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Assessing the stability and resilience of Islamic banks through stress testing under a standardized approach of the IFSB Capital Adequacy Framework

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Abstract - Stress testing is an essential risk management tool that helps financial institutions to identify, assess and mitigate risks in their businesses. Stress tests have been and are an excellent tools for understanding the plausible impact of a "what-if scenario" in the banking industry. The global financial crisis has placed the spotlight squarely on stress tests. Though Islamic banks operate within the similar financial environment, their balance sheet composition calls for different treatment in stress testing.

Stress testing work has been extensively discussed by the international framework such as of Basel Committee on Banking Supervision and Committee of European Banking Supervisors and is reflected in the IMF work as well. However, the existing literature on stress testing is either mostly from conventional banks perspective or is dominated by the qualitative nature from an academic perspective. There is significant gap in the literature to address the specificities of Islamic banks and the stress testing implications. This paper explores this gap.

The paper develops a stress testing matrix – a step-by-step approach, which is used as a benchmark for simulating solvency stress tests for Islamic banks, followed by a stylised numerical example through a tractable Excel-based framework for solvency stress testing. The paper highlights various implications and relationships arising out of solvency stress testing for Islamic banks, including the vulnerability of Islamic banks under defined scenarios, demanding appropriate immediate remedial actions by the Islamic bank on future capital resources and capital needs. The paper notes that stress testing for risk management in Islamic banks seems to be an underdeveloped area where much work at all levels, including by supervisory authorities and market players, is required. Thus, it is hoped that the findings of the paper provide preliminary discussion on developing a comprehensive toolkit for the Islamic banks similar to what is developed by the IMF FSAP programme.

Keywords: Islamic banks, solvency, stress testing, financial stability, excel-based framework, IFSB Capital Adequacy Framework, Alpha (α)

1. Introduction

Almost every aspect of banking, be it Islamic or conventional, is influenced either directly or indirectly by the availability of the capital. Capital plays an important role in the banking industry. This is one of the key factors to be considered when assessing the safety and soundness of a particular bank. An adequate base of capital serves as a safety net for a variety of risks (in particular credit, market, and operational risk), to which a bank is or is likely to be exposed in the course of its banking business. Capital absorbs possible losses and

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thus provides a basis for maintaining the confidence of the depositors. A bank's balance sheet cannot be expanded beyond the level determined by its capital adequacy ratio (CAR). This means that the availability of capital consequently determines the maximum level of assets. Keeping in view the importance of capital in the banking institutions, the regulatory bodies in all jurisdictions prescribe minimum capital requirements under the Basel Capital Accords. The importance of maintaining the regulatory capital requirements and quality capital has been emphasized after the global financial crisis (GFC) of 2008, which produced unexpected influences across the banking industry. This equally applies to institutions offering Islamic financial services (IIFS)[1] because of the nature of Islamic banking operation in the banking industry.

The balance sheet of IIFS varies from its conventional counterparts in a number of ways, which in turn has a direct impact on capital adequacy of IIFS. On the left-hand side of the balance sheet, the Islamic financial instruments are asset-based (*Murābahah*, *Salam* and *Istisnā,* which are based on the sale or purchase of an asset, and *Ijārah* which is based on selling the benefits of such an asset), profit-sharing (*Mushārakah* and *Muḍārabah*), or *Sukūk* (securities) and investment portfolios and funds, which may be based on the above assets. Such instruments may therefore involve exposure to market (price) risk, with respect to assets, as well as credit risk, with respect to the amount due from the counterparty (see Section 2 for more detail on the specificities of IIFS). These specificities of IIFS, in particular relating to solvency (i.e. capital), call for stress testing to ensure the stability and going concern of an IIFS. However, there is a significant gap in the literature to address the specificities of IIFS from the perspective of solvency stress testing implications.

Stress testing has been a useful tool but appeared to be "*less of an issue*" until the GFC (2008), which challenged the global financial systems, indicating the usefulness of this tool in the banks and their respective regulators. Financial stress tests have not only been used as a risk management tool and key component of financial stability analysis but also as a crisis management tool, especially during the financial crisis. As a result, two notable stress testing exercises were conducted. The first exercise was by the US Supervisory Capital Assessment Program in 2009 and another by the Committee of European Banking Supervisors (CEBS) predecessor to the European Banking Authority (EBA) in close cooperation with national regulators and the European Central Bank (ECB) in 2010 and 2011 respectively. This has resulted in deciding the level of capital support and has boosted market confidence, and the revision of stress testing guidelines by the Basel Committee on Banking Supervision (BCBS) and EBA respectively addressed the issues which were not adequately covered in the previous stress testing framework.

The guidelines as mentioned above, however, did not cover the specificities of the IIFS operations, and this gap is successfully filled by the Islamic Financial Services Board (IFSB) in March 2012 by issuing the *Guiding Principles on Stress Testing for IIFS* (also referred as to IFSB-13) in the banking segment. These *Guiding Principles*, built mainly on the BCBS and the EBA framework for level playing field, have prescribed guidance on the issues that should be addressed by the banks and their respective supervisors. However, as such, the *Guiding Principles* do not provide any assistance to the IIFS on how to do stress testing so much as "what to do" principles. Based on the *Guiding Principles,* a *Stress Testing Matrix* (a step by step approach) is developed, as shown in Table 1, which is used as a benchmark for simulating solvency stress tests for IIFS in this paper.

Table 1. Stress testing matrix – step by step approach.

#	Items	Description of items	Remarks
Step:1	**Objective of conducting the stress testing**	• What is the objective of conducting stress testing and forecasting period (i.e., long-term or short-term)?	• Solvency stress testing with one year forecasting period
Step:2	**Risk Factors**	• What are the risk factors that are going to be considered in stress testing (i.e., identification of risk parameters that need to be stressed, e.g., credit risk, market risk, operational risk, displaced commercial risk, liquidity or solvency)?	• CAR with stress alpha (different levels of alpha) • *(Please see Section 2 and Section 4)*
Step:3	**Data requirements**	• Whether the quality data, which is critical in ensuring a successful stress test simulation and its results, is available or proxy data needs to be considered?	• Data relating to solvency stress testing is available and the assumptions are made where the data is not available *(Please see Section 4)*
Step:4	**Scenarios type and Scenarios stress (stress shock)**	• What scenarios are going to be considered – whether *historical scenarios* (i.e. backward looking scenarios) or *hypothetical scenarios* (i.e. forward looking scenarios) • What is the scope of the scenarios (e.g. local, regional, and global)? • What are different levels of stress shock (i.e., mild, moderate and extreme)?	• Combination of both historical and forward looking with expert judgment • Local and regional perspectives • Three stress shocks: business as usual (BAU) – mild, moderate, worst case (extreme) *(Please see Section 4)*

(*Continued*)

Table 1 - *Continued*

#	Items	Description of items	Remarks
Step:5	**Frequency**	• How often stress testing should be conducted (i.e., the frequency of conducting stress testing on the risk factors identified in (step 2) e.g., weekly, monthly, quarterly, semi-annually or an ad-hoc basis?	• Annually and/or ad-hoc basis *(Please see Appendix A)*
Step:6	**Methodology**	• What is the methodology of conducting the stress testing (i.e., sensitivity test analysis and/or scenario test analysis, or reverse stress testing, through appropriate deterministic and/or stochastic (or probabilistic) models? • Which approach will be undertaken either the top-down (TD) or bottom-up (BU) approach?	• Combination of both scenario and sensitivity analysis with deterministic model (using the IFSB-2 CAR formula) • Bottom-up approach *(Please see Section 4)*
Step:7	**Output and remedial actions**	• Using the step 2-step 6, has the output being generated? • Are there any appropriate and meaningful mechanisms for translating the stress test results into actions to support a range of decisions appropriate to the purpose of the stress test (e.g., restructuring the portfolio/ positions, reviewing liquidity adequacy and capital allocation, and risk limits)? • After reviewing the stress test results and having considered certain possible remedial actions, is there any need to undertake further stress testing with some adjustments	• Output demonstrates the deficiency in capital and difficulty in meeting the regulatory requirements • *(Please see Appendix A and Section 5)*
Step:8	**Disclosures**	• Has the IIFS made adequate disclosures of the stress testing results to the BOD and senior management and the supervisory authority? • Does an IIFS require making public the qualitative and quantitative information on the stress testing results?	• At the moment only to BOD and senior management

Source: Author.

Note 1: The above matrix assumes that governance process of stress testing exist in the IIFS (i.e., involving the guidance from the board of directors and supervision of senior management – outlining the ultimate responsibilities for approving and conducting the stress testing in the IIFS) and is included in an IIFS's risk management framework and also promotes a culture of risk identification.
Note 2: Once the IIFS has conducted a stress testing exercise as per the steps identified above, the respective supervisory authority will have to consider examining the stress testing exercise under on-site examination or through off-site surveillance.
Note 3: Once the IIFS has conducted a stress testing exercise as per the steps identified in the Stress Testing Matrix above, as per IFSB-13, the respective supervisory authority should examine the stress testing exercise under on-site examination or through off-site surveillance, among others, the following:

(i) Whether the IIFS have adequate procedures in place to undertake rigorous forward-looking stress testing.
(ii) Whether senior management has been sufficiently involved in the stress testing programme and the BOD is sufficiently informed.
(iii) Review the IIFS' methodologies used in the stress testing exercise and evaluation of the inputs (period of time during which the data sample is taken (normal vs. crisis), sample size, proxy data, simulation of data, etc.) carried out within stress testing methodologies.
(iv) Review whether the IIFS uses output from stress testing results (obtained through stress testing methodologies such as sensitivity and scenario analyses) appropriately, and shares results within the organization (such as with risk managers and senior management) and properly acts upon the results (e.g., by taking remedial actions if sensitivity tests show large adverse outcomes or reveal model weaknesses).

The conceptual and technical understanding of the stress testing has been discussed widely in the academic literature, from a macro stress testing perspective in particular (Sorge 2004; Cihak 2004a and 2004b; Jones et al 2004; Hoggarth et al 2005; Alfaro and Drehmann 2009; Foglia 2009; Otani et al 2009; Rouabah et al 2010; Souto 2010; Buncic and Melecky 2011; Borio et al 2012). However, the discussion has been centered toward assessing the implications for the conventional banks rather than the implications for the Islamic banks. This is could be argued due to a lower number of Islamic banks worldwide compared to their conventional counterparts. This highlights a significant gap that this paper attempts to capture.

This paper particularly focuses on developing the solvency stress tests, under standardized approach, as per the IFSB Capital Adequacy Framework (IFSB-2),[2] under various assumptions and stress scenarios parameters specific to IIFS, as the IFSB-2 calls for different treatment for the Islamic banks. The following three *key objectives* are deliberated in this paper:

- To facilitate designing and simulating of the solvency stress tests, under standardized approach as per the IFSB-2, including the establishment of macro-financial links, running scenarios with a variation of various assumptions, and stress scenarios parameters (such as regulatory push to minimum capital requirement with various levels of stressed alpha (α))
- To provide a stylised numerical example through a tractable Excel-based framework, on which the IIFS can withstand additional regulatory requirements and show that they would remain in compliance with all capital requirements after moderate to severe shocks
- To comprehend the potential remedial actions plan (as part of the stress testing matrix – a step by step approach to conducting solvency stress testing) envisaged by the IIFS for potential capital deficiency as a result of solvency stress testing and supervisory response

After employing two-stage methodologies in the solvency stress testing, the results suggest that the *Post-shock* CAR impact highlights the vulnerability of IIFS under defined scenarios and necessitate as an appropriate remedial action by the IIFS on future capital resources and capital needs, including main assumptions and drivers of movements in capital needs. The simulation also indicates that there exists a positive relationship between CAR and the volume of PSIA. This means that the CAR ratio is more sensitive to the PSIA ratio and has a multiplier effects on CAR. Furthermore, the simulation provides the impact on capital adequacy as a hypothetical supervisory adjustment of "alpha" (please refer to Section 2 and Section 4 for more detail on alpha) to a higher value under normal conditions and under stressed conditions. This explains how IIFS's capital adequacy is affected under different values of the "alpha" parameter and the implications of the stressing. Considering minimum CAR of 8% in the jurisdiction and different values of alpha, it is evident that the CAR for IIFS is highly sensitive to changes in the values of "alpha." For the same level of alpha, increase of PSIA financed assets in percentage terms increases CAR and, for the same level of PSIA financed assets, an increase in alpha reduces CAR.

The remainder of the paper proposal is organised as follows. Section 2 provides an overview of specific issues of Islamic bank emphasising particular stress test – the solvency stress test. Section 3 covers a literature review on the stress testing framework. Section 4 explains the data and methodology used. Section 5 analyses simulation results and discusses the implications and key issues in stress testing. Finally, Section 6 concludes and offers a way forward followed by an Appendices.

