	At Cost	Fair / Market Value	Profit / Loss	Provisions (if any)	Underlying Assets / Collateral Value

Table 13: Islamic Bank Specific Variables Related to Capital and Liabilities

Capital and Liabilities	• Profit equalisation reserve • Investment risk reserve • Parallel <i>salam</i> • Parallel <i>istisnā`</i> • Funding liabilities (e.g. commodity <i>murābahah</i> transactions, etc.) • Unrestricted PSIA • Restricted PSIA
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A.2. Stress-Testing Shocks and Scenario Designs⁸⁶

246. Designing an appropriate scenario is one of the prominent aspects of stress testing. **There are four approaches in scenario designing, namely: (i) historical scenario, (ii) probabilistic scenario, (iii) hypothetical scenario, and (iv) reverse engineering scenario.**

247. The main objective of supervisors and individual institutions is to select a scenario or scenarios that will reflect the vulnerability of a financial institution or system. Table 14 illustrates the approach developed by the IMF to conduct a financial sector assessment programme (FSAP) in the UK.

Table 14: Scenarios Used by the IMF to Conduct FSAP in the UK

	Variable	Moderate	Severe
Core	US effective exchange rate	–20% in 2 quarters	–40% in 1 quarter
	US 10-year yields	+2.5 pp* in 4 quarters	+2.5pp in 4 quarters
Accompanying	Global 10-year yields ex-US	+2pp in 4 quarters	+2pp in 4 quarters
	US house prices	–10% in 8 quarters	–15% in 8 quarters
	UK and selected euro house prices	–10% in 8 quarters	–15% in 8 quarters
	Global equity prices	Endogenous (–5%)	–20% in 1 quarter
	Global credit spreads	+85bp in 12 quarters	+225bp in 12 quarters

*Note: pp = percentage points.

248. Serving the same purpose, the approach in scenario design may vary from one jurisdiction to another. For example, the Bank of England adopts three baseline and five stress scenarios (Box 3).

249. In the US Federal Reserve, scenarios are divided into baseline, adverse and severely adverse (Box 4).

250. For macro stress testing, the Bank of Japan implements one baseline and two stress scenarios. Stress scenarios are divided into two categories (Box 5). The first is known as the Economic Downturn Scenario, where the assumption is that a harsh shock equivalent to the Lehman shock in 2008 occurs in overseas economies and the main focus is the change in credit losses. The other stress scenario is an upward interest rate shift scenario, which focuses on the analysis of the impact on the financial system of various rises in interest rates.

⁸⁶ All examples in this section are for knowledge-sharing purposes and are not necessarily Sharī'ah-compliant.

251. The Central Bank of the UAE uses two extreme scenarios to measure the resilience of local banks (Box 6). The resilience of banks in the test is measured with reference to their ability to maintain a capital adequacy ratio above the minimum level prescribed by the Central Bank, currently 12% of their risk-weighted assets. (Note that stress tests in the UAE include local banks only.)

252. In the European Union, the European Banking Authority (EBA) is responsible for the orderly functioning and integrity of the financial markets and the stability of the financial system. The 2014 EU-wide stress test is coordinated by the EBA and is carried out in cooperation with the European Central Bank (ECB), the European Systemic Risk Board (ESRB), the European Commission, and the competent authorities from all relevant national jurisdictions. In this process, the EBA has developed a common methodology and plays an important role in ensuring a comprehensive, consistent and comparable disclosure of the results. The ESRB and the European Commission have developed, respectively, the adverse and baseline scenarios (Box 7). Competent authorities, including the ECB for the euro area, are responsible for the quality assurance of banks' data as well as for supervisory actions banks will have to take in response to the outcome of the exercise.

253. Overall, even though the details of scenarios may be different, all jurisdictions implement scenarios that are categorised as baseline, adverse and severely adverse.

Box 3

UK Stress Scenarios (2015–19)

Global growth disappoints materially relative to expectations, and disinflationary pressures build up further. This triggers a rapid deterioration of market sentiment globally. Risk appetite abruptly diminishes and market participants attempt to de-risk their portfolios, generating safe-haven capital flows to high-quality US assets. The dollar appreciates against a wide range of currencies, especially those of emerging market economies. Liquidity in some markets becomes seriously impaired and credit risk premiums rise sharply. Commodity prices fall further, putting additional downward pressure on global inflation.

