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INVESTIGATING INTERSECTORAL LINKAGES IN ISLAMIC FINANCIAL SERVICES INDUSTRY

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ABOUT THE ISLAMIC FINANCIAL SERVICES BOARD (IFSB)

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

For more information about the IFSB, please visit **www.ifsb.org**.

ABBREVIATIONS

AAOFI	Accounting and Auditing Organization for Islamic Financial Institutions
BCBS	Basel Committee on Banking Supervision
BGD	Bangladesh
BIS	Bank for International Settlements
CRD	Capital Requirements Directive
FNA	Financial Network Analytics
GFC	Global Financial Crisis
GOV	Government
G-SIFI	Global systemically important financial institution
G-SII	Global systemically important institution
H-H	Household
HLA	Higher loss absorbency
HQLA	High-quality liquid assets
IADI	International Association of Deposit Insurers
IAH	Investment account holder
IAIS	International Association of Insurance Supervisors
ICM	Islamic capital market
IDN	Indonesia
IFSB	Islamic Financial Services Board
IFSI	Islamic financial services industry
IIFS	Institutions offering Islamic financial services
IMF	International Monetary Fund
IOSCO	International Organization of Securities Commissions
ISIC	International Standard Industrial Classification of All Economic Activities
JOR	Jordan
LCR	Liquidity coverage ratio
MYS	Malaysia
NAV	Net asset value
NFC	Non-financial corporation
NCR	Net capital rule
NPISH	Non-profit institutions serving households
NSFR	Net stable funding ratio

OFI	Other financial institutions
OMN	Oman
OTC	Over-the-counter
PAK	Pakistan
PSIFIs	Prudential and Structural Islamic Financial Indicators
ROW	Rest of the world
RSA	Regulatory and supervisory authority
RWA	risk-weighted asset
SAU	Saudi Arabia
SDG	Sustainable development goal
SDN	Sudan
SIFI	Systemically important financial institution
SME	Small or medium-size enterprise
SNA	System of National Accounts
UAE	United Arab Emirates

GLOSSARY

Sharī'ah	The practical divine law deduced from its legitimate sources: the Qur'ān, Sunnah, consensus (*Ijmā'*), analogy (*Qiyās*) and other approved sources of the Sharī'ah.
Ṣukūk	Certificates that represent a proportional undivided ownership right in tangible assets, or a pool of tangible assets and other types of assets. These assets could be in a specific project or a specific investment activity that is Sharī'ah-compliant.
Takāful	A mutual guarantee in return for the commitment to donate an amount in the form of a specified contribution to the participants' risk fund, whereby a group of participants agree among themselves to support one another jointly for the losses arising from specified risks.

Abstract

Research carried out since the Global Financial Crisis (GFC) of 2007–8 to in an attempt to understand the systemic risk origination, propagation and mitigation relating to sectoral linkages has rarely focused on the specificities of the Islamic financial services industry (IFSI). The main aim of this IFSB working paper is to fill this gap by exploring intersectoral financial linkages within the IFSI, as well as between the IFSI and the real economy, via a financial network analysis. The preliminary indicative outcome is envisaged to prepare the ground for future work by the IFSB on *macroprudential* guidelines as it applies to the specificities of the IFSI. The Islamic banking balance sheet data from 4Q13 to 4Q17 extracted from the IFSB Prudential and Structural Islamic Financial Indicators database is used to generate a bilateral exposure adjacency matrix that indicates assets and liabilities across sectors of the IFSI and the real economy. The Financial Network Analytics software is used for missing data generation based on maximum entropy as well as for both the financial network measures and visualisation. The results obtained did not show the anticipated significant commonality across countries that would enable a strong (albeit descriptive) conclusion to be drawn. The results did, however, indicate what analysis could be done if the requisite data were available. While some inexplicable results were noticed, in general, all seven sectors studied across the four selected jurisdictions[1] have increased in interconnectivity over time. Both the other financial institutions and household sectors recorded increased bilateral exposure in terms of obligations to other sectors. Notwithstanding, the results indicated a reduced likelihood of the Islamic banking sector creating a devastating effect on the financial network in the event that a systemic risk originated from it.

[1] The countries selected feature a systemically significant Islamic banking sector or membership of the G20 economies. These countries are by no means representative of the entire global IFSI. As such, financial network analysis conducted is country-specific with an assumed possibility of finding cross-country common trends. The results obtained are assumed indicative, rather than inferential, due to data constraints; as such, they should be viewed with caution. Notably, the peculiarities of each country in terms of economic diversification and the size of the Islamic financial sector were not considered. Similarly, the possibility of interconnectedness of the IFSI with the conventional financial institutions and likely cross-border claims and obligations were also discounted due to data limitations.

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SECTION 1: INTRODUCTION

1.1 Background

The Global Financial Crisis (GFC) of 2007–8 offered a sharp reflection of the systemic linkages that exist across the various sectors and jurisdictions of the financial ecosystem. The consequences of the GFC on households, corporations and governments manifested in many guises and resulted in arguably the deepest peace-time contraction of the world economy since the 1930s.[2]

The vulnerability of the existing financial, fiscal and monetary policies at that time was also exposed to an extent that the prominent global banks then had excess leverage, and insufficient stable funding to see them through the crisis without a government bail-out.[3] In addition, the speed at which initial losses in a financial institution or sector can be magnified and transmitted across other sectors through risk propagation mechanisms became more discernible.[4] The GFC thus provided a number of lessons about the potential grave consequences of global financial instability.

Post-GFC, it became apparent that forces within the finance industry and interactions among financial institutions and particular segments of the real economy (such as the construction and real estate sector) played a major role in the propagation of the crisis.[5] Existing macroeconomic models had to be extended, and new models developed, to capture the internal dynamics of the finance industry and mitigate against systemic crisis in the financial sector and massive losses to the real economy.

While there is speculation about whether another financial crisis may be looming, a unanimous view holds that any next financial crisis may be fundamentally different from the previous crises, both in terms of origination and propagation.[6] Today, innovations in the financial sector arising from advancement in financial and technological developments differ in many regards from what obtained during the last GFC. For instance, the Bank for International Settlements (BIS) has noted the implication of the regulatory challenges posed by crypto-assets, digital currencies, shadow banking, etc., for financial system stability, especially under stress situations.[7]

A myriad of policy responses within and across the financial ecosystem has been put in place post the GFC.[8] This is with the ultimate aim of forestalling its impacts and contagious spread on the one hand, and reoccurrence across sectors and jurisdictions

[2] Financial institutions with large credit exposures to the property sector were greatly affected, while the consequent bail-out by the government with taxpayers' money resulted in a risk transfer from the banking sector to the government sector. This transfer of risk had severe negative implications for the sovereign bond yields in the capital market sector (Cussen, 2017, p. 2). Based on data covering 40 years and 187 different episodes of banking crisis in 126 countries, van Dijk (2013) found that a number of socio-economic indicators were significantly affected by the financial crises. For instance, life expectancy fell by nine months, school enrolment dropped by 3.5%, while fertility fell by 5.5%. In addition, there was an increase in outbound refugees and in inbound foreign aid.

[3] BIS (2018), *Annual Economic Report*, p. 80.

[4] Cortes, Lindner, Malik and Segoviano (2018), p. 5.

[5] The GFC led to the realisation that the interaction between the financial and the real economy, as reflected in the interlinkages in the asset prices and macroeconomic outcomes across the various financial subsectors, was more complex than hitherto thought.

[6] Depository Trust and Clearing Corporation (2018).

[7] BIS (2018), *Annual Economic Report*.

[8] Claessens and Kose (2018), p. 5.

on the other.[9] For example, based on the Basel III accords, a two-stage approach was adopted to mitigate the contagious spread of the financial crisis in the banking sector. In order to combat pro-cyclicality,[10] a higher overall equity capital requirement for banks was established, including a counter-cyclical buffer of between 0% and 2.5% and a capital conservation buffer of 2.5%.

Financial institutions may also be required to maintain a higher loss absorbency (HLA), depending on their relative importance in terms of size or position within a system, as a possible origin of a systemic financial crisis if they have attained "too big to fail"[11] or "globally systemically important financial institution"[12] status. Furthermore, macroprudential policy tools such as capital and liquidity surcharges have been suggested to lessen the effects of systemic risk.[13] Arguably, these various measures that were meant to provide a buffer and build resilience especially in the banking sector have proven to be useful complements of other financial, fiscal and monetary policies, albeit at the price of an unintended slow credit growth and restraints on a financial boom.[14]

For the Islamic financial services industry (IFSI), relevant Islamic Financial Services Board (IFSB) standards already contain requisite modifications relating to pertinent macroprudential issues.[15] For instance, provisions relating to capital buffer, leverage ratio, dynamic provisioning, sectoral risk weights, etc. are been revisited by the IFSB with a view to ensuring the stability of the IFSI.[16] In addition, the IFSB has produced a guidance note which provides key parameter settings that address the concerns relating to liquidity coverage ratio (LCR), net stable funding ratio (NSFR) and high-quality liquid assets (HQLA).[17]

Ensuring global financial stability entails that the focus of the intervening policies should be complementary and related to how they affect the real economy[18]. This is particularly relevant to the IFSI whose activities, considering its essential underlying philosophy, are strongly tied to the real economy.[19] Arguably, the effect of the GFC on

[9] BIS (2018), *Annual Economic Report*, p. 80.
[10] The tendency of financial variables to fluctuate around a trend during the economic cycle (Landau, 2009).
[11] Loepfe, Cabrales and Sánchez (2013), p. 1.
[12] Global systemically important financial institutions (G-SIFIs) are defined by the Financial Stability Board as institutions of such size, market importance and global interconnectedness that their distress or failure would cause significant dislocation in the global financial system and adverse economic consequences across a range of countries.
[13] In the insurance sector, the International Association of Insurance Supervisors (IAIS) states that from 2019, regardless of all group activities including non-insurance subsidiaries, global systemically important institutions (G-SIIs) will be expected to hold regulatory capital that is not less than the total required by the sum of the BCR and HLA requirements. In the securities sector, the International Organization of Securities Commissions (IOSCO) has updated its 1989 *Report on Capital Adequacy Standards for Securities Firms* (*Capital Standards Report*) with a focus on the net capital rule (NCR) approach and the capital requirements directive (CRD) following the Basel Committee approach although with recognition of relevant national variations.
[14] BIS (2018), *Annual Economic Report*, p. 63.
[15]The IFSB has also published its flagship *Islamic Financial Services Industry Stability Report* on an annual basis since 2013. The report tracks the stability and resilience-related developments in the IFSI across the Islamic banking, *takāful* and Islamic capital market sectors by providing in-depth trend analysis of, and the likely future outlook for, the IFSI as part of its core mandate to ensure the industry's financial soundness and resilience.
[16] The IFSB is presently revising a number of its standards, especially IFSB-15: *Revised Capital Adequacy Standard for Institutions offering Islamic Financial Services (Excluding Islamic Insurance (Takāful) Institutions and Islamic Collective Investment Schemes].*
[17] See GN-6: *Guidance Note on Quantitative Measures for Liquidity Risk Management in Institutions offering Islamic Financial Services [Excluding Islamic Insurance (Takāful) Institutions and Islamic Collective Investment Schemes].*
[18] Silva, da Silva, and Tabak (2017) p. 4.
[19] Aziz (2008) p. 3.

the Islamic financial sector was generally considered to be relatively less than that on the conventional financial sector. Plausible reasons in addition to the IFSI's linking its transactions to real assets include the inherent foundational principles that promote transparency, market discipline, and the avoidance of interest and uncertainty in contractual obligations.[20] For instance, Islamic banks, whose risk-sharing business model is essentially equity-based, were protected from the consequence of exposure to the high leverage and risk taking that underlay the GFC.[21]

There is, however, evidence that suggests the Islamic financial services sector was not absolutely immune from the effects of the GFC, given its link to the real sector of the economy. The vulnerability of institutions offering Islamic financial services (IIFS) to financial crisis is reflected in their link to the real estate sector – for instance, in the Gulf countries – as a second-round effect of the GFC.[22] This view is based on the notion that while an institution – or a financial sector, for that matter – may be sound in isolation, its susceptibility to, for instance, the real sector's pro-cyclicality can also be very costly[23].