2. Specific issues of islamic bank requiring particular stress testing

Before identifying gaps in the existing framework with regard to stress testing for IIFS, it is necessary to comprehend the uniqueness of Islamic finance in the banking industry. The unique features of an IIFS call for special treatment (i.e. customisation in developing and executing the stress testing) in the stress testing exercise due to its diverse composition (i.e. different types of exposures) of the balance sheet in different jurisdictions (please see Figure 1). The underlying unique features of Islamic finance for Islamic banks are explained below:

2.1. Specificities of Islamic finance

The underlying unique features of Islamic finance for Islamic banks includes, among others:

- **Basis of *Shariah*:** *Shariah* (Islamic law) forms the basis of the framework of Islamic finance. The *Shariah* is derived from primary and secondary sources.[3]
- **Prohibitions:** The following are specifically prohibited – '*Riba*' (interest), '*Gharar*' (uncertainty – about the subject-matter and terms of contracts; this includes a prohibition on selling something not owned), '*Maysir*' (gambling, hoarding, and dealing in unlawful goods or services). Followed by these prohibitions, Islamic banks structure their products and processes according to *Shariah* rules and principles.
- **No re-pricing of sale contracts (*Murābahah)*:** Under Islamic finance, once the sale price is fixed for financing in *Murābahah*, the IIFS cannot claim more than the pre-fixed sale price, even if the assets were to become 'non-performing' or the benchmark has been changed either upward or downward.
- **Asset-backed nature of structures:** Typically all Islamic structures followed by an Islamic bank have an underlying assets backing the deal.
- **Adherences to procedures align with *Shariah* rules and principles:** Each *Shariah*-compliant financial contract is required to adhere to certain procedures. When a transaction misses a certain stage, the transaction will be rendered invalid in accordance to *Shariah* rules and principles. For example, in a *Murābahah* transaction, an IIFS is permitted to earn profit only as a reward for risks undertaken as evidenced by the IIFS taking prior possession of the asset. If the IIFS does not have prior possession, the transaction will be considered invalid. In this scenario, the IIFS need to carefully structure their transactions and adhere to procedures and steps to ensure that the profits earned are according to *Shariah* rules and principles.

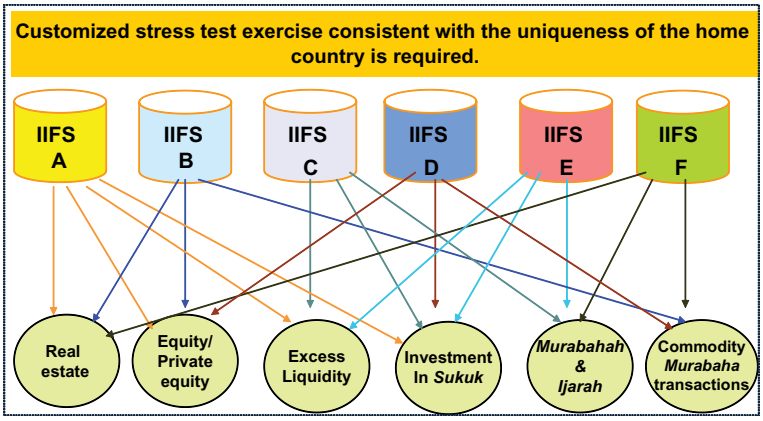


Figure 1. Diverse composition of balance sheet of IIFS in different jurisdictions.
Source: Author's study from various IIFS' annual report.

- **Risk transformation:** another unique feature is the existence of transformation of risk on the balance sheet of an Islamic bank. At different contract stages, transformation of risk takes place in *Shariah*-compliant financial contracts. For instance, in *Murābahah* transaction, the market risk transforms into the credit risk (i.e., market risk is applicable before selling the *Shariah*-compliant commodities to the counterparty and after selling to counterparty market risk converts into credit risk when the payment is on deferred terms) – see Table 2 above.

Based on the abovementioned explanation, the unique features of Islamic finance give rise to specific risks and issues as the balance sheet structure of an Islamic bank is different compared to the conventional institutions and, thus, they require additional work on risk assessment, measurement and management. Notably, the following specificities should be taken into consideration, as addressed by the IFSB:

- Unique risk characteristics of Islamic financial transactions and contracts have called for guidance on risk management controls from the perspective of an Islamic bank (addressed in IFSB-1)[4]
- In the capital adequacy of the Islamic bank, the calculation of risk weighted assets in each contract requires the recognition of various stages and requires special attention to investment account holders (IAHs) (addressed in IFSB-2)
- The presence of IAHs in the Islamic bank needs governance committee to protect the rights of IAHs (see IFSB-3)[5]
- Above all, the *Shariah*-compliance requirements in all aspects of the Islamic bank operation also need adequate *Shariah* governance system (see IFSB-10)[6]

2.2. Balance sheet structure of an Islamic bank and key issues for stress testing

In addition to specificities of Islamic finance as presented in Section 2.1, it is worth highlighting the balance sheet structure of an Islamic bank, which is also different compared to the conventional institutions (banks) and has different effects on risk management (please refer to Figure 2). In addition to the traditional banking risks (such as credit, market and operational risks), Islamic banks are also exposed to other specific risks such as *Shariah* non-compliance risk, fiduciary risk,[7] rate of return risk,[8] and displaced commercial risk (DCR).[9] Hence, while conducting transactions in the Islamic banks, there exists transformation of risk, which is inherited in the *Shariah*-compliant transactions (based on the types and stages of the contracts – see Table 2). Such specific risks should be well captured in stress testing scenarios, analysis and measurement of regulatory or economic capital.

2.2.1. Solvency (capital adequacy relating stress testing) – specific issues

As noted in the Section 2.1 under the *Shariah* rules and principles, once the sale price is fixed for financing, even if the assets were to become 'non-performing' or the benchmark has been changed either upward or downward, the IIFS cannot claim more than the pre-fixed sale price. Thus IIFS will be exposed to benchmark risk that should be captured through stress testing techniques to comprehend the vulnerability of an Islamic bank in the volatile benchmark regime. Hence, the need to ensure the solvency of an IIFS where, unlikely but not impossible, extreme price/rate changes are experienced.

An increase in capital requirements imposed by regulators or supervisors forces the Islamic bank to cut and decrease the

Table 2.

Applicable stage of the contract	Market risk	Credit risk
Asset available for sale	Applicable	N.A
Asset sold to customer	N.A	Applicable

Source: IFSB-1 (2005).

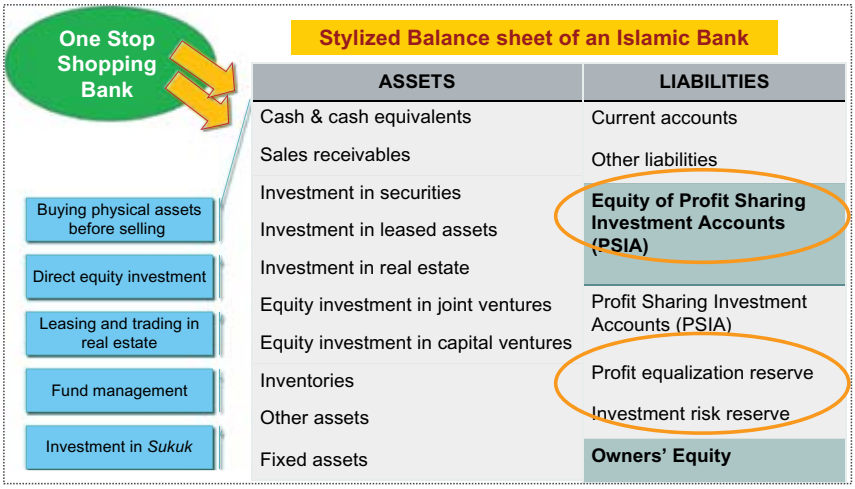


Figure 2. Stylized balance sheet of an Islamic bank.
Source: Author's study from various IIFS' annual report.

availability of financing for individuals and corporations. This regulatory burden should be stressed by Islamic banks in their stress testing programs which is taking into account the differences identified by the IFSB-2 in terms of capital adequacy. Capital adequacy is one of indicators of an Islamic bank's soundness. Hence, in order to determine capital assessment of the Islamic bank (i.e., whether an IIFS is undercapitalised), the stress testing techniques would be significant, and it will let us know how an Islamic bank's capital adequacy position will be affected in regard to crisis, also how much capital they may need in order to absorb losses and sustain financing.

In addition, while calculating the capital adequacy of an IIFS, when the supervisory discretion version of the CAR formula is applied, a proportion ("α (alpha)"[10]) of the risk-weighted assets financed by PSIA is included in the denominator of the CAR; thus the risk weights apply only to the proportion α of the assets financed by PSIA. It is important to take into account the stress conditions when determining alpha. DCR is likely to be higher during stressed conditions as investment returns tend to be lower. This increases the need for the Islamic bank to draw upon its reserves/shareholder funds in order to maintain the same level of payout to IAH. What will be the value of α used by Islamic bank under stress conditions? Therefore, stress testing techniques are required for determining the appropriate weight of α, which will be used for capital adequacy while employing a supervisory discretion formula in the denominator of CAR.

DCR is also an important consideration for the IIFS, especially with respect to recent smoothing practices among Islamic banks. Stress testing techniques are needed to determine the circumstances on the utilization of reserves – such as profit equalisation reserve (PER)[11] and investment risk reserves (IRR)[12] – to inquire whether they are sufficient enough to cover unexpected losses. Different stress testing scenarios will be needed to absorb abnormal shocks in times of stress.

In terms of credit risk, while calculating the CAR, *Shariah*-compliant risk mitigation techniques employed by the Islamic banks also requires considerations in the stress testing program, in particular to systematically challenging these mitigation techniques in the stress testing exercise (as not all the risk mitigation techniques are applicable to the IIFS, compared to their conventional counterparts).

Another risk factor relating to credit risk is non-performing financing (NPF) that will essentially determine the overall soundness of the Islamic bank, particularly in the case of economic downturns. Under standardised approach for credit risk, stress testing should reflect how an Islamic bank will be affected under various defaults which increases NPF which may erode net income of the Islamic bank. From this perspective, credit risk implications will be different in different contract cases, which will require the IIFS to consider different scenarios for stress testing. For instance, financing extended through predominantly *Murābahah* may require Islamic banks to consider different types of scenarios compared with *Ijarah* and *Istisna*.

Another consideration for the Islamic bank is defaults due to restrictions on recovery mechanisms. Hence, stress on default, either on total or selected portfolios, is regularly needed. The concentrations should be identified, and stress tests should be conducted on notably large concentrations.

With respect to market risk, while calculating CAR of an Islamic bank, it is important to note that an Islamic bank's investment book consists of investments in *Sukūk*, which are also prone to market shocks. So stressing the different types of *Sukūk* investment (i.e., variable rate *Sukūk* such as *Ijarah,* fixed rate *Sukūk* such as *Murābahah*, and *Mushārakah* or diminishing *Mushārakah, etc.)* undertaken by the Islamic banks is also imperative for the Islamic bank. In addition, the stress testing programs should also include the *Shariah*-compliant securitization at an Islamic bank. In this regard, the stress testing for capital treatment for the securitization exposures of an Islamic bank should be conducted where it acts in a capacity of an originator of a *Sukūk* issue, or as an issuer or servicer of a *Sukūk* issuance – that is, securitization exposures as mentioned in IFSB-7.[13]

3. Literature review and gaps

3.1. Conceptual understanding of the term "stress testing"

As defined by the BIS,[14] "stress testing" has been adopted as a *generic term describing various techniques used by financial firms to gauge their potential vulnerability to exceptional but plausible events.* In simple words*, stress testing is a process, which provides information on the behaviour of the financial system under a set of exceptional, but plausible, assumptions*. Stress tests, therefore, provide forward-looking assessments of risks to institutional level and system level. At institutional level, stress testing techniques provide a way to quantify the impact of changes in a number of risk factors (such as market risk, liquidity risk, credit risk, etc.) on the assets and liabilities of the institution. At the system level, stress tests are primarily designed to quantify the impact of possible changes in the economic environment of the financial system. The system level stress tests also complement the institutional level stress testing by providing information on the sensitivity of the overall financial systems to a number of risk factors. These tests help the regulators to identify structural vulnerabilities and the overall risk exposure that could cause disruption of financial markets.

3.2. General literature on the stress testing

Generally, stress testing has been discussed widely in the literature, in particular from a macro stress testing perspective (Sorge, 2004; Cihak, 2004a and 2004b; Jones *et al.,* 2004; Hoggarth *et al*., 2005; Alfaro and Drehmann, 2009; Foglia, 2009; Otani *et al*., 2009; Rouabah *et al.,* 2010; Souto, 2010; Buncic and Melecky, 2011; Borio *et al*., 2012). The financial crisis of 1990s led policy makers, researchers and practitioners to be more sensitive about vulnerability in financial systems. Among techniques, stress testing is considered one of the most reliable and trustworthy (Crockett, 1997).

According to Čihák (2007), stress testing is a generalized concept, which compiles a variety of techniques to study resilience to extreme events. Stress tests are valid and quite reliable to study stability of a given system or entity. In financial sectors, earlier stress testing is underestimated by applying it only on asset portfolios, but with the passage of time stress testing is applied not only on banks themselves but it is also functional on banking and financial systems as well.