1. In China, policy supports a rebalancing of the economy towards consumption, but that takes time to take effect. Property prices fall sharply and, in turn, investment in residential property and associated industries contracts. Growth slows materially and the Renminbi depreciates against the dollar.
2. In the euro area, weaker domestic demand, world trade and commodity prices lead to further disinflationary pressures and the rate of deflation increases. This amplifies the downturn in activity, as consumption and investment decisions are delayed. In combination with weak demand and business confidence, unemployment increases materially throughout the euro area. Deflation also increases the real burden of debt and increases market concerns. Although the recession is widespread through the euro area, the increases in credit risk premiums are largest for the most highly indebted sovereigns, households and firms.
3. These global shocks have adverse implications for activity in a number of emerging market economies, especially China's major trading partners, commodity exporters, and economies with large external financing needs. These countries also experience a higher risk premium on foreign borrowing, which triggers a sudden stop to capital inflows and a sharp contraction of domestic credit and demand. Businesses that have issued dollar-denominated debt are particularly affected, given the appreciation of the dollar.
4. The global downturn impacts the United Kingdom. Output growth turns negative as export demand falls sharply. There are additional spillovers, through financial linkages and confidence effects. The household and corporate saving rates increase due to precautionary behaviour and the higher cost of credit as banks face higher funding costs. These mechanisms lead to falls in consumption, investment and property prices. The deterioration of global financial market sentiment is also evident in the United Kingdom – for example, through a sharp rise in risk premiums on private-sector borrowers. In this scenario, it is assumed that policymakers observe these developments as a series of unexpected shocks. Additional monetary policy stimulus is pursued, which has the effect of lowering the yield curve over the course of the stress scenario.

UK Baseline Scenario (2015–19)

1. World PPP-weighted GDP has grown at an average rate of about 3.5% since its 2009 trough. In the baseline projection, world GDP growth is projected to rise somewhat from 2015, averaging 4% through the five-year horizon. Advanced economies continue to recover, albeit at different rates. The United States is projected to grow strongly, with growth peaking at 3.9% in 2015. Growth in the euro area is weaker, peaking at 1.8% in 2016. In the near term, recent declines in oil prices push down on inflation globally. Euro-area inflation remains low through the horizon, reaching 1.5% by the end of 2019.

2. Chinese growth slows through the projection, declining to around 6.2% by the end of 2019. But recovery in advanced economies supports a broader pickup in growth for other emerging markets through the five-year horizon. For example, growth in Brazil and South Africa reaches 3% and 2.6%, respectively, by end-2019, compared to outturns of –0.2% and 1.3%, respectively, in the latest data.
3. In the United Kingdom, growth remains robust in the near term, averaging 2.9% over 2015 and 2016, before moderating to an average of 2.6% thereafter. Unemployment continues to fall but at a reduced pace compared to recent outturns, reaching close to 5% by end-2017. Inflation falls further in the near term, as recent declines in energy prices continue to be passed through to petrol prices and utility bills. But in the second half of 2015, those and other temporary effects drop out, and inflation begins to increase. These projections are consistent with those presented in the Bank's February 2015 Inflation Report. Consistent with robust growth, asset prices continue to rise through the baseline scenario.

Source: Bank of England, www.bankofengland.co.uk/

Box 4

US Baseline Scenario (2014 4Q – 2017 4Q)

The baseline scenario for the United States is for a sustained, moderate expansion in economic activity. Real GDP grows at an average rate of just under 3% per year over the scenario; the unemployment rate declines modestly, reaching 5.25% by the end of the scenario in the fourth quarter of 2017; and CPI inflation averages just over 2% per year.

Accompanying this moderate economic expansion is a gradual normalisation in Treasury yields across the maturity spectrum. Short-term Treasury rates begin to increase in the second quarter of 2015 and rise steadily thereafter, reaching just over 3% by the end of 2017. Five- and 10-year yields increase from the start of the scenario period and reach 4% and 4.25%, respectively, by the fourth quarter of 2017. Spreads on investment-grade corporate bonds change little over the scenario period, as do spreads on residential mortgages and other consumer loans. As a result, yields on BBB-rated corporate bonds and mortgage rates both increase roughly in line with long-term Treasury yields and the prime rate increases roughly in line with short-term Treasury rates.