Notwithstanding the fact that the value of the IFSI is relatively small and Islamic financial institutions do not have a strong multinational presence in comparison to the conventional financial service industry in most jurisdictions,[24] the former has assumed systemic importance in a number of jurisdiction.[25] In addition, most countries have recognised the potential of Islamic finance as being crucial to their financial inclusion agenda, while the United Nations notes its potential contribution to achieving the financing goal aspect of sustainable development goals (SDGs).[26]

As the IFSI continues to gain traction across the world, its ascendance to being an integral part of the financial ecosystem will also grow in parallel due to increased intrasectoral linkages among the Islamic banking and non-banking financial sectors on the one hand, and intersectoral linkages with the real economy on the other. What is not clear is whether such interlinkages either impede or enhance the financial stability of the IFSI.

Due consideration of the implications of a financial crisis for the IFSI therefore seems pertinent now, more than ever. As such, an understanding of the multidimensional and evolving complex nature of systemic sectoral linkages requires in-depth research, especially in terms of systemic risk amplification mechanisms and consequential contagion effects peculiar to the IFSI, in order to come up with appropriate policy responses. Moreover, and quite specifically, the various macroprudential policy responses tailored to conventional finance, while applicable in many regards to Islamic

[20] Alqahtani, Mayes and Brown (2015); and Hashem and Giudici (2016), p. 2.
[21] Aziz (2008, p. 3.
[22] Kammer et al. (2015).
[23] For instance, due to external shock, the real sector's assets may be jeopardised triggering defaults on its financing obligations to the banking sector. The latter's need to comply with regulatory capital requirements may lead to a credit crunch to the former putting it at a risk of further default thus amplifying the systemic shock(Silva, da Silva, and Tabak, 2017, p. 7).
[24] Only Sudan and Iran have a full-fledged Islamic financial system.
[25] Koster (2012).
[26] IMF, *Core Principles for Islamic Finance Regulation* (2018).

finance, may also inadvertently discountenance the specificities of the IFSI given the latter's structural fragmentation and relatively smaller size in most jurisdictions.[27]

1.2 Objectives

This working paper is generally aimed at preparing the ground for the future work of the IFSB on developing macroprudential guidelines. As a prelude to another working paper on the effectiveness of macroprudential tools for financial stability in the IFSI, this preliminary working paper specifically aims to investigate the systemic linkages among the various IFSI sectors and their interconnectedness to the real sector in the selected countries.[28]

1.3 Scope of the Paper

This preliminary working paper, like most studies on sectoral linkages in the financial services industry, also faces an issue relating to requisite data availability on a granular scale[29]. As such, the scope of the working paper is mainly conceptual with a modest fractional empirical backing as much as the available data can permit to conduct financial network analysis and visualisation with a specific focus on four jurisdictions selected for this study.[30]

1.4 Methodological Assumptions and Limitations

A systemic analysis of the interlinkages between the IFSI and the real sector as well as among the various sectors of the IFSI requires data on a granular basis, which is presently not available. Specificities of Islamic finance were long ignored, both in national and international statistics. The IFSB's Prudential and Structural Islamic Financial Indicators (PSIFIs)[31] should be able to solve this dilemma in the future; however, for now, the issue of data limitation remains pertinent to conducting a granular data-driven analysis of the prevalence, transmission and effect of intersectoral systemic linkages in the IFSI. As such, some methodological assumptions are required, especially in relation to estimating the intersectoral bilateral exposure data needed for conducting a financial network analysis.

Based on the PSIFIs data, while it may be possible to know both the aggregate of the funding received (liabilities) from and financing advanced (assets) to the other sectors by the Islamic banks in a country, no data are available on what other sectors provided in funding to or received in financing from each other as counterparties. Consequently,

[27] Apart from Iran and Sudan, which have an Islamic financial system, only a few countries, such as Malaysia, Pakistan, Bangladesh and the GCC countries, have attained a significant level of development in their Islamic finance industry.

[28] The mapping also considers cross-sectoral systemic risks in the IFSI through the identification of linkages between banks and institutions in other sectors such as *takāful* and Islamic capital markets, as well as other non-financial, household, government and rest of the world (ROW) sectors as per the System of National Accounts (SNA) classification.

[29] Battiston and Martinez-Jaramillo (2018) p.7

[30] Four IFSB jurisdictions have been selected for this study. The selection was based on factors such as regional representation, IFSI development, attainment of systemic importance as per the IFSB's IFSI *Stability Report 2018* and the availability of comparable data. The initial basis of G20 membership could not be solely used, as relevant data needed are missing for a particular IFSB jurisdiction among the three IFSB members in the G20. The PSIFIs data for some jurisdictions that have attained systemic importance are only available in percentage format, which is not compatible with the type of analysis intended.

[31] The data provided by the IFSB PSIFIs database consists of macro-level data of the balance sheet claims and obligations of Islamic banks in various jurisdictions in an aggregate form, making it suitable for financial network analyses.

there are missing elements in the bilateral exposure matrix developed for analysis. Nonetheless, it is possible to partially estimate the aggregate sectoral assets and liabilities based on the PSIFIs Islamic banking data. For this, estimates of the missing data are generated based on maximum entropy in the first stage and RAS algorithm in the second.[32] This approach is used to distribute assets and liabilities as evenly as possible among the counterparty sectors based on available data in the IFSB PSIFIs database.[33]

In the bilateral exposure matrix created, the unknown elements are estimated assuming that the marginal distribution of the aggregate of the known assets and liabilities are independent. Thus, if sector A provides, for instance, 40% of aggregate funding, and Sector B receives 30% of total financing, the element AB in the matrix would be (0.4 x 0.3 = 0.12). In addition, for computational purposes, the adjacency matrix of the bilateral exposure among the sectors comprises country-level data rather than specific Islamic financial institutions data. As such, funding and financing data are taken in aggregates, rather than based on instruments or maturities.[34]

There are seven sectors considered in this study following the SNA classification and similar studies carried out at the International Monetary Fund (IMF) and a number of central banks.[35] Given that there are four countries sampled, the adjacency matrix consists of 28 cells for each of the 17 quarters from 4Q13 to 4Q17. As such, a closed system which posits a complete IFSI network and which results in a dense network is assumed in this paper, meaning that all sectors are expected to have relations with at least one other sector. The Financial Network Analytics (FNA) software is used for data generation, as well as both the financial network measures and visualisation.[36]

Due to the data limitations, the results obtained are, at best, indicative rather than inferential.[37] Even though the Islamic banking sector of some of the four countries selected is systemically important on the respective national level, these countries are by no means a representation of the global IFSI. Moreover, the fact that all jurisdictions with the exception of two operate a dual financial system would make an analysis of interconnection between the Islamic financial institutions and their conventional counterparts relevant. However, due to the lack of data, this fact, as well as possible cross-border transactions, had to be discounted in this working paper.

1.5 Structure of the Paper

The remainder of this working paper is broadly divided into four sections as follows. In Section 2, a brief review of the concept of systemic risk, and of various dimensions of

[32] "The RAS method is used in a situation when only row and column sums of desired input–output table are known. The table is then estimated from an older fully-known input–output table in a way that the resulting table is consistent with given row and column sums." Holy and Safr (2017) p.2

[33] This approach follows numerous financial network analysis research studies conducted at various RSAs and the IMF in which such missing bilateral exposure data are estimated via a maximum entropy algorithm in the first stage and a RAS algorithm in the second (see Upper and Worms,2004, 2011; Martinez-Jaramilo et al., 2012; Markose, 2012; and De Almeida Antoun, 2015), Anand et al (2018)

[34] The lack of such required granular data impeded analysis on maturities and instrument bases as was done in similar financial network analysis in the conventional system. See for instance, Castrén and Rancan (2014).,De Almeida Antoun (2015), Anand et al (2017)

[35] See Upper and Worms (2004, 2011); Martinez-Jaramilo et al. (2012); Markose (2012); and De Almeida Antoun (2015).

[36] www.fna.fi

[37] Markose (2012) and Kreis and Leisen (2017) provide evidence for the limitations of using simulated financial network models.

systemic risk, is provided. Section 3 focuses on intersectoral linkages in the IFSI. Section 4 offers a data-driven analysis of the interrelationship among the various subsectors of the IFSI and the real sector based on financial network analysis and visualisation. The dataset used, as well as the entire methodological approach adopted, are further described in detail. Section 5 concludes with highlights of macroprudential issues arising from the literature reviewed and the modest network analysis conducted in Section 4.

SECTION 2: SYSTEMIC RISKS, INTERCONNECTEDNESS AND HIDDEN VULNERABILITIES IN THE IFSI

Systemic risk reflects the vulnerability of a financial institution to external contagion and spillover due to financial interconnectedness. Defining systemic risk requires that the source, transmission channel, sectors affected and the implications for structural vulnerability are taken into consideration. Systemic risk is thus defined as "the risk of widespread disruption to the provision of financial services that is caused by an impairment of all or parts of the financial system, which can cause serious negative consequences for the real economy".[38]

Systemic risk's contagion effect on the real economy underscores the policy attention it receives from stakeholders including governments, regulatory and supervisory agencies (RSAs), operators and financial intermediaries, as well as both corporate and retail investors. Such risk primarily evolves due to, among other factors, financial market development, regulatory environment, and behaviour of other market participants often prompted by regulatory arbitrage, etc.[39]

For the IFSI, there seems to be a need for a clear-cut view of both what a system is and what systemic risk implies. From a jurisdictional regulatory perspective, an explicit statement on whether "system" refers to a sector, country, region or the world is required. For instance, there is a tendency to view the Islamic financial system as if it comprises only the Islamic banking system[40], due to the relative dominance of that sector, whereas Islamic capital markets and *takāful* may also be systemically important in their own right. Furthermore, the IFSB's mandate covers all three main sectors – that is, Islamic banking, the Islamic capital market and *takāful*.[41] As such, systemic risk from the IFSI perspective may not be restricted to a view from the angle of one sector only. Rather, it should be from a view that reflects sectoral interconnectivity to reveal hidden vulnerabilities among the various sectors and their links to the real economy.