Stress tests are particularly important from the perspective of supervisory authorities and policymakers because they provide useful benchmarks to assess the risks to the financial system as a whole (Čihák, 2004b). Accordingly, stress tests also help develop knowledge in a risk assessment framework among the supervisors and the financial institutions engaged in the process, and encourage collaboration and wider understanding and perception of risks by different regulatory institutions. In turn, this can contribute to a better understanding of the links between the financial sector and macro-level economy (Čihák, 2005b).

It has been noted that both Islamic and conventional banks managed to maintain a strong aggregate capital adequacy ratio in the post-shock scenario. However, intensity of change in the CAR was different for both groups of banks. The CAR ratio has increased by 1.6 percent in 2010, from 13.78 per cent in 2006, for conventional banks; however, the Islamic banks' CAR ratio has declined by 3.3 percentage point. This reflects more resilience shown by conventional banks, though at least 17.6 per cent of conventional banks have reported a capital ratio of less than 10 percent in 2010. This ratio, nevertheless, has improved considerably compared to earlier years in the period under review. This is also confirmed by the fact that conventional banks have assumed a rising trend in capital adequacy ratio in both scenarios as compared to a declining trend for Islamic banks.

International Monetary Fund (IMF) used stress tests to examine the financial stability in their member countries. IMF also used this test to forecast the potential threats for the stability of member countries' financial systems. IMF and WB jointly performed stress tests as part of the Financial Sector Assessment Program (FSAP). Since then the FSAP has been implemented so far in 120 countries and has addressed a variety of risks – essentially the credit risk, market risk, liquidity risk, and contagion risk. Many of these assessments are available on IMF and WB websites.

In particular, there are two recent papers published by the IMF that are worth mentioning. One is by Schmieder, Christian et al. (2012) on "*Next Generation System-Wide Liquidity Stress Testing,*" in which a framework to run system-wide, balance sheet data-based liquidity stress tests is presented. The paper covered a liquidity framework with three elements: (a) a module to simulate the impact of bank run scenarios; (b) a module to assess risks arising from maturity transformation and rollover risks, implemented either in a simplified manner or as a fully-fledged cash flow-based approach; and (c) a framework to link liquidity and solvency risks. In the paper, the framework also allows the simulation of how banks cope with upcoming regulatory changes (Basel III), and accommodate differences in data availability. A case study shows the impact of a "Lehman" type event for stylized banks.

The second paper is by Schmieder, Christian et al. (2011) on "*Next Generation Balance Sheet Stress Testing.*" This paper presents a "second-generation" solvency stress testing framework by extending applied stress testing work centered on Čihák (2007). The main contributions of this paper include (a) increasing the risk-sensitivity of stress testing by capturing changes in risk-weighted assets (RWAs) under stress, including for non-internal ratings based (IRB) banks (through a quasi-IRB approach); (b) providing stress testers with a comprehensive platform to use satellite models, and to define various assumptions and scenarios; (c) allowing stress testers to run multi-year scenarios (up to five years) for hundreds of banks, depending on the availability of data.

In 2012, Elsiefy conducted a stress test based on one sensitivity scenario. The test comprehended three kinds of risks, namely, credit risk, interest rate risk, and exchange rate risk. The mentioned analysis was conducted on five years of data (2006–2010). The sample included five conventional and 3 Islamic banks. He concluded that the pre-test CAR for the banking sector increased by only 1.1 percentage point between 2006 and 2010. He also observed that pre-shock CAR was 15.23% in 2006, which was increased up to 16.4% in 2010. Over the same period, post–test CAR has increased by 1.52 percentage point to

stand at 13.49 per cent in 2010, as compared to 11.96 per cent in 2006. The fact that this increase in the post-test scenario was higher than the increase in the pre-test CAR suggests that the overall pool of risks in the banking sector has declined.

3.3. Guidance from existing international framework for stress testing

In response to the current financial crisis, the financial industry, particularly the banking segment, has witnessed several regulatory developments among different standard setting bodies to deal with various prudential concerns. One of the prudential concerns has been to enhance and strengthen the existing stress testing framework from a financial stability point of view. Significant contributions by the BCBS, CEBS, and Committee on the Global Financial System (CGFS) in the area of stress testing are reflected in the following subsections.

In order to comprehend the stress testing practices among financial institutions, the guidance provided by the BCBS is very helpful in understanding the relevance of stress testing for the Islamic banks. This paper notes that broadly the BCBS has benefited from the comprehensive work of BIS-based CGFS in regard to stress testing. As a result, the BCBS introduced stress testing both in Pillar I and Pillar II of the Basel II framework, issued in June 2006. Subsequently, given the various developments in the industry, particularly in response to current financial crisis, the BCBS has enhanced the specific guidelines for stress testing practices by issuing *Principles for Sound Stress Testing Practices and Supervision* in May 2009. The BCBS document sets out a total 21 points comprising 15 "principles" for banks and 6 for supervisors.

The CEBS published its revised *Guidelines on Stress Testing* in August 2010. This CEBS document contains 22 points comprising 17 "guidelines" for banks and 5 for supervisors. The revised guidelines updated the *Guidelines on Technical Aspects of Stress Testing under the Supervisory Review Process* that were published in 14 December 2006, and complement the principles set out in the CEBS's *Guidelines on the Application of the Supervisory Review Process* under Pillar 2. The revised guidelines draw on the experience that supervisors have obtained by reviewing institutions' stress tests in recent years, and take account of the revised principles for sound stress testing practices and supervision published by the BCBS. The CEBS's guidelines are mainly built on BCBS guiding principles, which are supplemented by a range of annexes that focus on the stress testing of specific risks. The annexes explain the implementation of the general stress testing principles in the respective risk areas and illustrate existing supervisory expectations in those areas.

The Bank for International Settlements (BIS)-based CGFS, which monitors the stability of global financial markets for the G10 governors, has made significant contribution in the area of stress testing through conducting comprehensive studies on the practice of stress testing and its role in the risk management. For instance, CGFS has sponsored a task force (March, 2000) and working group (May 2004) on stress testing: i) to study the role of stress testing in risk management; ii) to identify which exceptional events were considered by market participants to be significant risks; and iii) to develop information on the heterogeneity of risk-taking at a point in time.

3.4. Gaps in the general literature on the stress testing

Though there seems to be extensive literature (including the international framework by BCBS and CEBS) on stress testing from many dimensions, it has skewed towards assessing the implications for the conventional banks rather than discussing the implications for the Islamic banks. It could be argued that this is due to the minority of the Islamic banks operating in society compared to their conventional counterparts.

In addition, one recent paper by Elsiefy (2012) covered three Islamic banks, but this paper as well seems to ignore the specificities of Islamic banks in terms of solvency (i.e., the capital adequacy requirement). The paper has not recognised the specific requirements such as the loss absorbency features of the IAHs and the role of "alpha" factor in the calculation of CAR of the Islamic banks. Also the scenarios and tests run in the paper lack the forward-looking assessment of the IIFS and the role of the supervisor to ensure that IIFS have considered specific characteristics, especially related to risk characteristics, capital adequacy and the position of IAHs, which is also an important stress testing exercise, yet it is not considered.

Therefore, it could be said that the existing framework focuses on the traditional risk, such as credit, market, and operational risk. However, it does not provide guidance on specific risks that the IIFS has exposed, such as *Shariah* non-compliance risk, fiduciary risk, rate of return risk, and DCR, which needs to be stressed by the IIFS. It also does not take into account the specific scenarios placing special attention on the presence and impact of the IAHs on the IIFS. This gap is addressed by the IFSB as highlighted below.

3.4.1. Guidance from Islamic Financial Services Board (IFSB)

In March 2012, in line with its mandate to promote the soundness and stability of the Islamic financial services industry (IFSI), the IFSB published *Guiding Principles on Stress Testing* for IIFS in the banking segment of the IFSI (IFSB-13) to address the specificities of IIFS with respect to stress testing. While addressing the specificities of the IIFS, the Stress Testing Working Group was tasked to prepare the IFSB-13 in order to acknowledge the significance of existing internationally recognised frameworks that sets-out sound principles and best practices pertaining to stress testing for conventional counterparts.

The IFSB intended that its guiding principles, as set out in IFSB-13, should incorporate the BCBS and CEBS while making appropriate adaptations to take into account the specificities of IIFS in terms of their risk exposures. In line with the BCBS and CEBS' framework on stress testing, IFSB-13 provided a comprehensive stress testing framework for both IIFS and supervisory authorities. The 29 Guiding Principles in IFSB-13 aim to provide a set of guiding ideas intended to complement the existing international stress testing framework, while taking into consideration the

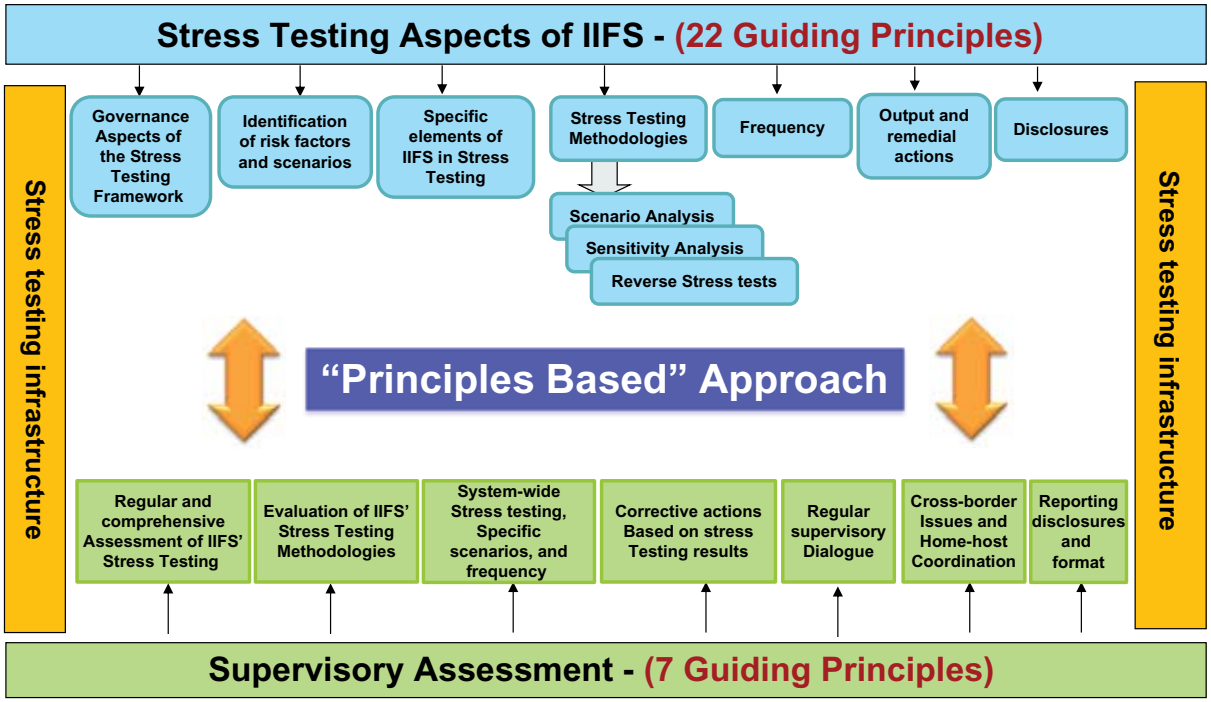


Figure 3. Stress testing framework by IFSB-13.
Source: Adapted from IFSB-13.

Twenty-two (22) guiding principles provide a framework for the Islamic banks with the aim to guide them in assessing and capturing vulnerabilities under various stress-testing scenarios including extreme but plausible shocks, in order to achieve the following, *inter alia*:

i. Identify how different portfolios respond to changes in key economic variables (e.g., benchmark rates,[15] foreign exchange rates, credit quality, etc.)
ii. Assess the quality of assets to identify existing and potential loss exposures
iii. Evaluate potential threats to the IIFS's ability to meet its financial obligations at any time arising from either funding or market liquidity exposures
iv. Estimate the impact of stress events on baseline profit (as profits normally act as the first line of defence before dipping into capital)
v. Analyse the IIFS's ability to meet its capital requirements at all times throughout a reasonably severe economic recession.

There are seven guiding principles for supervisory authorities, which can be used:

i. As surveillance tools for periodically testing the safety and soundness of the financial system (including IFSI)
ii. From a financial stability perspective, to identify "weaknesses" in the financial system and structural (systemic) vulnerabilities arising from the specific risk profiles of IIFS individually and collectively
iii. As a supervisory tool for designing macro-prudential policies.

specificities of IIFS as well as the lessons learned from the financial crisis in order to contribute to the soundness and stability of the IIFS, in particular, as well as the Islamic financial services industry on whole. The framework is reflected in Figure 3, and objectives of the IFSB-13 are presented below.