Consistent with these developments, asset prices are assumed to increase modestly in the baseline scenario. Equity prices, nominal house prices, and commercial property prices all rise steadily throughout the scenario; in addition, equity market volatility is assumed to remain at low levels.

The baseline scenario for economic activity and inflation outside the United States features an expansion in activity, albeit one that proceeds at different rates across four countries. The outlook for real GDP growth in developing Asia is 6.25% per year; the expansion in real output in the United Kingdom proceeds at 2.5% per year; and real GDP growth in the euro area and Japan is assumed to average 1.5% and 1.25% per year, respectively.

US Adverse Scenario (2014 4Q – 2017 4Q)

The United States experiences a mild recession that begins in the fourth quarter of 2014 and lasts through the second quarter of 2015. During this period, the level of real GDP falls approximately 0.5% relative to its level in the third quarter of 2014, and the unemployment rate increases to just over 7%. At the same time, the US economy experiences a considerable rise in core inflation that results in a headline CPI inflation rate of 4% by the third quarter of 2015; headline inflation remains elevated thereafter. Short-term interest rates rise quickly as a result, reaching a little over 2.5% by the end of 2015 and 5.3% by the end of 2017. Longer-term Treasury yields increase by less. The recovery that begins in the second half of 2015 is quite sluggish, and the unemployment rate continues to increase, reaching 8% in the fourth quarter of 2016, and flattens thereafter. Equity prices fall both during and after the recession and by the end of the scenario are about 25% lower than in the third quarter of 2014. House prices and commercial real estate prices decline by approximately 13% and 16%, respectively, relative to their level in the third quarter of 2014.

Outside the United States, the adverse scenario features recessions in the euro area, the United Kingdom and Japan and below-trend growth in developing Asia. This weakness in economic activity results in a period of deflation for some countries or country blocs. The exchange value of the dollar is little changed vis-à-vis the euro, the pound sterling, and the currencies of developing Asia. The dollar is assumed to depreciate against the yen, reflecting flight-to-safety capital flows.

This year's adverse scenario is qualitatively different from the 2014 adverse scenario. The main difference lies in the evolution of Treasury yields. The 2014 adverse scenario featured a sharp rise in long-term interest rates not accompanied by an increase in short-term interest rates and hence a steeper yield curve than in the baseline. In this year's scenario the hypothetical pick-up in US inflation results in a yield curve that is higher and flatter than in the baseline.

US Severely Adverse Scenario (2014 4Q – 2017 4Q)

The severely adverse scenario for the United States is characterised by a deep and prolonged recession in which the unemployment rate increases by 4 percentage points from its level in the third quarter of 2014, peaking at 10% in the middle of 2016. By the end of 2015, the level of real GDP is approximately 4.5% lower than its level in the third quarter of 2014; it begins to recover thereafter. Despite this decline in real activity, higher oil prices cause the annualised rate of change in the Consumer Price Index (CPI) to reach 4.3% in the near term, before subsequently falling back.

In response to this economic contraction – and despite the higher near-term path of CPI inflation – short-term interest rates remain near zero through 2017; long-term Treasury yields drop to 1% in the fourth quarter of 2014 and then edge up slowly over the remainder of the scenario period. Consistent with these developments, asset prices contract sharply in the scenario. Driven by an assumed decline in US corporate credit quality, spreads on investment-grade corporate bonds jump from about 170 basis points to 500 basis points at their peak. Equity prices fall approximately 60% from the third quarter of 2014 through the fourth quarter of 2015, and equity market volatility increases sharply. House prices decline approximately 25% during the scenario period relative to their level in the third quarter of 2014.

The international component of the severely adverse scenario features severe recessions in the euro area, the United Kingdom and Japan, and below-trend growth in developing Asia. For economies that are heavily dependent on imported oil – including developing Asia, Japan, and the euro area – this economic weakness is exacerbated by the rise in oil prices (to approximately \$110 per barrel) featured in this scenario. Reflecting flight-to-safety capital flows associated with the scenario's global recession, the US dollar is assumed to appreciate strongly against the euro and the currencies of developing Asia and to appreciate more modestly against the pound sterling. The dollar is assumed to depreciate modestly against the yen, also reflecting flight-to-safety capital flows.

This year's severely adverse scenario is similar to the 2014 severely adverse scenario. However, corporate credit quality is assumed to worsen even more than would be expected in a severe recession, resulting in a greater widening in corporate bond spreads, decline in equity prices, and increase in equity market volatility than in the 2014 severely adverse scenario.