Systemic risk may also be viewed from the perspectives of its origin and transmission channels.[42] This is because it can occur within or be transmitted across various financial markets, instruments, institutions or even infrastructure. There is also a

[38] See Cortes et al. (2018).
[39] See Smaga (2014).
[40] As at 2Q18, Islamic banking accounts for 72% of the global IFSI assets (IFSB IFSI Stability Report 2019)
[41] While supranational organisations like the Basel Committee on Banking Supervision (BCBS), IOSCO, IAIS and the IMF focus more on their particular supranational systems, it is not so in the case of the IFSI.
[42] Cortes et al. (2018).

possibility that the same sector may be the originator, transmitter and bearer of the consequence of a financial crisis. In this instance, systemic risk is strictly endogenous, emanating from either the collective behaviour of small financial institutions due to asset commonality and strategic complementarities,[43] fire sales or activities of a systemically important financial institution (SIFI) within a given sector or jurisdiction.

Sectors in a financial system are interconnected via a network of many financial obligations and claims to and from each other whose value is contingent on the individual and collective financial soundness of interconnected sectors in the network.[44] Numerous studies[45] on these sectoral linkages often accentuate the need for an understanding of the effect of interconnectedness in a financial system, especially towards developing macroprudential policies to mitigate the reoccurrence of the systemic financial crisis. Two possible views – vis. the "domino" effects and the "tsunami" effects – are noted as possible approaches that stimulate contagion. These effects are depicted in Figure 2.1.

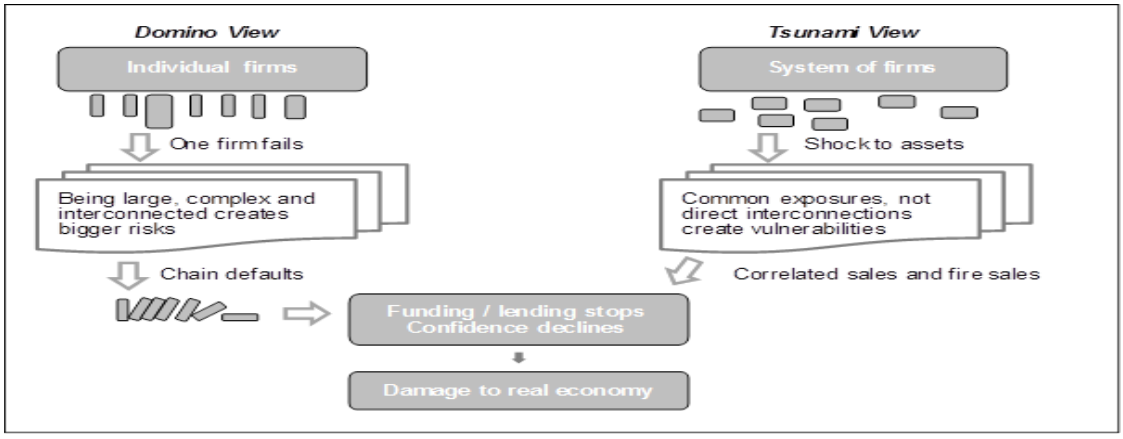

Figure 2.1 Domino vs. tsunami views of interconnectedness.

Source: Nematrian. Adapted from IMF (2016).

The "domino" effects view takes cognisance of the interconnectedness that exists in a financial system such that, if a firm fails, it can trigger chain defaults among other firms within the interconnected system. However, a focus on such direct interconnectivity may cloud the possible "tsunami" effect of hidden vulnerabilities within the system that may be triggered by sectors not focused on.

For instance, given that compared to the other sectors in the IFSI the Islamic banking sector is apparently more interconnected, the macroprudential focus may be on that sector. Nonetheless, other subsectors of the Islamic capital market sector, such as pension funds, are very popular in some economies and are considered to be very much related to the real economy given that such funds are both long-term and tied to a key socioeconomic fundamental – employment. Furthermore, given the fact that it takes a while to build up vulnerabilities in some instances and in some sectors such as *takāful*, there exists a possible susceptibility to misinterpretation which makes determining whether or not an event is systemic very much open to debate.

[43] See Basso and Costain (2016); and De Nicolo, Favara and Ratnovski (2012).
[44] Castrén and Rancan (2014).
[45] BIS (2018), *Annual Economic Report*, Castrén and Rancan (2014), De Almeida Antoun (2015)

Although systemic risk is often viewed as a "tail event" with low probability of occurrence, the severity of its consequences requires that a broad view of its manifestation is taken into consideration for macroprudential policy formulation. This is especially so given that lack of interconnectedness may not necessarily translate to avoidance of systemic risks. Recent views of systemic risks transcend those arising primarily from shock within the financial system. There are possibilities that national financial systemic risks may be triggered by hyperinflation due to political risks[46], or even climate change[47] On the flip side, recent considerations of systemic risks also factor in the effect of societal change as currently manifested in the disruptive technological innovation offered by cryptocurrencies, FinTech, TechFins, InsurTechs, etc.[48] In fact, systemic risks can spring up everywhere. However, not all possibilities are of equal probability.

SECTION 3: INTERSECTORAL LINKAGES IN THE IFSI

The underlying philosophy of Islamic financial service rendering that precludes engaging in speculative, highly leveraged and risky activities may explain why the IIFS were not affected by the first-wave effect of the GFC. However, the fact that the IFSI was not spared the second wave of the GFC due to, for instance, interbank activity and real estate investment[49] is a manifestation of the industry's susceptibility to systemic risk and systemic linkage among its various subsectors and between it and the real sector. This may result from external global financial instability and its many triggers. Internally, sectoral convergence in some regards and significant differences that result from factors such as regulatory capital frameworks, core business activities, supervisory approaches, etc. are also pertinent. The need for the IFSB to have a composite view – for instance, in its standards-setting responsibility in the IFSI – is also well noted.[50]

The dynamic nature of the IFSI may also require peculiar effective policy calibration given that in most jurisdictions where these IIFS operate, the relative dominance of the Islamic banking sector suggests that not much may be known about cost of policies and how they affect, for instance, Islamic capital market activities. Similarly, the relative smaller size of the *takāful* sector in most jurisdictions contributes to its being considered as non-systemically important[51]. Notwithstanding this, the sector provides a very essential service and also provides funds for both banking and capital market activities. In addition, systemic risks build-up is slower in the *takāful* sector (similarly to conventional insurance) than in the banking sector where liquidity issues cause a financial crisis to build more quickly.[52]

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[46] Bitar, Hassan and Walker (2017).

[47] Battiston and Martinez-Jaramillo (2018) p. 2

[48] Aurer and Claessens (2018); BIS (2018), *Annual Economic Report*.

[49] IFSB (2014), *IFSI Stability Report*.

[50] IFSB-16: *Revised Guidance on Key Elements in the Supervisory Review Process of Institutions offering Islamic Financial Services [Excluding Islamic Insurance (Takāful) Institutions and Islamic Collective Investment Schemes]. This technical standard explicitly specifies the entire gamut of Islamic financial service activities that the IFSB oversees.*

[51] Despite growing at a relative faster rate compared to conventional insurance, *takāful* accounts for less than 2% of the global Islamic finance asset worth (IFSB IFSI Stability Report 2019).

[52] The experience of Lloyds in the United Kingdom in the early 1990s suggests that systemic risks build up rather slowly in the insurance sector – on average, for between five and 10 years (Koster, 2012). In fact, Borio and Drehman (2009) warned about the false sense of security developed by regulators during a period of low volatility given that a financial crisis is not an instant event but rather one that builds up over time.

The propagation of shocks across various financial sectors, notwithstanding the diverse business models, derives either directly from the interlinkage in contractual obligations or indirectly through exposure to common triggers and transmission channels of systemic crisis[53]. For instance, in the Islamic capital market sector the diversity of businesses conducted by intermediaries in the market and the consequential risks they pose necessitate that regulatory attention is focused more on their business conduct.[54] These intermediaries may propagate and transmit shocks to the entire financial system through asset liquidation, direct exposure[55] and common risk factors channels.[56]

Open-ended funds such as Islamic mutual funds are faced with redemption risks, as investors may decide to redeem their shares in the short run, whereas the funds have been invested by the mutual fund in a longer tenure investment. Other open-ended funds like the Islamic exchange-traded funds, while not prone to redemption risk, often do hold assets with higher illiquidity, making them more exposed to liquidity risks. The effect of these risks on market performance can trigger a run by investors[57] given that flows and performance are co-integrated.[58] In the conventional sphere, studies have shown that such was the situation that played out during the peak of the GFC, resulting in extensive fire sales of assets by open-ended funds to meet shortfalls in liquidity and lost sales in individual stocks.[59]

Money market open-ended funds have also been shown to have the potential to trigger, or even propagate, systemic risk. This may be through the direct exposure channel as a result of the significant reduction in their exposure to risky issuers during market stress. Impairment of the large funding provided by money market funds infringes on their intermediation capability and their capacity to provide funding to other financial sectors, especially the banks,[60] as occurred in Europe during the European sovereign debt crisis that began in 2009.[61]

In recent years, there has been a proliferation of Islamic hedging instruments in both the Islamic banking and Islamic capital market sectors in many jurisdictions.[62] The instruments, tools and strategies align not only with the operationalisation of a number of Islamic contracts for the purpose of minimising risks, but also with one of the essential principles of Shari'ah , which is to protect wealth. A variety of such Islamic hedging instruments are being used in several jurisdictions, essentially as Shari'ah-compliant hedging alternative to conventional derivative instruments. These include

[53] For instance, Battiston and Martinez-Jaramillo (2018) p.3 for a brief on default contagion, distress contagion, common assets contagion and funding liquidity contagion.

[54] This is in terms of their relations with and claims made on customers, products offered and disclosure practices.

[55] Cortes et al. (2018) noted that banks, for instance, have direct exposure to hedge funds through the former's prime brokerage service provided to the latter.

[56] Even where systemic risks do not originate from hedged funds, their institutional structure that allows for a swift switch across investments and markets may amplify cross-sectoral financial shock in their bid to arbitrage for profit maximisation and funds protection.

[57] According to Ferroli, Schoenholtz and Song Shin (2014), risk-averse investors would opt to take the first mover advantage by redeeming early in anticipation that the net asset value (NAV) of the fund can only fall further.

[58] Cortes et al. (2018); and Coval and Stafford (2007).