4. Data and methodology

4.1. Data requirements and depiction

Initially the study extracted data from Bankscope and Annual Reports four cross-borders operating Islamic banking Groups (at consolidated level) from four GCC countries from 2007–2012,[16] such as Dubai Islamic Bank Group (UAE), Al Rajhi Group (KSA), Kuwait Finance House Group (Kuwait) and AlBarakah Group (Bahrain). After thorough examination of the data, it emerged that granularity of the data and relevant details on the calculation process with respect to risk weighted assets (RWA) are not satisfactory to perform the solvency stress testing on actual banking group due to the following reasons:

- Lack of implementation of IFSB-4 (i.e., transparency and market discipline), as most of the banking group are following Basel II Pillar III approach
- Banking groups summarise the capital requirements for credit risk, market risk and operational risk,

but there are no clear disclosures on how the components of credit RWA (such as individual claims based on ECA, short-term exposures, exposures under profit sharing mode, exposures with preferential risk weights, past due receivables, and off-balance sheet exposures), and market RWA related components (such as total equity risk capital charge, total specific risk capital charge for Sukuk positions, total general risk capital charge for *Sukuk* and off-balance sheet financial instruments, total foreign exchange capital charge, total commodity risk capital charge, total inventory risk capital charge) are calculated
- There is no detail on the segregation of funds used for financing assets, that is, percentage of assets financed by group funds and through IAHs funds
- The CAR calculations do not indicate any impact of IAHs and related DCR, that is, how the IAHs are treated in the CAR

In the light of above shortcoming in the data, and using the data of the one of the groups after certain amendments and related assumptions, the study develops a stylised numerical example through a tractable Excel-based framework for solvency stress testing purposes to explain the stress testing process. The details of simulated data (including the capital structure, credit RWA, market RWA, other relevant information) with respect to IFSB CAR is presented in the Section 5 and in Appendix A.

4.2. Methodology

The methodology of this study employs two stage processes. Before applying the stress scenarios and shocks as indicated in Table 3, the CAR computation is required. Therefore, in the *first stage*, the CAR of the IIFS is calculated using the IFSB formulas, depending on how the IAH are treated in the respective jurisdiction, as shown below.

The IFSB issued its *Capital Adequacy Standard* (IFSB-2) for IIFS in December 2005. The IFSB-2 addressed specific structure and contents of the *Shariah*-compliant products and services offered by the IIFS and also provided detailed guidance on calculating capital adequacy requirements for IIFS. The IFSB-2 is largely based on the Basel approach, with the necessary modifications and adaptations to cater for the specific nature and characteristics of the *Shariah* compliant products and services. It uses risk weights derived from those proposed in Basel II due to the lack of historical data to modify risk weights for IIFS.

It should be noted that the underlying contract for IAHs is the "*Mudarbaha,"* which in principle does not allow the guaranteeing of either capital (principle) or fixed return on capital. Nevertheless, the pure *Mudarbaha* structure is rare in the Islamic banking industry from the capital adequacy requirements perspectives and it is mainly termed as the *'supervisory override'* on the basic structure of the PSIA due to supervisory prudential considerations. In the standard formula, it is assumed that the IIFS follows pure *Mudarbaha* and supervisory discretion formula assumes that IAH are treated as partially risk absorbent, so that the IIFS bears part of the earnings volatility of the assets funded by their investment. In such a case, IIFS include a corresponding proportion (known as 'alpha' (α)) of the credit and market risk-weighted assets financed by unrestricted IAH in the denominator of the capital adequacy formula. Both of these approaches are explained below:

(a) ***The standard formula (SF):*** The main principle under SF is that IAHs bear 100% of credit and market risk of assets funded by IAH and IIFS bears 100% of operational risk.[17] This highlights that in the absence of any smoothing of the profit payouts[18] to IAH by an IIFS, the IIFS is not required to hold regulatory capital with respect to commercial (i.e. credit or market) risks arising from assets funded by PSIA. This implies that the RWA funded by such accounts are excluded with respect to commercial risks in calculating the denominator of the CAR, leaving only the operational risk. This is called the "standard formula" and is calculated as follows:

$$\frac{\text{Eligible Capital}}{\{\text{Total RWA}^{19}\ (\text{Credit}^{20} + \text{Market risks}) + \text{Operational risk} \quad \text{Less} \quad \text{RWA funded by PSIA}^{21}\ (\text{Credit} + \text{Market risks})\}}$$

(b) ***The supervisory discretion formula (SDF):*** The main principle under SDF is that an IIFS bears a proportion of credit and market risk of assets funded by IAH.[22] The Greek letter "(α) alpha" is the corresponding proportion of assets funded by unrestricted PSIA, as determined by national supervisors. Similar to SF, IIFS bears 100% of operational risk. The CAR under this formula is calculated as follows:

$$\frac{\text{Eligible Capital}}{\{\text{Total RWA (Credit + Market risks)} + \text{Operational risk} \quad \text{Less} \quad \text{RWA funded by restricted PSIA (Credit + Market risks)} \quad \text{Less} \quad (1-\alpha)\ [\text{RWA funded by unrestricted PSIA (Credit + Market risks)}] \quad \text{Less} \quad \alpha\ [\text{RWA funded by PER and IRR of unrestricted PSIA}^{23}\ (\text{Credit + Market risks})]\}}$$

In both formulas:

- **Credit RWA comprise:** Individual claims based on external credit assessments,[24] short-term exposures, exposures under profit sharing mode, exposures with preferential risk weights, past due receivables, and off-balance sheet exposures. (see Table A2 in Appendix A)
- **Market RWA contain:** Total equity risk capital charge, total specific risk capital charge for Sukuk positions, total general risk capital charge for Sukuk, and off-balance sheet financial instruments, total foreign exchange capital charge, total commodity risk capital charge, total inventory risk capital charge. (see Table A3 in Appendix A)

Table 3. Stress scenarios.

Description	***Remarks***
20% ↓ (reduction) in the RWA (CR & MR) *funded by unrestricted PSIA* under moderate shock and 30% ↓ (reduction) under a sever shock	This means IIFS's funding (which is *50% of total credit RWA and market RWA under BAU*) will be left to *30% of total credit RWA and market RWA*) under moderate and 20% under severe shock respectively It is assumed that this reduction is top-up by the IIFS through other sources of funding. In addition, *RWA (CR & MR) funded by restricted IAH/PSIA would be NIL as IIFS does not offer restricted investment accounts* Further, RWA funded by PER and IRR (CR + MR) are 10% of *unrestricted PSIA/IAH*
RWA funded by PER and IRR (CR + MR)	Keeping constant, no change in the % for moderate and severe impacts
Stressed level of alpha: (a) $\alpha = 0.3$ to $\alpha = 0.5$ (b) Change in CAR assuming $\alpha = 0$ and $\alpha = 1$	The actual level of alpha depends on the respective jurisdiction and the values of alpha vary from 0 to 1 In this simulation, two extreme values and two values between 0 and 1 are considered to see the impact on the CAR
Credit RWA: • With moderate shock of 20% ↑ (increase) and a severe shock of 40% ↑ (increase) for *RWA of individual claims based on ECA category*, with 20% discount (haircut) to the amount of collateral, under comprehensive approach • With moderate shock of 20% ↑ (increase) and a severe shock of 40% ↑ (increase) for RWA for *exposures with preferential risk weights*, in particular, for *Murabahah or Ijarah* collateralized by commercial real estate, due to significant drop in housing prices	The minimum CAR are 8% in the IIFS
Market RWA: • With moderate shock of 15% ↑ (increase) and a severe shock of 40% ↑ (increase) in *total equity risk capital charge* due to significant drop in stock prices • With moderate shock of 15% ↑ (increase) and a severe shock of 40% ↑ (increase) for total *specific risk capital charge for Sukuk positions* taking into account the rating Downgrade of *Long term Sukūk (with the maturity of >1 to ≤5)* from AAA to AA– (2% haircut) to BB+ to BB– (15%) • With moderate shock of 15% ↑ (increase) and a severe shock of 40% ↑ (increase) in *foreign exchange capital charge* due to forex currency exposures and fluctuations	Under equity (stocks), the reference to country stock exchange performance is to be made
Operational RWA: • With moderate shock of 30% ↓ (decrease) and a severe shock of 40% ↓ (decrease) in *Gross income*, due to decrease in profitability because of high non-performing financing (NPF) linked to economic decline of the respective country GDP growth	For NPL, historical losses rate (referred as "NPF" rate) under a standardized approach is to be considered Under the Internal Rating Based (IRB) approach, the IIFS should consider the default rate and probability of default (PD) for individual clients or groups of clients
↓ (Reduction) in Capital by 20% (i.e., erosion of capital) under moderate scenario and 30% under severe scenario, through high NPF and decrease in retained profits linked to economic conditions	

- **Operational RWA** are calculated under the basic indicator approach, which uses gross income as a proxy measure of exposure for operation risk of the IIFS. Under this approach, the capital charge of an IIFS is equal to the average of a fixed percentage of 15% of positive annual gross income over the previous three years. (see Table A4 in Appendix A)

In addition, with respect to alpha, the IFSB's GN-4 (*Guidance Note on the Determination of Alpha in the CAR for IIFS, March 2011*) provides a methodology to estimate the value of alpha to be used in the supervisory discretion formula in calculating the CAR of IIFS. An algebraic approach to the determination of DCR and alpha is provided in GN-4 that can be used by supervisory authorities to decide the appropriate level of alpha across the industry. The relationship between unexpected losses to IIFS' shareholders and the character of PSIA is presented in Appendix B.

Using the GN-4 approach, alpha can be obtained using the following equations:

$$\text{DCR} = \text{UL}_2 - \text{UL}_0$$
$$\text{Maximum DCR} = \text{UL}_1 - \text{UL}_0$$
$$\text{"Alpha"} = (\text{UL}_2 - \text{UL}_0)/(\text{UL}_1 - \text{UL}_0)$$

Where:

UL_0 = Unexpected loss to shareholders when PSIA are treated as pure investment products
UL_1 = Unexpected loss to shareholders when PSIA are treated as pure deposit-like products
UL_2 = Unexpected loss to shareholders when PSIA are treated as being in-between pure investment and deposit-like products

In the *second stage*, after calculating the CAR, the study uses the combination of both sensitivity analyses (univariate) and scenario analyses (multivariate) in the solvency stress testing for Islamic bank. In particular, the paper considered *one-factor scenario* (such as a change in the expected benchmark rate of return) and a *multifactor scenario* (such as a range of rate of return risk scenarios combined with a change in foreign exchange rates).

According to IFSB-13, sensitivity analysis (univariate tests) measures the change in the value of a portfolio resulting from shocks of various degrees due to different risk factors, while the underlying relationships between the risk factors are not considered (e.g., a straightforward shift in probabilities of defaults, or the default of an IIFS's largest counterparties, or a decline in value of assets, or a migration of loans to a weaker classification). Furthermore, a sensitivity test isolates the impact on a portfolio's value of one or more pre-defined moves in a particular market risk factor or a small number of closely linked market risk factors on a *ceterus paribus* basis (i.e., holding all other factors constant). For example, if the risk factor is an exchange rate, the shocks might be exchange rate changes of +/–2%, 4%, 6% and 10%, while the relationship between such a change and other risk factors – for example, benchmark rates, expected rates of return, asset values, etc. – is not considered.

In contrast, scenario analysis specifies a set of concurrent events comprising a possible scenario that might occur. It encompasses the situation where a change in one risk factor affects a number of other risk factors. Scenario analysis contains simultaneous moves in a number of risk factors (e.g., equity prices, foreign exchange rates, benchmark rates, etc.), reflecting a set of concurrent events that the IIFS's risk managers believe might possibly occur in the foreseeable future. A stress test scenario can be based on a significant market context experienced in the past (*a historical scenario or backward-looking approach*[25]), or on a plausible market context that has not yet happened (*a hypothetical scenario or forward-looking approach or pre-defined scenario based on expert judgement*).[26]

Using the above stress testing techniques, the stress scenarios as presented in Table 3 are employed in the simulation of solvency stress testing.

5. Simulation results, remedial actions and implications

This section presents the key findings of the simulation and discusses the emerging implications for the IIFS in terms of solvency capital stress testing. Based on the data information, this section provides calculation of CAR for an IIFS using IFSB standard formula and also IFSB supervisory discretion formula with different levels of alpha to determine scenarios identified in the Table 3 in the previous section.

5.1. The relationship between PSIA, Alpha, and CAR – pre- and post-stress shocks analysis

The computation of numerator (i.e., eligible capital) and denominator (i.e., credit RWA, market RWA, and operational RWA, etc.) of the CAR of IIFS is provided in Appendix A (please see Table A1 to A4) under *bottom-up approach,* using three stress shocks, which are BAU (business as usual), *moderate shock* and *severe shock*. The results of the calculation are plugged into the IFSB formulas as discussed in previous section. While Table A5 provides CAR using IFSB standard formula, Table A6(i) to A6(iv) provide results on CAR using IFSB supervisory discretion formula, when $\alpha = 0.30$, 0.50, zero, and 1.