Source: US Federal Reserve, www.federalreserve.gov/

Box 5

Japan Baseline Scenario

Assumptions made for the baseline scenario assume that the overseas real GDP growth rate rises moderately from 2.5–3.0% in 2013 to about 4.0% through 2016. We use annual forecast data from the International Monetary Fund (IMF) to create quarterly series with the spline function. The nominal GDP growth rate rises from minus 0.2% in fiscal 2012 to 2.3% in fiscal 2013 and hovers at 2.0–2.5% through fiscal 2016. This assumption is based on the ESP forecasts provided by the Japan Center for Economic Research (JCER) from fiscal 2014 to fiscal 2015. We assume the same growth rate for fiscal 2016 as that for fiscal 2015. Stock prices (TOPIX) and 10-year JGB yields remain unchanged from the levels observed at the end of September 2013.

Economic Downturn Scenario

Assumptions made for the economic downturn scenario are as follows. Stresses equivalent to the Lehman shock in 2008 arise in overseas economies and global financial markets in the first half of fiscal 2014. Specifically, we assume that a large exogenous negative shock causes large downward revisions of real GDP growth rates in overseas economies, a situation comparable with the downward revision of actual GDP growth rates for 2008–2010 from the forecasts made in April 2008 and published in *IMF World Economic Outlook*. We also assume that the declines in the US and European stock market prices are equivalent to those seen from the pre-Lehman shock peak to the subsequent trough. Based on the above-mentioned assumptions, the overseas economic growth rate plunges to 0.5% in 2014 from 2.5–3.0% in 2013 and returns to around the baseline scenario level in 2016. Stock prices (TOPIX) fall by 55% between the end of March 2014 and the end of March 2015, and 10-year JGB yields decline by about 0.3 percentage points during the same period. Thereafter, stock prices and 10-year JGB yields remain more or less unchanged.

Upward Interest Rate Shift Scenario

Macro stress testing assumes the following two rising interest rate cases: a case in which interest rates rise in line with economic improvement; and a case in which interest rates rise with an economic downturn. Both cases assume a steepening scenario under which market interest rates for instruments with longer maturities rise by two percentage points, while those for instruments with shorter maturities do not rise significantly. We set the same assumptions for overseas economies as those employed in the baseline scenario.

A rise in interest rates in line with economic improvement

The first case assumes that the yield curve steepens gradually as demand for funds increases in line with the economic improvement and a rise in stock prices. The assumptions are explained in more detail as follows: Market interest rates for instruments with a 10-year maturity rise from the baseline scenario level by two percentage points for one year from the end of March 2014 and remain unchanged through the end of fiscal 2016. Interest rates for instruments with shorter maturities remain more or less unchanged. The nominal GDP growth rate increases from the baseline scenario level by about two percentage points in fiscal 2014. The upward shift of the nominal GDP growth rate is calculated based on the correlation between changes in long-term interest rates and the nominal GDP growth rate, and the maximum elasticity of their positive correlation since early 1990 when the Heisei bubble collapsed. Stock prices are endogenous variables in this simulation and rise gradually in line with the economic improvement, rising from the baseline scenario level by about 25% in fiscal 2016.

A rise in interest rates with an economic downturn

The second case assumes that a decline in stock prices and an economic downturn in tandem with a sharp rise in interest rates hinder an improvement in financial institutions' interest rate spreads on loans. The interest rate yield curve steepens immediately after the start of the estimation period. Specifically, 10-year rates rise by two percentage points from the baseline scenario level at the beginning of the April–June quarter of 2014 and remain at the same level through the end of fiscal 2016. Stock prices fall by 34% during the quarter, with a simultaneous rise in interest rates. Changes in stock prices are calculated based on the correlation between stock prices and long-term interest rates, and we use the maximum negative elasticity of the correlation since 1990 recorded in the April–October period of 1991. After declining for one year along with the economic downturn, stock prices are endogenously determined and drop 45% below the baseline scenario level. Stock prices stay at the same level after fiscal 2015. With respect to the economy, the nominal GDP growth rate deviates from the baseline scenario level immediately after the start of the estimation period, sitting at around minus 1.5% in fiscal 2014.