[59] Anand et al. (2015); Cortes et al. (2018).

[60] The banking sector may also be affected by the money market funds, especially where the banks provide sponsor support to their money market funds subsidiary by purchasing a significant portion of the illiquid asset or guaranteeing the par value of the money market funds.

[61] Correa, Sapriza and Zlate (2012).

[62] Jurisdictions such as Malaysia, Indonesia, Iran and the UK, to name a few, have accommodated such tools.

alternatives to profit rate swaps, foreign currency swaps, foreign currency forwards and options, etc.[63]

A fundamental difference between conventional derivatives and their Islamic hedging alternatives is that the latter cannot be used, without a genuine underlying real transaction, for the sole aim of generating profits. In this regard, market volatility is minimised and systemic stability is ensured. However, most of such Islamic hedging transactions are traded over-the-counter (OTC) rather than through an organised exchange, which results in opaqueness of the market and unavailability of data, thus masking hidden vulnerabilities to systemic shock origination and propagation.

During the GFC, the hedge funds' significant exposure to, and losses from some asset classes, pointed to the fact that such funds are highly vulnerable to a combination of a myriad of liquidity, credit and equity risk factors.[64] Consequently, numerous investors exercised their right of redemption of shares with a level of alacrity that had to be moderated by the hedge funds' gates in order to meet outflow demand and to protect the remaining investors.

Due to the nature of the hedge fund transactions, it is important for regulatory and supervisory authorities to fully know the nature and size of such transactions being used by IIFS in their market, in their counterparties and in underlying contracts in order to fully understand the potential risk that such transactions pose to systemic stability.

In the *takāful* sector, the inverted production business model[65] adopted makes it relatively less susceptible to market volatility compared to the Islamic banking and Islamic capital market sectors. The *takāful* sector is thus relatively unlikely to be the source of a systemic risk in the IFSI, because it is less interconnected and less dependent on economic cycle. Nonetheless, the *takāful* sector, like the conventional insurance sector, may also be faced with various types of risks, including equity market risks, concentration risks, liquidity risks, technical risks, etc.[66]

The vulnerability of a *takāful* firm can be amplified by events such as major catastrophes or unusually high frequency and magnitude of policy surrender, which may necessitate fire sales to meet liquidity needs. Furthermore, significant indirect financial shock propagation can result if a *takāful* firm draws heavily on its banking line of credits, thus amplifying liabilities in the Islamic banking sector.[67]

The Islamic banking sector's dominance in a financial system is arguably linked to its pivotal role around which other sectors rotate. This is so, given that as part of its intermediation role it mobilises funds for financing purposes from the other sectors on its liabilities side to other sectors on its assets side. Furthermore, the role an Islamic

[63] Ibid
[64] Le Sourd (2009).
[65] Insurance is based on prepaid funding via premiums and penalties for policy discontinuation (Cortes et al., 2018). A stable cash flow is generated and funds are invested in long-term assets funded by short-term liabilities, which makes insurance companies not to involve in maturity transformations (IAIS, 2011).
[66] For instance, an insurance company may face exposure in the equity market or the property market in its bid to hedge against inflation. Similarly, concentration risks may result on the asset side from investment in a concentrated asset class, and from a narrow exposure to a range of underwriting channels on the liability side. Insurance firms are also susceptible to both technical risk and liquidity risk in the event of an unusually high claim due to a random fluctuation in business or a catastrophic event.
[67] Acharya and Richardson (2010).

bank plays in the IFSI is different due to the fact that any financing and funding that it originates or mobilises is basically a direct linkage and not traded in an exchange, unlike, for instance, equity securities traded in the Islamic capital market.

The interconnectedness and centrality of banks in a financial network is also differentiated given that they can participate in investment in the other sectors, such as the insurance or securities market, on their own account or act as an intermediary. So, the banking sector, by the nature of the transaction it engages in, is exposed to a variety of risks. For instance, financing to other sectors such as households,[68] non-financial corporations, etc., often represents the largest asset in a bank's balance sheet and may expose it to credit risk, while deposits mobilisation, as the largest liability, may expose the bank to funding and liquidity risks[69].

In the IFSI, the Islamic banks seem to be very much interconnected to other sectors. The balance sheets of Islamic banks indicate that, to varying degrees across countries, they are very active in their intermediation role. On the assets side of the balance sheet, in most instances in most countries, Shari'ah-compliant financing to households, non-financial corporations, government and the rest of the world accounts for more than 70% of total assets. Though this may be an indication of an over-exposure of the Islamic banks to the non-financial sector on the asset side, it nonetheless also indicates that the Islamic banks' financing to the real sector is very high in line with the fundamental philosophy of Islamic finance – that it be linked to the real economy.

The implication of this may need further exploration, especially to find out whether the intersectoral link between Islamic banks and the real economy has really strengthened somewhat due to a wider sectoral diversification of financing and investments. There may also be further "hidden" intersectoral links if, for example, a large part of consumer finance is for home furnishing and equipment. An analysis of Islamic banks' balance sheets might provide indications of whether such risk clustering (and, hence, a stronger link of Islamic banks with one segment of the real economy) does in fact exist.

Although the balance sheets of most countries' Islamic banks indicate that interbank funding and financing are, on average, about 4% and 6%, respectively,[70] there is also a need to take a closer look at the involvement of Islamic banks in interbank activities in the money market. This may be a significant asset channel through which intrasectoral systemic risk may be propagated.

The investment opportunities of Islamic banks are more limited compared to their conventional counterparts. For this reason, the former's typical balance sheet reveals a higher concentration in the real estate and construction industry.[71] In some other

68 As much as 46% of the total financing by Islamic banks was to households, while about 12% was to the construction and real estate sector (IFSB, *IFSI Stability Report 2018*)

[69] Battiston and Martinez-Jaramillo (2018) offers insights into how default contagion can originate and propagate though unsecured interbank market as well as the possibility of distress contagion even if the obligor does not default. The authors also highlighted the possibility of common assets contagion arising from the indirect connection among banks due to investment in common assets, as well as funding liquidity contagion on the liability side if banks decide to hoard credit rather than make it available to other market players.

[70] IFSB, PSIFIs database as at 4Q17.

[71] See IFSB (2019) IFSI Stability Report (*Forthcoming),* and IMF (2017) Country Report No. 17/145.

jurisdictions, there is a prominent presence of the IIFS in the small to medium enterprise (SME) sector, which further exposes them to financial instability due to the fragility of that sector.

In terms of interconnectivity, a concern from a system stability perspective could be, for example, the links between Islamic banks and *takāful* operators as issuers and holders of *ṣukūk*. Of particular interest in this regard is corporate *ṣukūk* and, even more specifically, *ṣukūk* issued by banks to strengthen their capital base. The assets side of the balance sheets of Islamic banks in most countries indicates a steady increase in *ṣukūk* financing and other Shari'ah-compliant securities. However, this accounts for less than 10% of total financing in most jurisdictions. A similar trend is also observed in terms of *ṣukūk* funding across countries.

Most *ṣukūk* are issued by sovereigns. The volume of corporate *ṣukūk* is approximately 25% of total issuances (and decreasing over time).[72] A large proportion, about 30% of corporate *ṣukūk*, are issued by Islamic financial institutions, which are also major investors in *ṣukūk*. There could be a problematic mutual dependency if bank A holds *ṣukūk* which have been issued by bank B to strengthen its capital base, and vice versa. Investment in *ṣukūk* can be a tool to diversify risk, but it could also lead to a sectoral risk concentration if the *ṣukūk* are issued by industries that are prime recipients of Islamic bank financing (e.g. construction and real estate).

SECTION 4: SECTORAL FINANCIAL NETWORK ANALYSIS IN IFSI

4.1 A Network Analysis of Sectoral Linkages in IFSI

This section adopts financial network analysis[73] and visualisation to investigate interconnectedness among the various sectors in both the real and Islamic financial systems of the selected countries.[74] Following previous studies,[75] the rationale for adopting a network approach,[76] notwithstanding the difficulty of obtaining the granular bilateral exposure data, is hinged on the possibility of using estimated data to generate sectoral linkage networks.[77]

The main goal of network analysis is to build a conceptually appealing network of intersectoral asset claims and financial obligations that permits a subsequent

[72] IFSB (2018), *IFSI Stability Report*.
[73] Hansen (2014) provides a detailed critique of the pros and cons of various systemic risk analysis techniques. Bisias et al. (2012) also provide a rich literature survey on systemic risk analytics
[74] Based on the SNA classification adopted in the PSIFIs, these sectors include the banking, Islamic capital market, insurance and other financial institutions, household, government and the ROW. The balance sheet is essentially that of the Islamic banks in the jurisdictions covered in this study. Full details of the data are given in the methodology section of the paper.
[75] Castren and Rancan (2014).
[76] Network analysis is an established and useful approach to modelling systemic interconnectedness. It cuts across numerous fields, although its use is rather limited and is emerging only recently in systemic links analysis in finance due to data limitations.
[77] Studies like De Almeida Antoun (2015), Castren and Rancan (2014), Markose (2012), Martinez-Jaramillo et al. (2012), Upper (2011), etc., have applied it. However, Markose (2012) and Kreis and Leisen (2017) provide evidence for the limitations of using simulated financial network models.

determination of aggregate network vulnerabilities.[78] Unlike the alternate approach of using stock market prices, evidence has shown that a network approach is more suitable given that default leading to a systemic crisis originates from changes in the balance sheets of financial institutions.[79] In fact, it is argued that the data availability argument of using the market-based model is not a strong justification for using it. The market-based model does not provide early warning signals of a crisis, as "by the time they spiked, [the] market would have tanked already".[80]

The network method is very useful for analysing both direct and indirect, as well as weighted, interlinkages in order to decipher the structural heterogeneity present in the linkages across financial subsectors of interest. Moreover, the PSIFIs database used in this study consists of macro-level data of the balance sheet claims and obligations of Islamic banks in various jurisdictions in an aggregate form. In addition to its content relevance, the form of data entry also suits the network analysis as the various sectors can be represented as nodes or vertex,[81] and the interlinkage among them as the link or the arc.

It is envisaged that at the end of the analysis, sectors from which potential shocks can originate can be identified in the countries selected. Moreover, since the data cover about nine semi-annual[82] or 17 quarterly observations, the network structure can be observed on a time-variant basis to capture structural heterogeneity in the trajectory of the interlinkages across sectors.[83] Finally, the various centrality and connectedness measures analysed can offer insights into the relative strength and importance of various sectoral linkages identified for systemic risk management and macroprudential policy designs.[84]

4.2 Network Construction

This section offers a brief description of how the network used in the analysis section is developed. There are two distinct routes towards the development of better information systems on structural data for the financial sector and its interrelations with the real economy. The first route takes the system of national accounts (SNA) as a macroeconomic point of departure. The second route takes the disclosure requirements of regulated financial institutions as a microeconomic point of departure. This working paper adopts the first approach given that it is less demanding in terms of data requirements and suits the format of the PSIFIs database towards constructing a bilateral exposure matrix.