Chart 1 summarizes pre- and post-stress shock under a standard formula. Considering minimum CAR of 8% in the jurisdiction, it appears that under the BAU, the IIFS is well capitalized, having 15.18% CAR. However, when a *moderate* to *severe* stress shock is applied on selected categories of the credit RWA, market RWA and operational RWA the post-shock CAR under *moderate* and *severe* shock goes down to 9.85% and 6.24% respectively. This represents essentially how an IIFS with adequate capital could be exposed under defined scenarios. Post-shock CAR under *severe* stress appears below the minimum regulatory requirements, thus calling for immediate remedial actions by the IIFS on capital planning. In the financial distress circumstances, like GFC (2008), it should be noted that the regulator or supervisor may raise the minimum CAR, which would be a concern to the IIFS keeping in mind the results of Table A5. This emphasizes the need of conducting solvency stress testing regularly in the IIFS in normal and abnormal settings.

The simulation results also designate that there exist a positive relationship between CAR and the volume of PSIA.

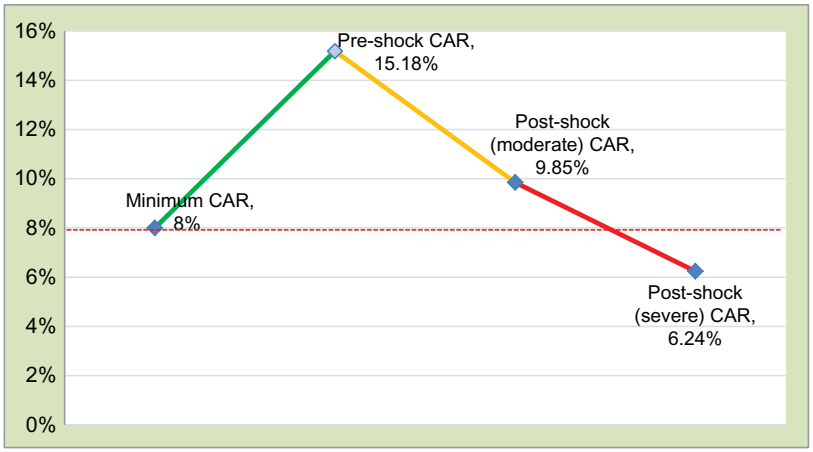


Chart 1. Pre- and post-shock CAR comparison under standard formula.
Source: Author's simulation of an IIFS. The red "dot" line reflects the minimum CAR.

This means that the CAR ratio is more sensitive to PSIA ratio and has a multiplier effect on CAR. This relationship is explained as follows: if the PSIA = 0 = > CAR is equivalent to Basel Formula (i.e., all the sources of funds are other than PSIA and hence considered liability of the bank) and CAR ratio appears in its minimum. However, if the PSIA = 100% = >, CAR would be in its maximum. According to Table A5, once the percentage of RWA (CR & MR) funded by unrestricted PSIA/IAH holders is raised from 20% to 30%, the CAR changes considerably 6.24% to 9.85%. Considering minimum CAR of 8%, this suggests how an undercapitalized IIFS stands out above the minimum CAR. Furthermore, once the percentage of RWA (CR & MR) funded by unrestricted PSIA/IAH holders is elevated to 50%, the CAR gets multiplier effects. This highlights the significance of PSIA in providing adequate buffers to IIFS.

Chart 2 provides the impact on capital adequacy of a hypothetical supervisory adjustment of "alpha" to a higher value under normal conditions and under-stressed conditions. This helps to explain how an IIFS's capital adequacy is affected under different values of the "alpha" parameter and the implications of the stressing. Considering minimum CAR of 8% in the jurisdiction and different values of alpha, it is evident that the CAR for IIFS is highly sensitive to changes in the values of "alpha" (please refer to Table A6(i) to A6(iv) in Appendix A for detail of results on CAR using IFSB Supervisory Discretion Formula, when $\alpha = 0.30, 0.50, 0$, and 1). For the same level of alpha, increase of PSIA financed assets in percentage terms increases CAR and for the same level of PSIA financed assets, increase in alpha reduces CAR (IIFS will be bearing more risk and keeping more capital when alpha increases). For instance, when the alpha 0.30 is applied at IIFS, then the pre-shock CAR, under BAU, is 12.55%; however, for the same level of alpha 0.30, when a *moderate* stress shock is applied, then the post-shock CAR is reduced to 8.93%; and likewise, post-shock CAR under *severe* stress goes at 5.88%, which is far below the prevailing

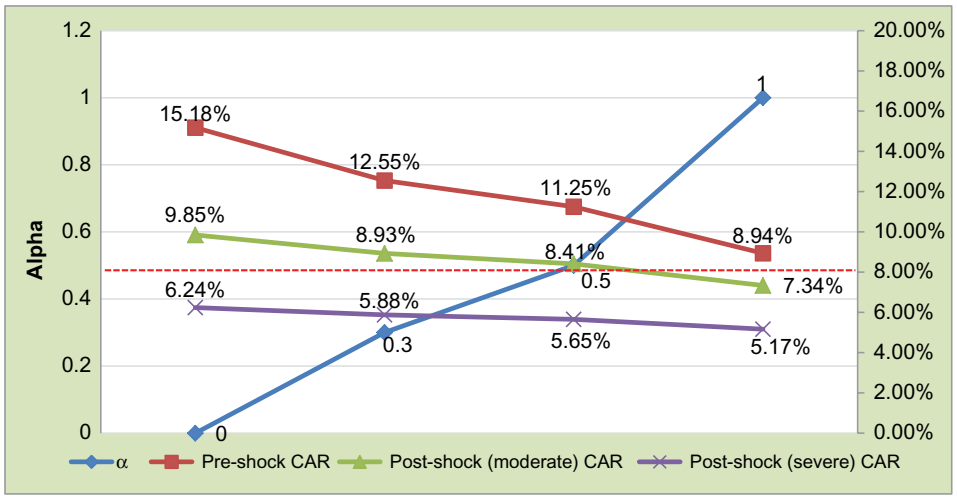


Chart 2. Pre- and post-shock CAR comparison under supervisory discretion formula.
Source: Author's Simulation of an IIFS. The red "dot" line reflects the minimum CAR in the jurisdiction.

minimum CAR in the jurisdiction. Chart 2 also indicates that when the alpha is zero, then the pre-shock CAR of the IIFS, 15.18%, is at its highest, which is also equivalent to pre-shock CAR under the standard formula.

It is also noticeable from Chart 2 that as alpha moves from zero to 1, the characteristic of PSIA changes from being a pure investment-like product to more of a pure deposit-like product, requiring increasing amounts of shareholder capital (additional capital requirements for IIFS). This relationship is also presented in the Appendix B. However, in practice, it should be noted that alpha is between zero and 1, because IIFS does not always make a payout to the UIAH according to market rates, nor does it strictly follow the rate of profit on investments made with the *Muḍārabah* funds. IIFS uses various techniques of setting aside or drawing from reserves, or making donations from shareholders' funds, in order to smooth the returns with a view to setting aside some reserves in good times and avoiding paying low returns in times of low profits (para. 35 of IFSB GN-4). It is also worth mentioning that the higher values of alpha may be applicable in jurisdictions where IAH tend to be highly protected by the governments and central banks for strategic reasons. Supervisors should base their judgments on the actual legal status of PSIA in their jurisdictions (i.e., whether PSIA are explicitly/implicitly protected by the central bank and/or deposit insurance).

Despite the fact that IIFS across the industry are well-capitalised due to predominantly common equity-based capital structure compared to their conventional counterparts. Nevertheless, Chart 2 shows that an IIFS with adequate capital could be vulnerable under defined scenarios through stress testing. Chart 2 reflects the post-shock (*severe*) CAR, in which all the post-shock CAR values are below minimum requirements, which necessitates an appropriate immediate remedial action by the IIFS on future capital resources and capital needs including main assumptions and drivers of movements in capital needs. This also indicates whether the IIFS maintains an appropriate capital buffer to support its operations at all times and absorbs unexpected losses resulting from the risks incurred through the IIFS's business activities.

5.2. Remedial actions

Once the results are produced then the IIFS should take appropriate actions. The list of actions would depend on the objective of stress tests at the IIFS. Nevertheless, an IIFS should have strategies approved in advance with regard to the actions that would be taken based on the results of the solvency stress test in identifying the points requiring remedial actions, such as those provided below. The level of authority for such actions should include the BOD and senior management.

a. Adjusting positions and restructuring the various credit and market risk relating exposures in specific sectors, countries or regions in order to decrease the vulnerability of the portfolio to large losses in the event of the stress conditions
b. Future capital resources and capital needs of an IIFS under adverse scenarios
c. The composition and quality of capital (e.g. an IIFS's ability to raise additional capital through common stock and other forms of capital in the market such as hybrid or debt capital through *Sukuk,* etc.)
d. Transferability of capital during periods of severe downturn or extended market disruption, taking account of potential funding difficulties (i.e., the possibility that a crisis impairs the ability of even very healthy IIFS to raise funds at a reasonable cost) that may be expected in stressed conditions (para. 154 of IFSB-13)

One of the measures available to management, while examining the adequacy of capital within IIFS, may be the raising of additional capital. However, the presence of a capital buffer, of appropriate quality, can be a significant mitigating factor as higher levels of capital increase the degree of freedom management has when taking mitigating actions. Therefore, an IIFS should be aware that capital raising in stressed market conditions would be quite challenging, so that considering other possible alternatives may be necessary.

Following the range of remedial actions envisaged by an IIFS in response to the results of the solvency stress testing, the IIFS should be aware that under the supervisory review process of Pillar 2, their respective supervisors would examine IIFS's stress testing results as part of a supervisory review of the IIFS's internal capital adequacy assessment process (ICAAP), in order to ensure that they maintain an appropriate capital buffer to support their operations at all times. In this way, supervisor should take a more holistic view of all the remedial actions and their impact on the IIFS and taking into consideration the magnitude and likelihood of potential stress events, the overall IIFS's risk management framework, and its risk mitigating policies (para. 172 of IFSB-13). In cases where a supervisory assessment reveals material deficiencies in the solvency stress testing and its usage, the supervisory authorities should require the IIFS to detail a plan of corrective action aimed at improving the stress tests.

5.3. Key challenges and issues

Despite the usefulness of the forward-looking stress testing as a risk management tool, there are several challenges and issues that can impede the accurate execution of a stress testing exercise within the IIFS. An IIFS and its respective supervisors should pay due consideration to these challenges and issues. Some of the key challenges and issues are discussed below:

- Up-to-date, *comprehensive and high-quality data* is needed when conducting credible stress tests and therefore lack of necessary data would be considered a major challenge for IIFS. There is also a possibility that the data may not be up to date or the IIFS may not have access to the breadth of data needed for proper stress testing. This issue should be resolved within a reasonable period of time by the management of IIFS (i.e., establishing a strategy and a plan, with the involvement and approval of the BOD for acquiring the data needed). To overcome data gaps, it is vital to start collecting data and explore relevant proxies for stress testing. The proxies may be derived internally from other assets that possess similar risk characteristics or externally through industry

benchmarking. Nevertheless if proxies are used, IIFS would have to document the source and any known limitations comprehensively (para. 21 of IFSB-13).