Source: Bank of Japan, www.boj.or.jp

Box 6

UAE

Central Bank of UAE uses two extreme scenarios to measure the resilience of local banks. (Note that ST in UAE includes the local banks only.) The resilience of banks in the test is measured with reference to their ability to maintain a capital adequacy ratio above the minimum level prescribed by the Central Bank, currently 12% of their risk-weighted assets.

The stress tests were based upon the two following scenarios:

Scenario 1:

Economic conditions deteriorate and NPL for each bank is assumed to rise from its current level to 15% of the total loan book. As an example, a bank with an 8% NPL ratio is now saddled with a 15% ratio; this 7% increase must be 75% provisioned and this provision is deducted from the bank's capital.

Scenario 2:

It recognises that the assets quality can differ from one bank to another. Accordingly, the NPL ratio is recalculated taking into account an increase of 50%, 75% and 100% from the level reported by each bank at the end of 2011. Again using the example of the same bank with an 8% NPL ratio, this bank is now tested with the NPL rising to 12%, 14% and 16% of its risk-weighted assets. Similar to the first scenario, 75% of the increase on NPL for each bank will be provisioned and deducted from the bank's capital.

Source: Central Bank of the Arab Emirates, *Financial Stability Review September 2012*, www.centralbank.ae/pdf/reports/FinancialStabilityReportSept2012.pdf

Box 7

EU Baseline Scenario (EC)

The winter 2014 forecast foresees a continuation of the economic recovery in most Member States and in the EU as a whole. After exiting recession in spring 2013 and three consecutive quarters of subdued recovery, the outlook is a moderate step-up in economic growth. Following real GDP growth of 1.5% in the EU and 1.2% in the euro area in 2014, activity is expected to accelerate in 2015 to 2.0% in the EU and 1.8% in the euro area. These figures each represent an upward revision of 0.1 percentage points compared with the autumn 2013 forecast. The forecast remains based on the assumption that the implementation of agreed policy measures at EU and Member State level sustains improvements in confidence as well as financial conditions and advances the necessary economic adjustment in Member States, by increasing their growth potential. The labour market is characterised by slowly stabilising employment, with unemployment remaining high, as labour market developments typically lag those in GDP by half a year or more. In keeping with this pattern, the outlook is for a modest rise in employment from this year onwards and a decline in the unemployment rate towards 10.4% in the EU and 11.7% in the euro area by 2015, with cross-country differences remaining very large. Subdued consumer-price inflation is expected to prevail in the EU and the euro area in 2014 at rates of 1.2% and 1.0%, respectively, before rising slightly by about one-quarter of a percentage point in 2015 when economic growth gains momentum.

EU Adverse Scenario (ESRB)

The adverse scenario, designed by the ESRB, reflects the systemic risks that are currently assessed as representing the most pertinent threats to the stability of the EU banking sector: (i) an increase in global bond yields amplified by an abrupt reversal in risk assessment, especially towards emerging market economies; (ii) a further deterioration of credit quality in countries with feeble demand; (iii) stalling policy reforms jeopardising confidence in the sustainability of public finances; and (iv) the lack of necessary bank balance sheet repair to maintain affordable market funding. The negative impact of the shocks, which include also stress in the commercial real estate sector, as well as a foreign exchange shock in Central and Eastern Europe, is substantially global. In the EU, the scenario leads overall to a cumulative deviation of EU GDP from its baseline level by –2.2% in 2014, –5.6% in 2015, and –7.0% in 2016. The EU unemployment is higher than its baseline level, by 0.6 percentage points in 2014, by 1.9 percentage points in 2015 and by 2.9 percentage points in 2016. For most advanced economies, including Japan and the US, the scenario results in a negative response of GDP ranging between 5–6% in cumulative terms compared to the baseline.

Source: European Banking Authority, www.eba.europa.eu

A.3. Stress-Testing Frameworks in Selected Jurisdictions

254. Stress testing is defined as a “what if” exercise that measures the sensitivity of a portfolio, an institution or a financial system to major changes in the macroeconomic environment or to exceptional but plausible shocks. A stress test can be conducted either at the portfolio level or the aggregate level. While portfolio-level stress testing measures the portfolio-level exposure to certain risks, an aggregate stress test is defined as a measure of the vulnerability of a group of reporting firms to specific stress scenarios.