[78] Markose (2012), p. 13, comments that intervention and stabilisation policies crucially depend on knowing who is linked to whom and how.
[79] Kreis and Leisen (2017).
[80] Markose (2012), p. 1.
[81] Nodes or vertex, indicated by a circle in a network diagram, represent a financial sector – for example, Islamic banking or Islamic capital market. The arc or the links are the arrows that show interconnectedness among the sectors in a network.
[82] The data for Country 4 are available on a semi-annual basis. Other countries are available on a quarterly basis.
[83] Adding more subsectors and more detailed lists of financial instruments would come at a high price. Each additional subsector and instrument requires more input data. A complete SNA requires four different types of accounts (tables) for each category of instrument. First, a balance sheet for the stocks of assets and liabilities at the beginning of the period, and a financial account for all transactions between institutional units during the period. Two other requirements are an account for the impact of "exceptional" events (such as natural catastrophes) that cause changes in the volume of assets and liabilities (e.g. by destruction), and a revaluation account for changes in the values of assets and liabilities due to price changes.
[84] Martinez-Jaramillo et al. (2012).

The seven sectors[85] in each of the four selected countries represent the nodes indexed by "i". The weighted financial linkage between any two nodes is indexed by W_{ij}. Each country network W_D is derived based on the total amount of assets and liabilities for each sector in each country. In a closed system like that assumed in this paper, every asset in one sector has a corresponding liability in one or several other sectors within the network.

While it is usually possible to know the value of the assets a sector has, based on aggregate data, it may be impossible to find detailed statistics on how much of these assets correspond to specific liabilities in the other sectors. If data are not available in the necessary granularity, several techniques can be employed to "generate" it – that is, the matrix of (the results of) all bilateral interactions in the network, from the available aggregate data. If only the sums of the rows and columns on the margins of a matrix are known and the non-marginal cells are unknown, it is not possible to calculate the missing cell entries in a deterministic manner because the number of equations is far less than the number of unknowns. This means that more than one set of cell entries is compatible with the aggregate marginal sums, and there is probabilistic uncertainty with respect to the generated network structure and the interlinkages matrix, respectively. Hence, it has to be decided which of the possible solutions of the under-identified system is to be chosen. The maximum entropy method offers a solution to this problem[86].

A comprehensive empirical study[87] have surveyed and assessed seven methods for uncovering financial network structures from partial data. Several methods applied the maximum entropy principle, with the iterative standard maximum-entropy method being one of the two best performers for the reproduction of the structure of exposures.

The basic idea is to choose "that solution which injects the minimum amount of additional and, by definition, non-verifiable information into the data"[88] (such as, for example, assumptions about the behaviour of nodes). Entropy measures the informational content of a message, and it "is greatest when the message recipient is the most uncertain as to the outcome of a given event".[89] Maximising entropy thus means to choose that solution which is associated with the maximum uncertainty or randomness of the distribution of cell entries.[90] If only a minimum of additional information (such as non-negativity conditions) has to be injected (in order to decide which solution will be chosen for further analysis), the uncertainty remains at its maximum. In formal terms, the entropy has to be maximised subject to a number of constraints, and the resulting optimisation problem is usually solved by an iterative process. Should additional data become available, they could be fed into this process.

From a practical perspective, an "initial guess" of the network (the matrix with initial cell entries) is generated by computing the exposure of sector i to sector j as the product

[85] The sectors are: Islamic Banking (IB), Islamic Capital Market (ICM), Other Financial Institutions (OFI), Non-Financial Corporation (NFC), Household (H_H), Government (GOV), and Rest of the World (RoW).
[86] Hazan (2018) p. 1
[87] Anand et al (2018)
[88] Sheldon and Maurer (1998), p. 693.
[89] Ibid.
[90] Zhou, Cai and Tong (2013).

of the row sum of sector i and the column sum of sector j. “This network is subsequently re-scaled by the aggregate positions, first along the rows and then the columns, until the aggregate position constraints are satisfied.”[91]

4.3 Network Measures, Visualisation and Analysis

Although the listed issues regarding the data quality and comparability cannot all be solved, this working paper adopts an innovative tool via an in-built command in the FNA software used in similar studies for the sectoral network data analysis and visualisation. While other methods have been proposed, such as those that minimise density,[92] maximum entropy is preferred in the financial network literature, especially in contexts similar to that in this study, where there are few interconnected nodes with the possibility of yielding a dense and almost complete network.[93]

4.3.1 Network Measures

The FNA software is applied to generate a number of network measures that can be used to interpret the potential shock transmission and vulnerabilities arising from bilateral exposures among the various sectors in a network. These measures are broadly divided into centrality and connectedness algorithms.[94] The centrality algorithms generally help to identify the relative importance of a node or vertex in a network based on a number of network topological criteria, some of which are specifically meant for financial applications.[95] The connectedness algorithms help to identify how nodes are connected in the network. In this study, two connectedness algorithms used are the clustering co-efficient and degree.

Computation of the network centrality and connectedness algorithms is based on the sectoral data for aggregate assets and liabilities between two points in time, 4Q13 and 4Q17.[96] In order to cater for effect size and to mitigate the implications of different volumes of sectoral activities,[97] especially where all the data are extracted from a predominantly Islamic banking database, the sectoral links are weighted relative to their values in the network. This is important given that networks are built to depict financial stability, as drawing links based on absolute value may not be representative of a sector’s relative bilateral exposure.[98]

4.3.2 Network Visualisation

A network is basically a graphical representation of an adjacency matrix that consists of the bilateral exposures of the various nodes in the network. While the position of the node in the graph is arbitrary, its size indicates the relative net bilateral exposure

[91] Anand et al. (2018); see also Upper and Worms (2004).
[92] Anand et al. (2014).
[93] De Almeida Antoun (2015).
[94] www.fnalab.com.
[95] The various measures used in this study include: Betweeness, Closeness, Degree, Eccentricity, Farness, PageRank and Random Walk Betweeness. The specific algorithms for financial network analysis include CheiRank, SinkRank and SourceRank
[96] 4Q13 is used as the base period, while 4Q17 is used as the reference period. The choice of the periods, though mainly arbitrary, is meant to reflect any changes between the two periods as the earliest and latest data points in the PSIFIs database. Moreover, it suits the inclusion of Country 4, whose data are compiled on a semi-annual basis.
[97] The data used are predominantly from the banking sector, which may be more exposed to certain sectors than others.
[98] De Almeida Antoun (2015). FNA Analysts Guide (2018)

position of a sector in the network.[99] Similarly, the thickness of the arrow that links nodes indicates the proportional exposure of the sector from which the arrow emanates to the sector that the arrow connects. Each node in the diagram represents a sector. Green indicates a sector that has a net claim from the other sectors, while red indicates a net obligation from a sector to others. The arrows show the direction of flow of funds between two sectors.

The sectoral links for each of the four selected countries for 4Q17 are presented below. Figures 4.1 to 4.4 depict the network interconnectedness across the seven sectors based on Islamic banking data obtained from the PSIFIs database and bilateral exposures generated via a maximum entropy algorithm.[100] The figures should be interpreted together with the tables in Appendix 1, which show the various network centrality measures for 4Q13 as the base period and 4Q17 as the reference period.

Based on Figure 4.1, it can be seen that the 'Other financial institutions' (OFI) sector in Country 1 has the top bilateral linkage to the 'Non-financial corporation' (NFC), 'Household' (H-H) and 'Islamic capital market' (ICM) sectors.[101] The red colour of the OFI sector node indicates that it has lower claims to receive from, compared to obligations it needs to fulfil to the other sectors. This contrasts sharply with Country 2, where the top bilateral exposures are to the household sector. In terms of size, the H-H sector's node is bigger in this instance, denoting larger exposure. The largest exposure of the Country 2 H-H is to the NFC.[102] This denotes that, even though Country 2 households have claims to the OFI, they nonetheless also have obligations to the other sectors. However, the fact that the OFI's node is also red indicates some consistency with Country 1's sectoral linkage in that regard.

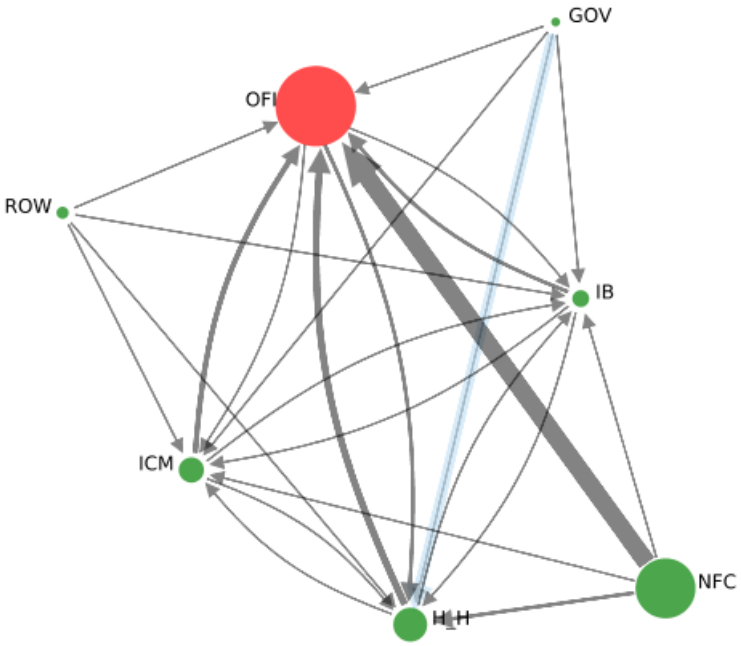
In the case of Country 3, similar to Country 2, the H-H sector seems to be the sector most exposed to a bilateral relationship with the other sectors. It is also the only sector with a red node, indicating that the H-H sector in Country 3 has more obligations to the other sectors than claims due to it. The greatest obligation is to the NFC sector, indicated by the thickness of the link between the two sectors. All the financial sectors and the ROW sector also have claims against the H-H sector. Compared to Country 4, a sharp contrast can be observed given that the most exposed sector is the OFI. This is similar to the trend in Country 1 especially and, to a lesser extent, in both Country 2 and Country 3. In Country 4, also, the nodes for both the H-H sector and the Islamic banks are red, indicating that both sectors also have larger obligations to other sectors than claims receivable by them.

The general trend observed across the various jurisdictions sampled in this paper is similar in many regards to those of the Financial Stability Board Report.[103] The report also measured bilateral linkages among the various financial sectors based on balance

[99] In the network visualisation, red indicates that the ratio of the liability to the asset in a sector is greater than 1.
[100] See De Almeida Antoun (2015) for a description and example of data generation via maximum entropy.
[101] The ICM is essentially represented by funding generated by and financing through *ṣukūk* and other Sharī'ah-compliant securities. The *ṣukūk* is further divided into corporate and sovereign *ṣukūk*. The latter is used together with related measures to represent the 'Government' (GOV) sector.
[102] This may be in terms of the H-H investments in shareholding in the various sectors captured under the NFC sector, as listed in the table in Appendix 2.
[103] FSB (2018), *Report on Shadow Banking*.