- The existence of relevant *models and modelling expertise* for the proper functioning of stress testing exercises. This would be another key challenge for IIFS as lack of adequate models may weaken the capacity of IIFS to take account of sectoral interlinkages as well as contagion risk (para. 24 of IFSB-13). Once the development of a model (in-house possibly with the help of consultants) or acquisition of a model (from software vendors) is completed, then the model needs to be validated. This means that the model validation requires the inclusion of an expert opinion on the effectiveness of the models that would be used in the stress testing programme by the IIFS
- Availability of *comprehensive guidance on conducting the stress testing* will be key issue for IIFS. In the absence of such guidance, IIFS may not conduct standardise stress testing resulting in underestimation of risk. In this context, IIFS will benefit from specific guidance from the respective regulator or supervisory authority on specific scenarios and shocks while conducting stress testing.
- With respect to *solvency stress testing*, a cautious approach is required when conducting stress testing on consolidated basis (e.g., Albarkah Banking Group, Dubai Islamic Bank Group, AlRajhi Banking Group, Kuwait Finance House Group, etc.), due to different levels of implementation or different treatment of Basel frameworks across the subsidiaries of the parent. Some subsidiaries might be using Basel I, some still at Basel II, and few may have started the implementation of Basel III. These variations in calculating regulatory capital requirements can produce different and misleading results that should be given due consideration. For instance, the credit risk component in the denominator of the capital adequacy ratio can be calculated in three different ways of varying degrees of sophistication, namely (i) *standardised approach* (ii) *foundation internal ratings-based (IRB) approach* (iii) and *advanced IRB approach.*[28] Similarly, market and operational risk components in the denominator of the CAR can be calculated in different ways.
- Some IIFS may demonstrate that their *liquidity buffers framework* is robust enough having liquidity coverage ratio (LCR) and net funding stability ratio (NFSR) more than 100% or 200%, and therefore the stress testing may not be justified in their context. This is may be a rare case but certainly should not be treated as a main reason for not conducting the stress testing on IIFS-level as there is significant trade-off in liquidity and profitability.
- Some IIFS may establish that the *real estate market* in their respective jurisdiction has not been prey of any external shock resulting in crash in last 10 years or 20 years, and therefore the stress testing with respect to real estate is not relevant. IIFS should note that the global financial crisis (2008) has indicated the interlinkages and cross-border transactions flows which have potential to impact the local markets due to foreign participation in the local market. In this context, the IIFS should conduct real estate stress testing taking into account cross-correlations and inter-connectivity of the markets.
- Another significant challenge for the IIFS under the stress testing would be that the stress testing results remain within the *risk appetite statement* of the IIFS as approved by their BOD depending on the business risk profile. If the results exceed the risk appetite then the BOD may have concern on the continuity of stress testing exercise and would call for reconsidering the severity of scenarios and assumptions made in the stress testing.
- The supervisory authorities should take *holistic view of stress testing results* of the IIFS. Some IIFS may pass the stress test with their own data, variables and scenarios. However, when the supervisory recommendations of the scenarios and variables are provided, then the IIFS may fail the stress test. In this case, the challenge for an IIFS would be on the submission of results to the supervisor for validation of the stress testing programme.
- Some IIFS may keep the *CAR at par* (i.e., keeping CAR close to minimum regulatory capital requirements), and would be prone to the results of the stress tests under defined scenarios. This can often underestimate the risk of IIFS. To avoid this, supervisors should require IIFS the implementation of ICAAP. The ICAAP requirements can play significant role in capital planning according to the risk profile of the IIFS rather than keep CAR at regulatory requirements level.
- Another challenge would be the *selection of methodologies* for stress testing. While it is important to distinguish between sensitivity analysis and scenario analysis, there are circumstances where IIFS will have to use the combination of both approaches depending on their risk profile and strategic decisions. A less sophisticated IIFS may use sensitivity analysis to form a first approximation of the impact. Often a combination of both approaches may result in more resilience and diversification of the scope of analysis, by taking into account different severities and perspectives (para. 124 of IFSB-13).
- Development and execution of *reverse stress tests* (to complement the existing stress testing framework) may also appear challenging as it requires an IIFS to assess scenarios and circumstances *that would put its survival in jeopardy* (such as breaching regulatory capital ratios, or a liquidity crisis) and consider scenarios beyond its normal business settings and highlights potential events with contagion and systemic implications (para. 126 of IFSB-13). It should be understood that reverse stress testing is not expected to result in capital planning and capital add-ons. Instead, its use as a risk management tool is in identifying scenarios, and the underlying dynamism of risk drivers in those scenarios, that could cause an IIFS's business model to fail (para. 127 of IFSB-13).

6. Conclusion and moving forward

The paper attempted to provide insights on the *operationalization of the IFSB-13*, through simulating the stress scenarios for an IIFS under different conditions.

The Excel-based simulation provides kick-start for the IIFS and a start for developing a complex simulation.

Taking into consideration the *unique characteristics of IIFS* such as use of PSIA, which have the potential to impact how the CAR is calculated in IIFS and how the stress scenarios would have potential impact on the IIFS in terms of capital planning strategies. The results suggest the sensitivity of CAR for IIFS with respect to the changes in the values of "alpha" and composition of PSIA. The simulation also indicates that an IIFS operating above minimum CAR could easily be made vulnerable by mild to severe shocks, thus bringing the CAR below minimum regulatory requirements calling for appropriate remedial actions. There are two levels of stress testing, one identifies the vulnerability and second takes mitigating actions (both from IIFS and respective supervisory authority). Both of these stages are important in the accurate estimation of risk and in ensuring the going concern of the IIFS in financial distress situation under severe stress.

In the light of simulation, the objective of the stress tests should not be to "*pass the stress test*" rather finding could IIFS fail. In this respect, IIFS has to have a skeptical attitude and it should look for weaknesses within the IIFS, which could potentially threaten the viability of the IIFS in stress situations. For instance, one could clearly see from European Banking stress tests exercises that illuminated which banks were organized to fail. We have seen that some of the banks that passed the stress test subsequently went through financial distress. Therefore, it is important for stress testing to spot the weaknesses and then mitigate the risks involved through appropriate actions.

While IIFS can apply appropriate *stress testing methodology*, they should keep in mind that their supervisors can challenge the assumptions used in the stress tests in order to ensure IIFS does not underestimate the risk under certain defined scenarios. In the methodology, as per IFSB-13, it is worth mentioning that a less sophisticated or a smaller IIFS may place greater emphasis on the qualitative elements of its stress testing program and hence may use *sensitivity analyses* to form a first approximation of the impact. Whereas a large and sophisticated IIFS would be expected to run complex models, which would be complemented by appropriate qualitative oversight and supported by combination of approaches (i.e. *sensitivity analyses and scenario analyses*). The level of stress shock is going to vary from one IIFS to another IIFS.

The stress testing has become part of the regulatory and supervisory authorities within the financial stability analysis. In the beginning, the stress test may not appear a simple task for the IIFS. However, a proper consideration to the challenges identified in the paper would certainly tend to improve the overall effectiveness and credibility of the stress testing programs. The stress testing itself is not that complex, rather the relationships that need to be understood require *sufficient knowledge* (including mathematical, economics, statistical, and accounting and financial skills) of financial data and translation of economic behaviors into financial impacts. This raises capacity building issues that need to be given due consideration in developing an appropriate stress testing regime.

Finally, it is also important to recognize the *limitations of the data* used in the simulation which are well known. It is also important to comprehend that the simulation conducted in the paper provides a preliminary discussion. However, more aspects of solvency can be considered in further research with plausible severe shocks according to the business profile of the IIFS. Also more sophisticated analysis can be expanded depending upon the accurate granularity of data.

Moving forward, generally, the stress testing for risk management at IIFS seems to be an underdeveloped area where much work at all levels, including by supervisory authorities and market players, is required. In this context, it is hoped that the paper makes contribution in the literature and simulation results provides preliminary discussion on developing a *comprehensive toolkit* for the IIFS similar to what is developed by the IMF FSAP programme.

Notes

1. The term "IIFS mused in the paper also referred as to "Islamic banks" and both these terminologies are used interchangeably in the paper. It is important to note that the term "IIFS" has been used by the IFSB.
2. The IFSB issued its *Capital Adequacy Standard* (also referred to as IFSB-2) for IIFS in December 2005. However, in the light of financial crisis, and global developments with respect to capital framework, the IFSB issued the Exposure Draft (ED) of Revised IFSB *Capital Adequacy Standard* (ED-15), in November 2012, which is scheduled to be finalised in December 2013. The capital adequacy formulas in ED have not been changed and thus will not affect this simulation results. Please refer to Section 4 for more details.
3. The jurists state that the primary sources of Islamic finance laws are the *Holy Qur'an* and the *Sunnah* (the traditions of the Prophet Muhammad (pbuh). These two sources are classified as sources being agreed upon among the majority of jurists. Some of the other sources are agreed upon by the majority of the schools are *Ijma'* (consensus) and *Qiyas* (analogy). The secondary sources are techniques of legal reasoning that the mujtahid employs during his *Ijtihad*. The secondary sources include Juristic preference (*al-istihsan*), Consideration of public interest (*al-istislah*) *Maslahah Mursalah*, Presumption of continuity (*al-istishab*), *Saad Al-dariah* (Blocking the lawful means to an unlawful end), Companion's opinion (*qawl al-sahabi*), *Shar' Man Qablana* (earlier scriptures and general customary practices (*al-'adah*).
4. IFSB-1(Guiding Principles on Risk Management), Dec 2005.
5. IFSB-3 (Guiding Principles on Corporate Governance), Dec 2006.
6. IFSB-10 (Guiding Principles on *Sharī'ah* Governance Systems), Dec 2009.
7. Fiduciary risk is the risk that arises from IIFSs' failure to perform in accordance with explicit and implicit standards applicable to their fiduciary responsibilities (see IFSB-1 for detail).
8. It refers to the possible impact on the net income of the IIFS arising from the impact of changes in the market rates and relevant benchmark rates on the return on assets and on the returns payable on funding. Rate of

return risk differs from interest rate risk in that IIFS are concerned with the returns on their investment activities at the end of the investment holding period and with the impact on net income after the sharing of returns with IAH. The rate of return risk leads to Displaced Commercial Risk (see IFSB-1 for detail).

9. DCR is the consequence of the rate of return risk. It refers to the magnitude of risks that are transferred to shareholders in order to cushion the IAH from bearing some or all of the risks to which they are contractually exposed in *Muḍārabah* funding contracts (see IFSB-1 for detail).
10. Alpha (α) refers to the proportion assets funded by unrestricted PSIA which is to be determined by the supervisory authorities. The value of α would therefore vary based on supervisory authorities' discretion on a case-by-case basis. If "alpha" is 0, then all RWA corresponding to the unrestricted IAH funds are excluded from the denominator. If "alpha" is 1, then traditional CAR applies, with CAR applying to all on-balance sheet assets. Please see Section 4 more detail.
11. The amount appropriated by the institution offering Islamic financial services out of the *Mudārabah* profits, before allocating the *Mudārib*'s share of profit, in order to maintain a certain level of return on investment for investment account holder and to increase owners' equity.
12. The amount appropriated by the institutions offering Islamic financial services out of the profit of investment account holders, after allocating the *Mudārib*'s share of profit, in order to cushion against future investment losses for investment account holders.
13. IFSB-7 (Capital Adequacy Requirements for Sukuk, Securitisations and Real Estate Investment), Jan 2009.
14. See Committee for Global Financial System (CGFS), A Survey of Stress Tests and Current Practice at Major Financial Institutions, BIS, April 2001.
15. Benchmark rates include market-based reference interest rates such as LIBOR (London Interbank Offer Rate), EIBOR (Emirates Interbank Offer Rate), etc.
16. According to Rushdi (2009), right after the global financial crisis (2008), Islamic financial institutions have indeed captured negative headlines. These examples showcase the impact of Gulf-based Islamic financial institutions, notwithstanding the crisis started in US, and from the conventional financial industry. The Kuwait-based Islamic firm "Investment Dar" business model based on Commodity Murabahah Transactions and acquiring the car manufacturer Aston Martin and recently defaulting on US $100 million Islamic debt issue and went through restructuring; Dubai's two Islamic mortgage offering entities "Amlak and Tamweel" suspended operations; Government of Qatar purchased strategic interests in banks, including Islamic, in Qatar; Bahrain-based Gulf Finance House received a negative outlook by S&P in early 2009 because of excessive leverage and worsening operating environment for 2009; Dubai Islamic Bank first quarter profit (2009) plunged 33% to AED 370 million (US$ 101 million) following provision for bad financing.
17. The rationale is explained as follows. When IAHs provide funds to the IIFS on the basis of profit-sharing and loss-bearing *Muḍārabah* contracts, or on the basis of agency for an agreed upon fee, instead of debt-based deposits, i.e. lending money to the IIFS, would mean that the IAH would share in the profits of a successful operation, but could also lose all or part of their investments. The liability of the IAH is exclusively limited to the provided capital and the potential loss of the IIFS is restricted solely to the value of its work. However, if negligence, mismanagement, fraud or breach of contract conditions can be proven, the IIFS will be financially liable for the capital of the IAH. Therefore, credit and market risks of the investment made by the IAH shall normally be borne by themselves, while the operational risk is borne solely by the IIFS. This implies that assets funded by either unrestricted or restricted PSIA would be excluded from the calculation of the denominator of the capital ratio.
18. For more details on the smoothing payout, please see IFSB GN-3 (*Guidance Note on the Practice of Smoothing the Profits Payout to IAH, December 2010*).
19. Total RWA include those financed by both restricted and unrestricted PSIA.
20. Credit and market risks for on- and off-balance sheet exposures.
21. Where the funds are commingled, the RWA funded by PSIA are calculated based on their pro-rata share of the relevant assets. PSIA balances include PER and IRR, or equivalent reserves.
22. In jurisdictions where the IIFS practice the type of income smoothing for IAH (mainly unrestricted IAH) that gives rise to DCR, the supervisory authority have to require regulatory capital to cater for DCR. In this approach, commercial risks of assets financed by unrestricted IAH are considered to be borne proportionately by both the unrestricted IAH and the IIFS. Hence, a proportion of the RWA funded by unrestricted IAH, denoted by "alpha", is required to be included in the denominator of the CAR, the permissible value of alpha being subject to supervisory discretion. A supervisory authority may also decide to extend this treatment to restricted PSIA/IAH. Such risk-sharing between PSIA and IIFS gives rise to a *supervisory discretion formula* that is, applicable in jurisdictions where the supervisory authority takes the view that, in order to mitigate withdrawal risk and the attendant systemic risk, IIFS in the jurisdiction are permitted (or in some jurisdictions required) to smooth income to the IAH.
23. The relevant proportion of risk-weighted assets funded by the PSIA's share of PER and by IRR is deducted from the denominator. The PER has the effect of reducing the displaced commercial risk, and the IRR has the effect of reducing any future losses on the investment financed by the PSIA.
24. For more details, please see IFSB GN-1 (*Guidance Note in Connection with the Capital Adequacy Standard: Recognition of Ratings by External Assessment Institutions (ECAIs) on Shariah-compliant Financial Instruments, March 2008*).
25. The *historical scenario* involves the reconstruction of historical events and involves less judgement as it reflects the actual stressed market conditions. Since *historical scenarios* are backward looking, they may not be the worst that can happen and may lose relevance over time due to market and structural changes.
26. *Hypothetical scenarios* involve simulating the shocks caused by events that have not yet happened or which have no historical precedent. Key areas of focus in a

hypothetical scenario include market volatility, trading liquidity and risk linkages. *Hypothetical scenarios* can be more relevant, flexible and forward looking, but they involve more judgement and management support. In addition, at times *hypothetical scenarios* are very difficult to analyse and may generate confusing outcomes, so it is important to take care in crafting hypothetical analysis.