255. The difference between an aggregate stress test and a portfolio stress test is that the objective of an aggregate stress test is to help regulators to identify structural vulnerabilities and overall risk exposures in a financial system that could lead to the disruption of financial markets. In contrast, the objective of a portfolio-level stress test is to assess and manage risks within the institution.

256. Two other widely used terms in stress testing are top-down (TD) and bottom-up (BU) approaches. In 2011, the IMF conducted an online survey among 23 jurisdictions, including G-20 countries. Of the 23 jurisdictions, seven were emerging markets and 16 were advanced economies. All responders shared a broadly similar working definition, where a BU was defined as an exercise implemented by individual institutions using their internal data and models, but based on common assumptions provided by a central authority. In contrast, the TD test is implemented solely by the central authority. The data used for TD tests is either confidential supervisory data or publicly available institution-by-institution data, or both.⁸⁷

257. Stress tests are also classified as macroprudential and microprudential – or “macro” and “micro” – stress tests. Macroprudential stress testing is supervisory-level stress testing.

258. Today, in practice, most of the authorities conduct macroprudential stress tests by using both the TD and BU approaches, thus utilising the complementary strengths of each approach. The strength of TD testing lies in the fact that it can impose a more uniform methodology, whereas the strength of BU testing is that it reflects each bank’s own risk profile more accurately.

259. However, elsewhere there are some similarities and differences in terminology interpretation. The following section gives a broader overview of the stress-testing practice in selected jurisdictions.

⁸⁷ IMF, *Macrofinancial Stress Testing: Principles and Practices – Background Material*, <https://www.imf.org/external/np/pp/eng/2012/082912a.pdf>.

Selected Jurisdictions

Pakistan⁸⁸

260. The mandatory tests cover credit, market and liquidity risk, and contain three levels of shocks under each scenario. The three levels of shocks are defined as: (i) minor, (ii) moderate, and (iii) major shocks. This classification reflects the intensity of the shocks and magnitude of their impact. In total, 16 stress scenarios/shocks are defined.

261. Mandatory stress tests are minimum requirements to promote a culture of stress testing in banks/development financial institutions (DFIs). However, the State Bank of Pakistan encourages banks/DFIs to conduct additional stress tests, for their in-house consumption, that are commensurate with the size and complexity of their operations.

Malaysia⁸⁹

262. Given the margin for error in modelling techniques and key assumptions used in the conduct of stress tests, and the inherent limitations of both the TD and BU approaches, the combination of multiple stress-testing approaches in Malaysia serves to support a more robust assessment of systemic stability and institutional soundness. These approaches are further explained below.

Macro Stress Test

263. The macro stress test represents a TD approach that is used to:

- assess system-wide resilience and behaviour under exceptional but plausible risk events;
- identify systemic risks and vulnerabilities, including cross-sector or cross-institution contagion, and the potential spillovers to the broader economy; and
- determine potential system-wide capital and liquidity needs under stress conditions.

⁸⁸ *Guidelines on Stress Testing*, www.sbp.org.pk/bsrvd/2012/c-01-annex.pdf.

⁸⁹ Bank Negara Malaysia, *Guidelines on Stress Testing*, www.bnm.gov.my/guidelines/01_banking/04_prudential_stds/22_stress_test.pdf.

264. Macro stress tests were first used during the Asian Financial Crisis in 1997–8 to form the basis for decisions on the formulation of a holistic resolution strategy to address the crisis. By projecting the potential deterioration in asset quality and impairment in the revenue-generating capacity of banks across the financial system, the stress tests facilitated the assessment of the potential scale, scope and financial resources required of the institutional arrangements that were put in place at that time. Information obtained through the stress tests on the potential losses and capital shortfalls was critical in shaping the recapitalisation and asset carve-out strategies that followed. Since then, macro stress tests have become a regular feature of Bank Negara's (Central Bank of Malaysia) financial stability assessments and are used to evaluate pre-emptive actions by Bank Negara to address emerging risks well before conditions deteriorate to the point of an imminent system-wide crisis. When used in conjunction with sensitivity analyses and other early warning indicators, the macro stress tests provide valuable information for deciding on the nature, timing and calibration of macroprudential policy responses. The results of macro stress tests are deliberated at the Financial Stability Committee of Bank Negara.