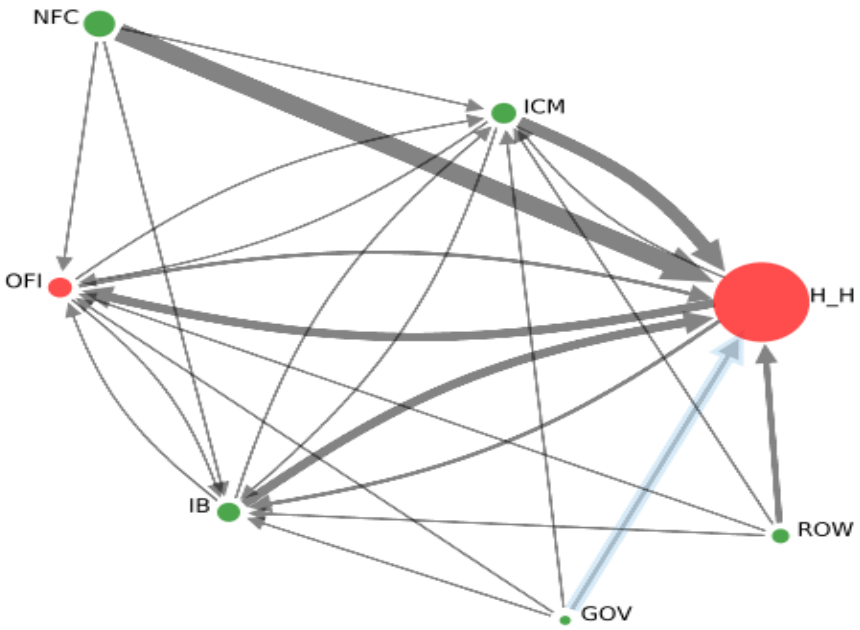
sheet data. The report noted a low relationship between the OFIs and the banking sector, as well as an increasing trend in non-bank funding, especially to households.

Figure 4.1 Sectoral Linkages Network, Country 1, 4Q17



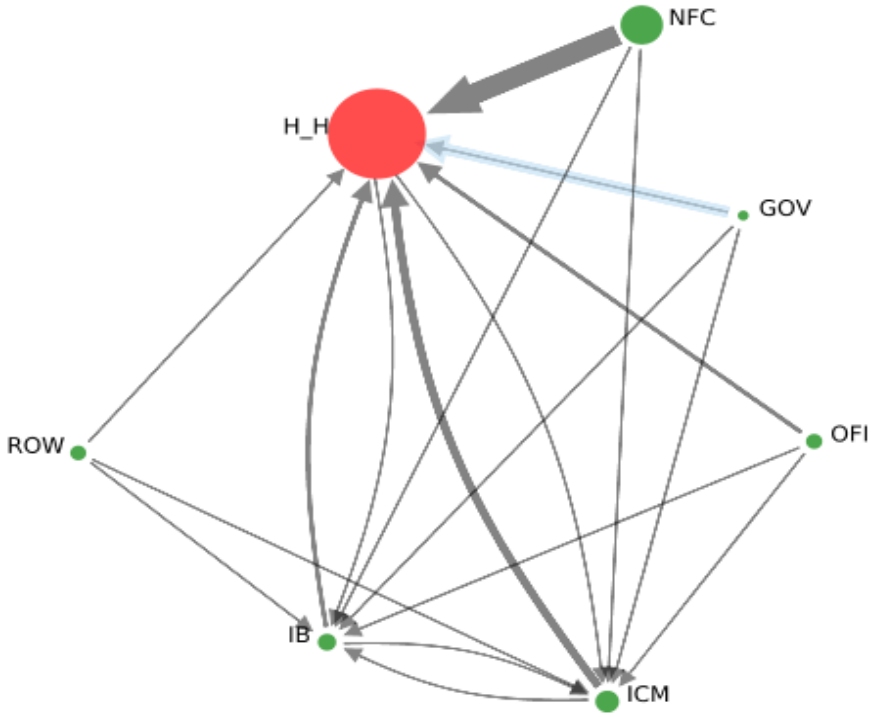
IB: Islamic Banks; NFC: Non-Financial Corporation; ICM: Islamic Capital Market; OFI: Other Financial Institutions; GOV: Government; H-H: Household; ROW: Rest of the World.

Figure 4.2 Sectoral Linkages Network, Country 2, 4Q17



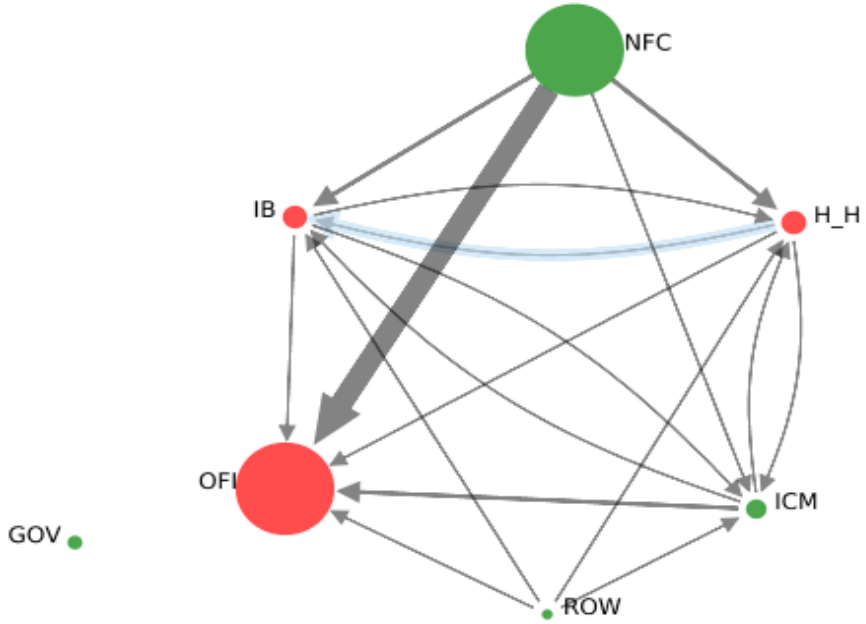
IB: Islamic Banks; NFC: Non-Financial Corporation; ICM: Islamic Capital Market; OFI: Other Financial Institutions; GOV: Government; H-H: Household; ROW: Rest of the World.

Figure 4.3 Sectoral Linkages Network, Country 3, 4Q17



IB: Islamic Banks; NFC: Non-Financial Corporation; ICM: Islamic Capital Market; OFI: Other Financial Institutions; GOV: Government; H-H: Household; ROW: Rest of the World.

Figure 4.4 Sectoral Linkages Network, Country 4, 4Q17



IB: Islamic Banks; NFC: Non-Financial Corporation; ICM: Islamic Capital Market; OFI: Other Financial Institutions; GOV: Government; H-H: Household; ROW: Rest of the World.

4.3.3 Network Centrality Algorithms

Centrality algorithms are very crucial in network analysis and have been commonly used in the various fields of related analysis. A very essential attribute of this algorithm is that, over the years, some specific variants peculiar to financial networks have been developed to capture the power, influence, control and independence of the various nodes in a network.[104] To assess the relative importance of a sector in a financial network, it is suggested in the literature that a number of attributes should be explored.[105]

First, it is expected that nodes do not exist in isolation. There should be as many interlinkages among the various sectors in a network (degree) as possible. Second, the total monetary value of assets and liabilities upon which the bilateral linkages would be established should be sufficiently large (strength). Other features mentioned include closeness, which indicates the likelihood of contagious transmission of risks among the sectors in a few steps in the network. While it is important that there are many paths through which a sector can link to any other sector in the network (betweenness), of very high importance is the cognisance given to the counterpart sectors in a network relative to a particular sector (eigenvector and PageRank).[106] Specifically, the FNA software also provides algorithms for calculating SinkRank as a measure of systemic importance in the network.[107] Other financial centrality measures are SourceRank and CheiRank. It is important to note that for all the centrality measures, the basic interpretation is that the higher or larger the centrality measure, the greater the importance of a sector in the network.

4.3.3.1 Betweenness Centrality and Closeness Centrality

Of the various general network centrality algorithms identified, the betweenness and closeness centrality algorithms are interpreted in this paper.[108] The betweenness centrality algorithm signifies the number of the shortest paths between any two sectors in the network passing through a given sector for which the betweenness centrality is interpreted. In other words, it indicates the mediating or bridging importance of a sector in the interlinkages between any other two sectors. Unlike other network centrality measures, it is captured in its absoluteness. As such, the higher the centrality the higher the influence a sector can exert as a propagation channel. It is an important indicator of the systemic risk propagation potentiality of a sector, especially through an indirect means.

Closeness is a measure of influence denoting how quickly a node can reach other nodes in a network – in other words, how quickly a sector can reach other sectors in the network (e.g. in terms of risk propagation). It is also described as an interpretation of a sector's relative independence in a network, as a high closeness centrality means

[104] Only the relevant financial network centrality measures are analysed and interpreted in this study.
[105] Henggeler and Muller (2006), cited in Martinez-Jaramillo et al. (2012).
[106] See Saltoglu and Yenilmez (2010) for the use of these measures in financial network analysis.
[107] This importance depicts strong ties and interconnectedness to other sectors. Systemic Importance as it is used for prudential regulation by the RSAs follows a more detailed methodology. See the threshold used for Islamic banking sector in the IFSB's *IFSI Stability Report 2019*.
[108] According to Peltonen, Rancan and Sarlin (2015), betweenness and closeness consider both the direct and indirect linkages, thus denoting the central position that a node occupies in a network.

a sector relies less on other sectors for it to be exposed to systemic risk.[109] In most instances, a network that is not strongly connected would not generate a closeness centrality score.[110]

As shown in Appendix 1, an assessment of the betweenness centrality and closeness centrality across the four countries in this study reveals that between 4Q13 and 4Q17, all sectors in Country 2 except for the IBs and all sectors in Country 4 except for OFIs recorded increased centrality over time. In both Country 1 and Country 3, the relative importance of every sector in isolation as a bridge connecting any other two sectors in the IFSI recorded an increase over time. This implies that while the IBs' capacity to act as a channel of shock propagation declined considerably in Country 2, a similar outcome was recorded in the OFI in Country 4.

In terms of the closeness centrality measures, similar trends are observed in both Country 1 and Country 3. No measure was generated for Country 4, apparently due to the weak connectedness in the network.[111] In the case of Country 2, the closeness measure for the NFC declined considerably, suggesting that the NFC over time recorded declining capacity to quickly propagate systemic risk to any other sector in the network.