27. The *foundation IRB approach* refers to a set of credit risk measurement techniques proposed under the Basel II capital adequacy rules for banking institutions under which the banks are allowed to develop their own empirical model to estimate the probability of default (PD) for individual clients or groups of clients. Under this approach banks are required to use the regulator's prescribed Loss Given Default (LGD) and other parameters required for calculating the risk weighted assets (RWA). Then total required capital is calculated as a fixed percentage of the estimated RWA. Under the *advanced IRB approach*, the banks are allowed to develop their own quantitative models to estimate PD, LGD, and Exposure at Default (EAD) and other parameters required for calculating the RWA.

References

Alfaro R, and Drehmann M. (2009) Macro stress tests and crises: What can we learn? *BIS Quarterly Review*. December:29–41.

Basel Committee for Banking Supervision. (2009) *Principles for Sound Stress Testing Practices and Supervision.* Basel. http://www.bis.org.

Basel Committee for Banking Supervision. (2006) International Convergence of Capital Measurement and Capital Standards – A Revised Framework (Comprehensive version referred as to Basel II–June 2006). Basel. http://www.bis.org.

Basel Committee for Banking Supervision. (2009) Enhancement to the Basel II Framework. Basel. http://www.bis.org.

Basel Committee for Banking Supervision. (2010) Basel III International Framework for Liquidity Risk Measurement Standard and Monitoring. Paras. 154 and 158. Basel. http://www.bis.org.

Borio C, Drehmann M, Tsatsaronis. (2012) Stress-Testing Macro Stress Testing: Does it Live up to Expectation. *BIS Working Paper no. 369*. Monetary and Economic Department.

Buncic D, Melecky M. (2011) Macro-Prudential Stress Testing of Credit Risk: A Practical Approach for Policy Makers. *Discussion Paper no. 2011-39.* School of Economics and Political Science, Department of Economics, University of St. Gallen.

Schmieder C, Hesse H, Neudorfer B, Puhr C, Schmitz SW. (2012) Next Generation System-Wide Liquidity Stress Testing. *IMF Working Paper no. 12/3.*

Cihak M. (2004) Designing Stress Tests for the Czech Banking System. *CNB Internal Research and Policy Note /3/*.

Cihak M. (2004b) Stress testing: A Review of Key Concepts. *Czech National Bank, Internal Research and Policy Note no. 2.*

Committee for European Banking Supervisors. (2006) Technical Aspects of the management of concentration risk under the Supervisory Review Process. United Kingdom, http://www.eba.europa.eu.

Committee for European Banking Supervisors. (2010) *Guidelines on Stress Testing.* United Kingdom. http://www.eba.europa.eu.

Elsiefy. (2012) Stress Test for Islamic and Conventional Banks Using Sensitivity Scenario Test: Evidence from Qatari Banking Sector. *International Journal of Economics and Management Sciences*. 1(12):44–63.

Foglia A. (2009) Stress Testing Credit Risk: A Survey of Authorities Approaches. Banking and Financial Supervision. *International Journal of Central Banking*. 5(3). Bank of Italy.

Hoggarth G, Sorensen S, Zicchino L. (2005) Stress Tests of UK Banks Using a VAR Approach. *Working Paper No. 282.* Bank of England.

Islamic Financial Services Board. (2005) *IFSB-1: Guiding Principles on Risk Management for Institutions (Other Than Insurance Institutions) Offering Only Islamic Financial Services*. Kuala Lumpur, Malaysia.

Islamic Financial Services Board. (2005) *IFSB-2: Capital Adequacy Standard for Institutions (Other Than Insurance Institutions) Offering Only Islamic Financial Services*. Kuala Lumpur, Malaysia.

Islamic Financial Services Board. (2006) *IFSB-3: Guiding Principles on Corporate Governance for Institutions Offering Only Islamic Financial Services (Excluding Islamic Insurance (Takāful) Institutions and Islamic Mutual Funds)*. Kuala Lumpur, Malaysia.

Islamic Financial Services Board. (2007) *IFSB-4: IFSB Disclosure to Promote Transparency and Market Discipline for Institutions Offering Only Islamic Financial Services (Excluding Islamic Insurance (Takāful) Institutions and Islamic Mutual Funds)*. Kuala Lumpur, Malaysia.

Islamic Financial Services Board. (2009) *IFSB-7: Capital Adequacy requirements for Sukuk, Securitisation and Real Estate Investment*. Kuala Lumpur, Malaysia.

Islamic Financial Services Board (March 2008) *IFSB GN-1: Guidance Note on Recognition of Ratings by External Credit Assessment Institutions on Sharī`ah-Compliant Financial Instruments.* Kuala Lumpur, Malaysia.

Islamic Financial Services Board. (2010) *IFSB GN-3: Guidance Note on the Practice of Smoothing the Profits Payout to Investment Account Holders.* Kuala Lumpur, Malaysia.

Islamic Financial Services Board. (2010) *IFSB GN-4: Guidance Note in Connection with the IFSB Capital Adequacy Standards: The Determination of Alpha in the Capital Adequacy Ratio.* Kuala Lumpur, Malaysia.

Islamic Financial Services Board. (2010) *IFSB-10: Guiding Principles on Sharī'ah Governance Systems for Institutions offering Islamic Financial Services*. Kuala Lumpur, Malaysia.

Islamic Financial Services Board. (2012) *IFSB-13: Guiding Principles on Stress Testing For Institutions Offering Only Islamic Financial Services (Excluding Islamic Insurance (Takāful) Institutions and Islamic Collective Investment Schemes)*. Kuala Lumpur, Malaysia.

Islamic Financial Services Board. (2012) *IFSB ED-15: Revised Capital Adequacy Standard for Institutions (Other Than Insurance Institutions) Offering Only Islamic Financial Services*. Kuala Lumpur, Malaysia.

Jones M, Hilbers P, Slack G. (2004) Stress Testing Financial Systems: What to Do When the Governor Calls. *IMF Working Paper No. 127*.

Otani A, Shiratsuka S, Tsurui R, Yamada T. (2009) Macro Stress-Testing on Loan Portfolio of Japanese Banks. *Bank of Japan Working Paper Series, No. 09-E-1*.

Rouabah A, Theal J. (2010) Stress Testing: The Impact of Shocks on the Capital Needs of the Luxembourg Banking Sector. *Working Paper No. 47*.

Rushdi. (2009) The Need for Islamic Finance Stress Test. *WIFE Foundations' Newsletter No. 3*. Kuala Lumpur, Malaysia.

Schmieder C, Puhr C, Maher H. (2011) Next Generation Balance Sheet Stress Testing. *IMF Working Paper No. 11/83*.

Sorge M. (2004) Stress-Testing Financial Systems: An Overview of Current Methodologies. Bank for International Settlement, Monetary and Economic Department. *IMF Working Paper No. 165*.

Vazquez F, Tabak BM, Souto M. (2010) Macro Stress Test Model of Credit Risk for the Brazilian Banking Sector. Central Bank of Brazil. *Working Paper Series 226*.

Appendices

Appendix A: Simulation, calculations, results

Table A1. Calculation of total eligible capital.

Amounts in local currency

		Scenarios		
		BAU	Moderate*	Severe*
A. Total Eligible Capital (EC)** =	Tier-1 + Tier-2	Pre-shock	Post-shock	
		4,550,100.00	4,095,090.00	3,276,072.00

*For the respective scenario shocks for EC, please see Table 4.1.

Both Tier 1 and Tier 2 are subject to individual IIFS's capital structure. However, generally Tier 1 capital components include: (i) issued and fully paid ordinary shares/common stock; (ii) disclosed reserves (such as legal/statutory reserves, share premium); (iii) retained profit; and (iv) non-controlling interest in consolidated subsidiaries. On the other hand, Tier 2 capital components include (i) undisclosed reserves; (ii) asset revaluation reserve; (iii) general provisions (general loan-loss reserves); (iv) hybrid debt capital instruments. There are IIFS who consider PER and IRR as part of the Tier-2, however, the **IFSB ED-15, has made it clear that they should not be part of capital of IIFS as IRR and a portion of the PER belong to the equity of IAHs/PSIA, and thus are not part of the capital of the IIFS.

Table A2. Calculation of total CRWA.

Amounts in local currency

			Scenarios		
			BAU	Moderate*	Severe*
B. Total Credit Risk Weighted Assets (CRWA):			Pre-shock	Post-shock	
Category	RWA	CAR	CRWA	CRWA	CRWA
1	2	3	4(2 × 3)	5(2 × 3)	6(2 × 3)
RWA of individual claims based on external credit assessment (i.e., rating agency) **	245,350,650.00	8%	19,628,052.00	23,553,662.40	27,479,272.80
RWA for short-term exposures	47,520,620.00	8%	3,801,649.60	3,801,649.60	3,801,649.60
RWA for exposures under profit sharing mode	50,650,100.00	8%	4,052,008.00	4,052,008.00	4,052,008.00
RWA for exposures with preferential risk weights **	25,500,600.00	8%	2,040,048.00	2,448,057.60	2,856,067.20
RWA for past due receivables	10,512,500.00	8%	841,000.00	841,000.00	841,000.00
RWA for off-balance sheet exposures	5,850,750.00	8%	468,060.00	468,060.00	468,060.00
Total	**385,385,220.00**		**30,830,817.60**	**35,164,437.60**	**39,498,057.60**

*For the respective scenario shocks for items 1 and 4 in column 1, please see Table 4.1. Other categories are kept constant.

**According to IFSB-2, under this category, the assignment of RW shall take into consideration, among others, the following: (i) the credit risk rating of a debtor, counterparty, or other obligor, or a security, based on external credit assessment-the IIFS to refer to their supervisory authorities for eligible external credit assessment institutions (ECAI) that are to be used in assigning credit ratings for the purpose of calculating credit RW; (ii) credit risk mitigation techniques adopted by the IIFS; (iii) types of the underlying assets that are sold and collateralised or leased by the IIFS; and (iv) amount of specific provisions made for the overdue portion of accounts receivable or lease payments receivable.

Note: The exposures presented in column 1 reflect the net exposures after incorporating appropriate risk weights and credit risk mitigation techniques (i.e., appropriate eligible collateral adjustments, guarantees, applicable haircuts, applicable margin requirements).

Table A3. Calculation of total MRWA.

Amounts in local currency

			Scenarios		
			BAU	Moderate*	Severe*
C. Total Market Risk Weighted Assets (MRWA):			**Pre-shock**	**Post-shock**	
Category	**Capital requirements**	**CF****	**MRWA**	**MRWA**	**MRWA**
1	**2**	**3**	**4**	**4 (2 × 3)**	**5 (2 × 3)**
Total equity (liquid and diversified stocks) risk capital charge***	195,261.00	**12.50**	2,440,762.50	2,806,876.88	3,417,067.50
Total specific risk capital charge for *Sukuk* positions	200,000.00	**12.50**	2,500,000.00	2,875,000.00	3,500,000.00
Total general risk capital charge for *Sukuk* and off-balance sheet financial instruments	50,000.00	**12.50**	625,000.00	625,000.00	625,000.00
Total foreign exchange capital charge****	213,000.00	**12.50**	2,662,500.00	3,061,875.00	3,727,500.00
Total commodity risk capital charge	75,000.00	**12.50**	937,500.00	625,000.00	625,000.00
Total inventory risk capital charge	525,500.00	**12.50**	6,568,750.00	7,554,062.50	9,196,250.00
	1,258,761.00		**15,734,512.50**	**17,547,814.38**	**21,090,817.50**

*For the respective scenario shocks for items 1, 2 and 4 in column 1, please see Table 4.1. Other categories are kept constant.
**Conversion factor (CF) converts the market risk capital charges into equivalents of risk weighted assets. CF is actually reciprocal of minimum capital adequacy ratio (i.e. 1/8%) = 12.5. If a national supervisor decides to impose a minimum capital requirement different from (e.g., higher than) 8%, the CF should be changed accordingly. For instance, if the minimum capital requirement is 10% CAR in the jurisdiction, then the CF will be 10. This will affect the computation of MRWA.
***This reflects "equity position in trading book," whereas "equity position in banking book" is presented under CRWA. Separate calculations have to be performed for each individual national market where the IIFS has equity positions (e.g., Qatar Market, Malaysian Market, Bahrain Market, etc.), such that capital charges for those individual national market equities risk is provided.
****The process requires converting net position in each foreign currency and in gold/silver into the reporting currency using spot rates and then aggregating the sum of converted net short/long positions. After the calculations, the greater sum of net short or long positions is added to the net position of gold/silver before applying capital charge.