Micro Stress Test by Supervisors

265. Micro stress testing by supervisors is a BU approach and is conducted primarily to assess the vulnerabilities and risk-bearing capacity of individual financial institutions. Forward-looking information derived from these tests has become increasingly important to better inform Bank Negara's supervisory assessments and interventions, which aim to identify and address risks in a timely manner. Results of the tests are deliberated on during regular engagements between supervisors and financial institutions to obtain a view on the adequacy of an institution's contingency plans, risk mitigation strategies and financial buffers. Where relevant, the Bank may, based on these engagements, require institutions to increase capital and liquidity buffers, including through adjustments to dividend payments or by reining in expansion plans. In addition, micro stress tests serve to cross-check the results of macro stress tests and stress tests by financial institutions. Supervisory micro stress testing serves a particularly important role in reducing the risk of overdependence on complex and computationally intensive models; in identifying institution-specific vulnerabilities and cross-institutional interlinkages that might be obscured in aggregated data and system-wide estimations; and in encouraging financial institutions to observe an appropriate degree of prudence in conducting internal stress tests and to maintain an adequate focus on tail risks.

Stress Tests by Financial Institutions

266. Stress testing by financial institutions has been a prudential requirement since 1998, a BU approach to complement the macro stress testing. When first introduced, these stress tests were conducted by financial institutions using a set of scenarios and shock parameters prescribed by Bank Negara. This practice offered an opportunity for financial institutions to build internal stress-testing capabilities while providing useful, if relatively generic, insights into the potential vulnerabilities of individual institutions to risks.

267. The three stress-testing approaches are closely coordinated and integrated within the Bank. The macro stress test provides an important robustness check to BU tests, while achieving consistent applications of stress factors across all institutions to support the identification of system-wide vulnerabilities. It can also promptly surface weaknesses in the data quality and risk management models and practices of individual financial institutions. It also fosters a deeper understanding of the impact of collective behavioural responses to stress and the potential for second-order effects arising from systemic linkages between the financial system and the macroeconomy, thus contributing to more comprehensive risk assessments by supervisors and financial institutions.

Japan⁹⁰

Macro Stress Test

268. The Bank of Japan conducts macro stress testing with various scenarios reflecting financial and economic conditions at each point in time and publishes the results in its semi-annual *Financial System Report*. The framework has been improved over time to ensure it appropriately analyses risk factors in Japan's financial system. Current notable features of the bank's macro stress testing are as follows. First, it includes a mechanism reflecting the feedback loop between the financial and economic sectors by using the Financial Macro-econometric Model, a medium-sized structural macro model comprising two sectors: financial and macroeconomic. Second, it can analyse not only aggregate figures such as capital adequacy ratios and net interest income, but also those for individual financial institutions.

⁹⁰ *Macro Stress Testing at the Bank of Japan*, https://www.boj.or.jp/en/research/brp/ron_2014/data/ron141008a.pdf.

Micro Stress Testing

269. Financial institutions started to use stress testing (micro stress testing) in the 1990s as an analytical tool to measure the potential vulnerability of financial institutions. National authorities and international organisations started to use stress testing as an evaluation tool to assess the vulnerability of a country's financial system based on the experience of international financial crises such as the Asian crisis. This was the beginning of macro stress testing.

270. According to the above-mentioned definition, the term “micro stress testing” refers to the BU stress test conducted by financial institutions on a bank-by-bank basis.

European Union⁹¹

Macro Stress Test

271. The European Central Bank (ECB) developed a TD stress-testing framework that currently covers the largest 80–90 banking groups in the European Union (EU). The analysis is of relevance to the ECB from a broad financial stability perspective, but it can also provide important insights that are useful for monetary policy analysis, crisis-related activities and potentially also for macroprudential policy purposes.

Micro Stress Test

272. Micro stress testing is known as EU-wide stress-testing exercises coordinated by the European Banking Authority (EBA). The aim of such tests is to assess the resilience of financial institutions to adverse market developments, as well as to contribute to the overall assessment of systemic risk in the EU financial system. The EBA's EU-wide stress tests are conducted in a BU fashion, using consistent methodologies, scenarios and key assumptions developed in cooperation with the ESRB, the ECB and the European Commission (EC).

United States⁹²

Dodd-Frank Act

⁹¹ *EU-wide Stress Testing*, www.eba.europa.eu/risk-analysis-and-data/eu-wide-stress-testing.

⁹² Dodd-Frank Act Stress Test, 2015: Supervisory Stress Test Methodology and Results, March 2015; www.federalreserve.gov/newsevents/press/bcreg/bcreg20150305a1.pdf.