4.3.3.2 Strength Centrality and Degree Centrality[112]

The degree centrality denotes the importance of a sector in a network depending on how many other sectors it is connected to. The more connected a sector is, the greater will be the severity of its failure and the higher the risk of propagation to the other sectors. One of the main criticisms of this measure is the fact that it does not take into consideration the importance of other sectors except those to which it is closest, and the fact that it is based on absolute measures.[113] As such, it is suggested that where it is weighted based on the value of the parameters used in a financial network analysis, it can be a measure of the strength of a sector in a network.[114]

Based on the table in Appendix 1, notwithstanding the declining clustering coefficient score indicating weak connectedness, the weighted degree centrality measure denotes an increase over the period 4Q13 to 4Q17. Country 1 sectoral connectedness is confirmed by both its higher weighted degree centrality and clustering coefficients.[115] Country 2 and Country 3 had a consistent clustering coefficient over the period of the study. However, based on the weighted degree centrality, both the OFI and ROW sectors in Country 2 had a comparatively lower measure in 4Q17 relative to 4Q13. The case of Country 3 presents a sharp contrast given that its degree centrality scores for the GOV, H-H, IBs and ROW sectors are all lower in the reference period compared to the base period.

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[109] Martinez-Jaramillo et al. (2012).
[110] *FNA Analyst Guide* (2018).
[111] This was also confirmed based on the vertex clustering coefficient score for Country 4, which indicated declining network connectedness (see Appendix 1).
[112] Network Centrality Measures: Betweenness, Clustering Co-efficient and Degree (show importance of interconnectedness and capacity for systemic shock transmission among various sectors).
[113] Martinez-Jaramillo et al. (2012).
[114] fnalab.com/command
[115] Clustering coefficient as a measure of connectedness ranges from 0 to 1. The higher the figure, the more connected a sector is.

4.3.3.3 Financial Network Algorithms[116]

Four important specific financial network algorithms are considered to capture the centrality of each sector considered in this study. These include the CheiRank, PageRank, SourceRank and the SinkRank algorithms.

The CheiRank centrality is essentially calculated on the transposed network to measure the proportion of time a sector contacts another within a network in an infinite random walk over the transposed network.[117] As a result of the matrix transposition, the resulting inverted link direction is used by the CheiRank to rank the sectors in a financial network on the basis of the average link it has to other sectors to which it has net obligations. The PageRank is similar in many regards to the CheiRank except that it is an eigenvector-based measure of network centrality.[118]

The SourceRank and the SinkRank are related centrality metrics used to assess the systemic importance of a sector in a financial network. In fact, the former is an equivalent to calculating the latter on the transposed network.[119] SinkRank centrality's relative importance is hinged on its capacity to measure how central a failing sector is in a network via its bilateral interlinkages with others. This metric assumes a strongly connected network and takes a value of between 0 and 1. The higher the SinkRank, the higher the likelihood that a sector will have a devastating effect on the network in the event of its failure.[120]

Based on the table in Appendix 1, the financial network centrality algorithms show a consistent pattern in each of the various countries. In Country 4, the GOV, H-H, ICM, and OFI sectors all recorded lower centrality scores in 4Q17 compared 4Q13. In Country 1, the GOV, IB, NFC and ROW sectors all recorded lower financial centrality, indicating the reduced likelihood of these sectors creating a devastating effect on the financial network in the event that a systemic risk originates from any of them. In the case of Country 2, the two sectors with relatively lower financial centrality measures in 4Q17 compared to 4Q13 are the IBs and the OFI sectors. Finally, in Country 3, while the IB sector recorded a lower SinkRank, both the NFC and ROW had lower measures in the other financial network centrality algorithms.

SECTION 5: CONCLUSION AND RECOMMENDATIONS

Drawing policy inferences from the modest financial network analysis conducted in this study requires some care as the results obtained are only indicative of the likely actual outcome. This is hinged on the fact that the data upon which the network is constructed are strictly Islamic banking data. While, based on the balance sheet, we can have an idea of what the Islamic banks mobilised in funding and what they disbursed as financing, the bilateral linkages among the other sectors had to be estimated. This may frustrate testing the various measures developed to assess the impact of macroprudential policies for timely identification, follow-up and policy efficacy. The lack

[116] Financial Network Measures: CheiRank, PageRank, SourceRank and SinkRank (show systemic importance of a sector in a financial network).
[117] fnlab.com/manual
[118] Ibid.
[119] Ibid.
[120] Soramaiki and Cooks (2013).

of data may also frustrate clear-cut cost/benefit analyses of the policy implementation in order to calibrate policy design which is very crucial to the standard setters and supervisory bodies – for instance, the IFSB as well as the RSAs.

Nonetheless, the various network centrality and connectedness measures computed in this study have highlighted that sectoral bilateral linkages vary across different jurisdictions. The exposure to systemic risk seems more likely to originate from the OFI sector in most of the countries sampled. This, however, is not prejudicial to the relative importance of other sectors as potential systemic risks originators and propagators. **There may, therefore, be a need to have a look at the existing macroprudential policy put in place in most jurisdictions with a view to identifying what likely issues are emerging and what implications they may have for the peculiar nature of the IFSI pending when the requisite granular data are available to conduct a sectoral linkage study that strongly guides policy.**

Data could be extracted from databases of multilateral organisations like the World Bank and the IMF, as well as from balance sheets and income statements of financial institutions. However, the availability of data does not ensure that they are always comparable. IFSIs in various jurisdictions have different disclosure practices, apparently due to differences in cross-country supervisory and regulatory approaches to Islamic banking supervision. For instance, caveats regarding the comparability of data between Islamic banks (in different GCC countries) due to differences in the structuring of Sharī'ah-compliant products is noted. The caveat also extends to the balance sheet and income statement items between Islamic and conventional banks – in the same country – because of different business philosophies and product orientations.

Ample arguments have also been provided as to why company accounts may not be suitable for use in national accounts.[121] Both accounts have different regulatory requirements, level of details required, presentation style and timeliness. At most, such data from company accounts can be used as a proxy for national accounts after due adjustments to the variables extracted.

The IFSB PSIFIs should be able to solve this data availability dilemma in the future; however, for now, the issue of data limitation remains pertinent in conducting a granular data-driven analysis of the prevalence, transmission and effect of cross-sectoral systemic linkage in IFSIs. **It is hoped that ongoing efforts by the IFSB to provide the data for the IFSI to capture both the *takāful* and Islamic capital market sectors, in addition to the already existing data on Islamic banking, would include, sometime in the future, requisite flow of funds data at a granular level. Such data are needed for constructing a for-whom-to-whom matrix as a basis for understanding the systemic linkages that exist within the Islamic financial services industry.**

The exposure to systemic risk seems higher for the other (Islamic) financial institutions comprising *takāful*, Islamic microfinance institutions, cooperatives and the various non-bank Islamic financial institutions. However, this is not prejudicial to the relative importance of other sectors such as households and non-financial corporations as

[121] Mahajan (2013).

potential systemic risks originators and propagators. **Therefore, there may be a need to have a look at both the existing and likely systemic linkage issues, and the implications they may have for the peculiar nature of the IFSI in various jurisdictions pending when the requisite granular data are available to conduct a sectoral linkage and cross-country study that guides policy**.[122]

The IFSI, it would seem, rarely or marginally features in the prudential policy, as well as in the complementary fiscal, monetary and structural policy, formulation in most jurisdictions. As such, the Islamic banking, Islamic capital market and *takāful* sectors and their conventional counterparts are often subjected to the same prudential policy that lacks due cognisance of the specificities of institutions offering Islamic financial services. Arguably, macroprudential policies are often not clearly articulated to reflect such specificities. Key drivers of pro-cyclicality and activities of Islamic financial intermediaries leading to the build-up of systemic risk that are often microprudential in nature may perhaps not be comprehensively captured.

The BCBS, IOSCO, IAIS and International Association of Deposit Insurers (IADI), based on their core mandates, focus on the identification, measurement, management and monitoring of certain aspects of specific systemic risks and linkages peculiar to their specific supranational domain. **The conglomerate structure of the IFSIs necessitates that a broad spectrum of Islamic financial services is provided across numerous sectors. This peculiarity underscores the need for a composite supervisory outlook.**

The IFSI is not absolutely immune from prudential and structural impediments that may have both intrasector and intersector stability implications across jurisdictions given the interconnectedness of the institutions within the IFSI and with the real sector. There are now 12 jurisdictions in which Islamic banking is considered as systematically important. Although less prominent today, a likely extension of their services across geographical borders creates the potential for contagion and spillover effects in the years ahead. **Obviously, to achieve an optimal outcome from the macroprudential policies for the IFSI, there may be a need to have a cross-sectoral approach to IFSI regulation and supervision. This of course would require an investigation into the institutional supervisory arrangements across the IFSB jurisdictions, as well as a set of prudential standards and effective review process that ensures achieving reasonable degree of convergence across sectors and minimizing moral hazard[123] and arbitrage opportunities.**

No doubt, the financial regulation and supervision from a microprudential point of view are important in many regards. What the GFC has shown, however, is the insufficiency of such policy for ensuring sustainable financial stability. Complementing the microprudential policy with a macroprudential policy seems a more effective means of averting financial crisis. Based on the indicative findings in this study, and from extant related studies on systemic linkages among the various sectors in a financial system,

[122] Although a few Islamic finance corporations have established subsidiaries in different jurisdictions, cross-border transactions seem to be of very limited size, at least for now. The use of a network analysis may be hinged on its perceived usefulness to build on this study for future cross-border contagion spillover analysis as and when data become available.

[123] A highly interconnected financial system may incentivize collective moral hazard manifest in excessive risk-taking against the notion of being too-interconnected to fail.

a common conclusion is that the positive effect of the financial soundness of individual institutions may be attenuated by the complexity of the interactions and interdependency in a financial network**. Therefore, averting financial instability would require a blend of both the micro- and macroprudential framework in a way that aligns the objectives of both policies.**

The data used in this study do not cater for spillover effects that are quite well-researched in the conventional sphere. This may be due to the fact that most Islamic banks are as yet non-systemically important on a global scale. There is evidence to suggest that, in the short term, macroprudential policy may generate unintended systemic risk spillovers across both sectoral and country divides, especially due to regulatory arbitrage.[124]

In addition, there is an increasing impetus to understand the implication of climate risk on financial stability and resilience due to financial system interconnectedness. This specifically relates to the effect of changing climate not only on physical assets and implication for insurance liabilities and real sector default on financial contracts, but also the consequential various policies and advocacies across the globe promoting transition to a low carbon economy. Such transition is estimated to result in stranded assets as much as 82% of global coal reserves, 49% of global gas reserves and 33% of global oil reserves.[125] **For the IFSI, most of the jurisdictions that have attained systemic significance derive their revenue from the oil and gas sector. The implication of the implementation of the climate policies for financial stability and resilience of the IFSI may warrant further investigation[126] through among other means a financial network approach due to the interconnectedness among the sectors in the IFSI.**

While there are presently no global systemically important institutions in the IFSI, the sectoral interlinkages noted in the network analysis raise concerns of systemic risks. This is more so viewed from the perspective of potential origination and propagation of risks emanating from a common behaviour among non-systemically important intuitions. **There may, therefore, be a need in future related work of the IFSB to have an activity-focused approach to supplement the entity-based approach that is presently prevalent, in order to capture potential systemic risks that may derive from asset commonality or behavioural commonality archetypal of non-systemically important institutions.**

[124] FSB (2018), *Report on Shadow Banking*, p. 36.
[125] Battiston and Martinez-Jaramillo (2018) p.10.
[126] This suggestion is not prejudicial to the availability of requisite data for this purpose which is also still a major challenge in the conventional financial system.