Table A4. Calculation of total ORWA.

Amounts in local currency

		Scenarios		
		BAU	Moderate*	Severe*
D. Total Operational Risk Weighted Assets (ORWA)**		**Pre-shock**	**Post-shock**	
Taking Average of previous 3 Years	**X**	3,565,002.00	2,495,501.40	2,139,001.20
Assigned Capital Charge	**15%**			
Capital Charge for Operational Risk (X * 15%)	**Y**	534,750.30	374,325.21	320,850.18
Operational Risk (Y × 12.5*)	**12.5**	**6,684,378.75**	**4,679,065.13**	**4,010,627.25**

* For the respective scenario shocks for operation risk, please see Table 4.1.
**Measurement of capital charge for operational risk in IIFS may be based on either the basic indicator approach or the standardized approach as set out in IFSB-2. The former approach is considered, which requires the annual average gross income for the last 3 years to be multiplied by a capital charge factor of 15%. For the detail on the gross income, please see IFSB-2.

Table A5. CAR using IFSB standard formula under defined scenarios.

Amounts in local currency

E (i) CAR using IFSB standard formula under defined scenarios	Scenarios		
	BAU	Moderate	Severe
	Pre-shock	Post-shock	
I) Capital			
(A) Total eligible regulatory capital which is used as the numerator for CAR	**4,550,100.00**	**4,095,090.0**	**3,276,072.00**
II) Risk-weighted assets			
(B) Total RWA for credit risk	30,830,817.60	35,164,437.6	39,498,057.60
(C) Total RWA for market risk	15,734,512.50	17,547,814.4	21,090,817.50
(D) Total RWA for operational risk	6,684,378.75	4,679,065.1	4,010,627.25
(E) Total RWA	**53,249,708.85**	**57,391,317.10**	**64,599,502.35**
(F) RWA (CR & MR) funded by unrestricted PSIA/IAH holders *(50% of Total Credit RWA and Market RWA under BAU, 30% under moderate and 20% under severe)*	23,282,665.05	15,813,675.59	12,117,775.02
(G) (E) – (F)	**29,967,043.80**	**41,577,641.51**	**52,481,727.33**
CAR (A)/(G)	**15.18%**	**9.85%**	**6.24%**

Note: Please see Table A1 for (A) and Tables A2 to A4 for (B), (C), and (D).

Table A6(i). CAR using IFSB supervisory discretion formula under defined scenarios.

Amounts in local currency

F (i) CAR using IFSB supervisory discretion formula, when $\alpha = 0.30$	Scenarios		
	BAU	Moderate	Severe
	Pre-shock	Post-shock	
I) Capital			
(A) Total eligible regulatory capital which is used as the numerator for CAR	**4,550,100.00**	**4,095,090.0**	**3,276,072.00**
II) Risk-weighted assets			
(B) Total RWA for credit risk	30,830,817.60	35,164,437.6	39,498,057.60
(C) Total RWA for market risk	15,734,512.50	17,547,814.4	21,090,817.50
(D) Total RWA for operational risk	6,684,378.75	4,679,065.1	4,010,627.25
(E) Total RWA	**53,249,708.85**	**57,391,317.10**	**64,599,502.35**
(F) RWA (CR & MR) funded by unrestricted PSIA/IAH holders *(50% of Total Credit RWA and Market RWA under BAU, 30% under moderate and 20% under severe)*	23,282,665.05	15,813,675.59	12,117,775.02
(G) *$(1 - \alpha)$ [RWA funded by unrestricted PSIA/IAH (CR + MR)]*	16,297,865.54	11,069,572.91	8,482,442.51
(H) *RWA (CR & MR) funded by restricted IAH*	–	–	–

(*Continued*)

Table A6(i) - *Continued*

Amounts in local currency

F (i) CAR using IFSB supervisory discretion formula, when α = 0.30	Scenarios		
	BAU	Moderate	Severe
	Pre-shock	Post-shock	
(I) *RWA funded by PER and IRR (CR + MR) [10% of unrestricted PSIA/IAH)]*	2,328,266.51	1,581,367.56	1,211,777.50
(J) *α [RWA funded by PER and IRR of unrestricted PSIA (CR + MR)]*	698,479.95	474,410.27	363,533.25
(K) (E) – (G) – (J)	**36,253,363.36**	**45,847,333.92**	**55,753,526.59**
CAR (A)/(K)	**12.55%**	**8.93%**	**5.88%**

Note: Please see Table A1 for (A) and Tables A2 to A4 for (B), (C), and (D) calculations.

Table A6(ii). CAR using IFSB supervisory discretion formula under defined scenarios.

Amounts in local currency

F (ii) CAR using IFSB supervisory discretion formula, when α = 0.50	Scenarios		
	BAU	Moderate	Severe
	Pre-shock	Post-shock	
I) Capital			
(A) Total eligible regulatory capital which is used as the numerator for CAR	**4,550,100.00**	**4,095,090.0**	**3,276,072.00**
II) Risk-weighted assets			
(B) Total RWA for credit risk	30,830,817.60	35,164,437.6	39,498,057.60
(C) Total RWA for market risk	15,734,512.50	17,547,814.4	21,090,817.50
(D) Total RWA for operational risk	6,684,378.75	4,679,065.1	4,010,627.25
(E) Total RWA	**53,249,708.85**	**57,391,317.10**	**64,599,502.35**
(F) RWA (CR & MR) funded by unrestricted PSIA/IAH holders *(50% of Total Credit RWA and Market RWA under BAU, 30% under moderate and 20% under severe)*	23,282,665.05	15,813,675.59	12,117,775.02
(G) *(1 – α) [RWA funded by unrestricted PSIA/IAH (CR + MR)]*	11,641,332.53	7,906,837.80	6,058,887.51
(H) *RWA (CR & MR) funded by restricted IAH*	–	–	–
(I) *RWA funded by PER and IRR (CR + MR) [10% of unrestricted PSIA/IAH)]*	2,328,266.51	1,581,367.56	1,211,777.50
(J) *α [RWA funded by PER and IRR of unrestricted PSIA (CR + MR)]*	1,164,133.25	790,683.78	605,888.75
(K) (E) – (G) – (J)	**40,444,243.07**	**48,693,795.52**	**57,934,726.09**
CAR (A)/(K)	**11.25%**	**8.41%**	**5.65%**

Table A6(iii). CAR using IFSB supervisory discretion formula under defined scenarios.

Amounts in local currency

F (iii) CAR using IFSB supervisory discretion formula, when α = 0	Scenarios		
	BAU	Moderate	Severe
	Pre-shock	Post-shock	
I) Capital			
(A) Total eligible regulatory capital which is used as the numerator for CAR	**4,550,100.00**	**4,095,090.0**	**3,276,072.00**
II) Risk-weighted assets			
(B) Total RWA for credit risk	30,830,817.60	35,164,437.6	39,498,057.60
(C) Total RWA for market risk	15,734,512.50	17,547,814.4	21,090,817.50
(D) Total RWA for operational risk	6,684,378.75	4,679,065.1	4,010,627.25
(E) Total RWA	**53,249,708.85**	**57,391,317.10**	**64,599,502.35**
(F) RWA (CR & MR) funded by unrestricted PSIA/IAH holders *(50% of Total Credit RWA and Market RWA under BAU, 30% under moderate and 20% under severe)*	23,282,665.05	15,813,675.59	12,117,775.02
(G) *(1 – α) [RWA funded by unrestricted PSIA/IAH (CR + MR)]*	23,282,665.05	15,813,675.59	12,117,775.02
(H) *RWA (CR & MR) funded by restricted IAH*	–	–	–
(I) *RWA funded by PER and IRR (CR + MR) [10% of unrestricted PSIA/IAH)]*	2,328,266.51	1,581,367.56	1,211,777.50
(J) *α [RWA funded by PER and IRR of unrestricted PSIA (CR + MR)]*	–	–	–
(K) (E) – (G) – (J)	**29,967,043.80**	**41,577,641.51**	**52,481,727.33**
CAR (A)/(K)	**15.18%**	**9.85%**	**6.24%**

Table A6(iv). CAR using IFSB supervisory discretion formula under defined scenarios.

Amounts in local currency

F (iv) CAR using IFSB supervisory discretion formula, when α = 1	Scenarios		
	BAU	Moderate	Severe
	Pre-shock	Post-shock	
I) Capital			
(A) Total eligible regulatory capital which is used as the numerator for CAR	**4,550,100.00**	**4,095,090.0**	**3,276,072.00**
II) Risk-weighted assets			
(B) Total RWA for credit risk	30,830,817.60	35,164,437.6	39,498,057.60
(C) Total RWA for market risk	15,734,512.50	17,547,814.4	21,090,817.50
(D) Total RWA for operational risk	6,684,378.75	4,679,065.1	4,010,627.25
(E) Total RWA	**53,249,708.85**	**57,391,317.10**	**64,599,502.35**

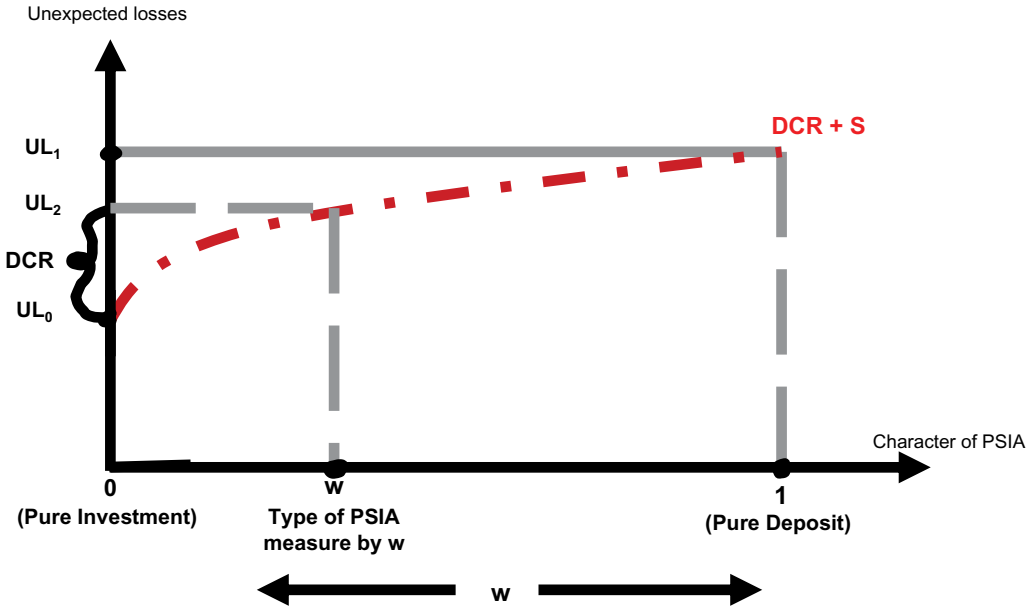
(*Continued*)

Table A6(iv) - *Continued*

Amounts in local currency

F (iv) CAR using IFSB supervisory discretion formula, when α = 1	Scenarios		
	BAU	Moderate	Severe
	Pre-shock	Post-shock	
(F) RWA (CR & MR) funded by unrestricted PSIA/IAH holders *(50% of Total Credit RWA and Market RWA under BAU, 30% under moderate and 20% under severe)*	23,282,665.05	15,813,675.59	12,117,775.02
(G) *(1 – α) [RWA funded by unrestricted PSIA/IAH (CR + MR)]*	–	–	–
(H) *RWA (CR & MR) funded by restricted IAH*	–	–	–
(I) *RWA funded by PER and IRR (CR + MR) [10% of unrestricted PSIA/IAH)]*	2,328,266.51	1,581,367.56	1,211,777.50
(J) *α [RWA funded by PER and IRR of unrestricted PSIA (CR + MR)]*	2,328,266.51	1,581,367.56	1,211,777.50
(K) (E) – (G) – (J)	**50,921,442.35**	**55,809,949.54**	**63,387,724.85**
CAR (A)/(K)	**8.94%**	**7.34%**	**5.17%**

Appendix B: The relationship between unexpected losses to IIFS' shareholders and the character of PSIA



This figure shows the relationship between the character of PSIA expressed in "w" and unexpected losses to IIFS' shareholders.

As "w" moves from zero to 1, the character of PSIA changes from being a pure investment-like product to a pure deposit-like product. (Since DCR exists only in cases of smoothing returns, the "S" factor, given above, is by assumption to cater for the guaranteed principal of *Muḍārabah* capital so that PSIA assimilate pure deposits.) In such a case, it is required to increase the amount of shareholders' funds.

The additional capital requirement – that is, the increase in unexpected losses as "w" shifts from zero (a pure *Muḍārabah* **outcome) to** its actual level "w" – is given by $(UL_2 – UL_0)$**,** which is the measure of displaced commercial risk (DCR).

The maximum possible value of DCR is given by $(UL_1 – UL_0)$**.** The value of alpha in the capital adequacy formula is given by the ratio of actual size of DCR to its maximum value.

Source: IFSB GN-4, March 2010.

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