273. The *Dodd-Frank Wall Street Reform and Consumer Protection Act* (Dodd-Frank Act, or DFA) requires the US Federal Reserve to conduct an annual stress test of bank holding companies (BHC) with US\$50 billion or more in total consolidated assets and all non-bank financial companies designated by the Financial Stability Oversight Council (FSOC) for Federal Reserve supervision. DFA supervisory stress testing is a forward-looking quantitative evaluation of the impact of stressful economic and financial market conditions on BHC capital. This programme serves to inform these financial companies, as well as the general public, how the institutions' capital ratios might change during a hypothetical set of adverse economic conditions as designed by the Federal Reserve. In addition to the annual supervisory stress test conducted by the Federal Reserve, each BHC is required to conduct annual company-run stress tests under the same supervisory scenarios and conduct a mid-cycle stress test under company-developed scenarios.

Comprehensive Capital Analysis and Review

274. The Comprehensive Capital Analysis and Review (CCAR) evaluates a BHC's capital adequacy, capital adequacy process and planned capital distributions, such as dividend payments and common stock repurchases. As part of CCAR, the US Federal Reserve evaluates whether BHCs have sufficient capital to continue operations throughout times of economic and financial market stress, and whether they have robust, forward-looking capital-planning processes that account for their unique risks. If the Federal Reserve objects to a BHC's capital plan, the BHC may not make any capital distribution unless the Federal Reserve indicates in writing that it does not object to the distribution.

Hong Kong⁹³

Macro Stress Testing

275. "Macro stress testing" refers to a range of techniques used to assess the vulnerability of a financial system to "exceptional but plausible" macroeconomic shocks. Increasingly, macro stress testing plays an important role in the macroprudential analysis of public authorities. The

⁹³ *Supervisory Policy Manual*, "Stress-testing", www.hkma.gov.hk/eng/key-information/guidelines-and-circulars/circulars/2003/20030228-1.shtml.

main objective is to identify structural vulnerability and overall risk exposures in a financial system that could lead to systemic problems. In conjunction with stress testing to assess the vulnerability of the portfolios of individual institutions, macro stress testing forms the main part of system-wide analysis, which measures the risk exposure of a group of financial institutions to a specific stress scenario. It can also serve as a tool for cross-checking results obtained by financial institutions' internal models.

276. Macroeconomic stress tests involve two major elements. First, scenarios of extreme yet plausible adverse macroeconomic conditions need to be devised. Second, the impact of the adverse macroeconomic scenarios needs to be mapped on the banks' balance sheets. Through this, the robustness of banks can be evaluated.

Conclusion

277. Overall, in all the jurisdictions we have considered, the terminology used is almost identical. However, the interpretation may differ from one jurisdiction to another. For example, a TD approach in all the above-mentioned jurisdictions refers to the stress-testing approach conducted by the supervisory authority to assess the vulnerability of the whole system against changes in economic and financial conditions.

278. Also, in all the above-mentioned jurisdictions, macro stress testing or macroprudential stress testing is conducted in a TD fashion by supervisors. However, the divergence appears in interpretation of the BU approach. In some jurisdictions – for example, in Japan – the BU approach is used solely by individual banks to stress their portfolios.

279. Interestingly, the definition of macro stress test in Japan includes both approaches – top-down as well as bottom-up; in all the other jurisdictions under consideration, however, the macro stress test is conducted by utilising only a TD approach.

280. In Malaysia, stress testing is classified as follows: (a) macro stress tests, (b) stress tests by financial institutions, and (c) micro stress tests. Macro and micro stress tests are conducted by the supervisory authority using a TD and BU approach, respectively. In contrast, the stress test by financial institutions also utilises a BU approach but conducted on the institutional level using the stress scenarios and shock parameters prescribed by the central bank.

281. In the US, two types of stress testing – namely, CCAR and DFA – correspond, respectively, to macroprudential and microprudential stress tests. CCAR adopts a TD approach, while the DFA adopts both TD and BU approaches.

282. In conclusion, almost all the jurisdictions adopt the same approach of interpreting the terminology in a way that is compliant with the IMF's description. A TD approach is described as an approach implemented solely by the supervisory authority, whereas a BU approach could be utilised by supervisors as well as individual institutions.