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APPENDICES

Appendix 1

Various Network Centrality and Connectedness Measures Based on Maximum Entropy

Country 1

Base Period	Sector	Betweenness	Chei Rank	Clustering Co-efficient	Degree	Page Rank	Sink Rank	Source Rank
2013-12-31	GOV	0	0.0283	0	0	0.0283	0.099	0.0895
2013-12-31	H_H	0	0.087	0	2397	0.087	0.1457	0.0999
2013-12-31	IB	6	0.0548	0.3333	1118	0.0548	0.1207	0.1077
2013-12-31	ICM	3	0.0578	0.3333	1232	0.0578	0.1173	0.1146
2013-12-31	NFC	0	0.406	0.5	14935	0.406	0.1105	0.6032
2013-12-31	OFI	0	0.3377	0	12629	0.3377	0.4103	0.0989
2013-12-31	ROW	0	0.0283	0	0	0.0283	0.099	0.0895
Reference Period	Sector	Betweenness	Chei Rank	Clustering Co-efficient	Degree	Page Rank	Sink Rank	Source Rank
2017-12-31	GOV	10.5	0.0214	1	1.0508	0.0214	0.0214	0.0756
2017-12-31	H_H	0	0.125	1	7398	0.125	0.3388	0.1466
2017-12-31	IB	13.5	0.043	1	1618	0.043	0.0834	0.0992
2017-12-31	ICM	0	0.0888	1	4520	0.0888	0.1152	0.1359
2017-12-31	NFC	0	0.2983	1	16653	0.2983	0.0214	0.4195
2017-12-31	OFI	0	0.4015	1	22689	0.4015	0.7521	0.194
2017-12-31	ROW	0	0.0219	1	26.2712	0.0219	0.0214	0.076

Country 2

Base Period	Sector	Betweenness	Chei Rank	Clustering Co-efficient	Degree	Page Rank	Sink Rank	Source Rank
2013-12-31	GOV	4.3333	0.0266	1	4133	0.0266	0.0214	0.0824
2013-12-31	H_H	0	0.4505	1	335809	0.4505	0.8216	0.3609
2013-12-31	IB	20.6667	0.0893	1	80848	0.0892	0.1022	0.1516
2013-12-31	ICM	0	0.0933	1	57059	0.0933	0.0214	0.1523
2013-12-31	NFC	0	0.1057	1	66835	0.1057	0.0214	0.166
2013-12-31	OFI	0	0.1907	1	136435	0.1907	0.3862	0.0992
2013-12-31	ROW	0	0.044	1	17876	0.044	0.0214	0.0996
Reference Period	Sector	Betweenness	Chei Rank	Clustering Co-efficient	Degree	Page Rank	Sink Rank	Source Rank
2017-12-31	GOV	10.0526	0.0297	1	10140	0.0297	0.0214	0.0642
2017-12-31	H_H	0	0.471	1	529120	0.471	0.8714	0.5071
2017-12-31	IB	1.7	0.0827	1	92369	0.0827	0.0942	0.1192
2017-12-31	ICM	58.8795	0.1114	1	114511	0.1114	0.0367	0.1421
2017-12-31	NFC	0	0.173	1	186867	0.173	0.0214	0.1957
2017-12-31	OFI	11.3882	0.0814	1	89076	0.0814	0.3564	0.0789
2017-12-31	ROW	1.5882	0.0508	1	36155	0.0508	0.0214	0.0814

Country 3

Base Period	Sector	Betweenness	Chei Rank	Clustering Co-efficient	Degree	Page Rank	Sink Rank	Source Rank
2013-12-31	GOV	13.6526	0.0237	1	6017	0.0237	0.0214	0.0796
2013-12-31	H_H	0	0.471	1	1116200	0.471	0.8714	0.3857
2013-12-31	IB	39.3895	0.0619	1	127444	0.0619	0.2275	0.1174
2013-12-31	ICM	10.7143	0.0696	1	148758	0.0696	0.2334	0.1216
2013-12-31	NFC	0	0.293	1	732037	0.2931	0.0214	0.2689
2013-12-31	OFI	0	0.0374	1	43112	0.0374	0.0214	0.0877
2013-12-31	ROW	0	0.0433	1	58832	0.04326	0.0214	0.0912
Reference Period	**Sector**	**Betweenness**	**Chei Rank**	**Clustering Co-efficient**	**Degree**	**Page Rank**	**Sink Rank**	**Source Rank**
2017-12-31	GOV	15.1526	0.023	1	4771	0.023	0.0214	0.0782
2017-12-31	H_H	0	0.471	1	1309504	0.471	0.8714	0.3857
2017-12-31	IB	41.8895	0.0476	1	103387	0.0476	0.1822	0.1087
2017-12-31	ICM	10.7143	0.0938	1	260260	0.0937	0.2795	0.1341
2017-12-31	NFC	0	0.2922	1	848270	0.2922	0.0214	0.2694
2017-12-31	OFI	0	0.0382	1	52403	0.0382	0.0214	0.0873
2017-12-31	ROW	0	0.0343	1	40414	0.0343	0.0214	0.085

Country 4

Base Period	Sector	Betweenness	Chei Rank	Clustering Co-efficient	Degree	Page Rank	Sink Rank	Source Rank
2013-12-31	GOV	0	0.0283	0	0	0.0283	0.025	0.0879
2013-12-31	H_H	0	0.0692	1	128560	0.0692	0.3298	0.98
2013-12-31	IB	0	0.0607	1	105020	0.0607	0.1309	0.1159
2013-12-31	ICM	5	0.0659	1	119967	0.0659	0.0462	0.1271
2013-12-31	NFC	0	0.3706	1	1081536	0.3705	0.0299	0.5801
2013-12-31	OFI	3	0.3770	1	1094502	0.377	0.5841	0.0976
2013-12-31	ROW	0	0.0283	0	0	0.0283	0.025	0.0879
Reference Period	**Sector**	**Betweenness**	**Chei Rank**	**Clustering Co-efficient**	**Degree**	**Page Rank**	**Sink Rank**	**Source Rank**
2017-12-31	GOV	0	0.0243	0	0	0.0244	0.0791	0.0894
2017-12-31	H_H	0	0.0655	0.67	229803	0.0655	0.1262	0.0992
2017-12-31	IB	0	0.0632	0.67	222218	0.0632	0.1151	0.1085
2017-12-31	ICM	6	0.0492	0.67	142614	0.0492	0.0927	0.1142
2017-12-31	NFC	0	0.4065	0.75	2144567	0.4065	0.0871	0.6024
2017-12-31	OFI	0	0.3668	0	1911236	0.3668	0.6589	0.0988
2017-12-31	ROW	8	0.0244	0.75	18	0.0243	0.0871	0.0894

Appendix 2
PSIFIs as a Bridge to Flow of Funds

In summary, the following is a "translation" of the International Standard Industrial Classification of All Economic Activities- (ISIC-) inspired classification of activities into an SNA-reminiscent sector and subsector scheme:

- non-financial corporations sector = i + ii + iv + v + vi + vii +viii;
    - *manufacturing (ii)*
    - *real estate (vii + viii)*
        - *commercial (vii)*
        - *residential (viii)*
    - *other non-financial corporations (i + iv + v + vi)*;
- financial corporations sector = iii;
- general government sector = x;
- households sector (including NPISH) = ix;
- rest of the world = xi.

The PSIFIs database provides for a number of jurisdictions figures that can add quantities to the categories. Two structural Islamic financial indicators and one additional prudential Islamic financial indicator are of relevance here:

	Indicator	
PSIFI code		
ST01	Total assets	
	ST01a	Total Sharīʿah compliant financing (excluding interbank financing)
	ST01b	*Ṣukūk* holdings
	ST01c	Other Sharīʿah-compliant securities
	ST01d	Interbank financing
		All other assets
ST02	Total funding/liabilities and equities	
	ST02a	Profit-sharing investment accounts (PSIA)
	ST02b	Other remunerative funding (*murābaḥah*, commodity *murābaḥah*, etc.)
	ST02c	Non-remunerative funding (current account, *wadīʿah*)
	ST02d	*Ṣukūk* issued
	ST02e	Other Sharīʿah-compliant securities issued
	ST02f	Interbank funding/liabilities
	ST02g	All other liabilities

ST03	Capital and reserves	
	ST03a	Total revenues
	ST03b	Financing based
	ST03c	Investment based (*ṣukūk*, other Sharīʿah-compliant securities, etc.)
	ST03d	Fee based
AD06	Value of Sharīʿah-compliant financing by economic activity	
	AD06a	Agriculture, forestry, hunting and fishing
	AD06b	Mining and quarrying
	AD06c	Manufacturing
	AD06d	Electricity, gas, steam and air-conditioning supply
	AD06e	Water supply; sewerage and waste management
	AD06f	Construction
	AD06g	Wholesale and retail trade; repair of motor vehicles and motorcycles
	AD06h	Transportation and storage
	AD06i	Accommodation and food service activities
	AD06j	Information and communication
	AD06k	Financial and insurance activities
	AD06l	Real estate activities
	AD06m	Professional, scientific and technical activities
	AD06n	Administrative and support service activities
	AD06o	Public administration and defence; compulsory social security
	AD06p	Education
	AD06q	Human health and social work activities
	AD06r	Arts, entertainment and recreation
	AD06s	Other service activities (export)
	AD06t	Activities of households as employers
	AD06t*	Other financing of households
	AD06u	Activities of extraterritorial organisations and bodies
	AD06u*	Financing to non-residents

The PSIFI indicators are assigned to the SNA-inspired sectors and subsectors as follows:

Allocation of PSIFI Codes to Sectors and Subsectors			
Sector/subsector			**PSIFI code**
NFC	Non-financial corporations		AD06a+b+c+d+e+f+g+h+i+j+l+m+n+p+q+r+s
	NF01	*Manufacturing*	*AD06c*
	NF02	*Real Estate*	*AD06l*
	NF09	*Other non-financial corporations*	*AD06a+b+d+e+f+g+h+i+j+m+n+p+q+r+s*
FC	Financial corporations		AD06k
GG	General government		AD06o
HH	Households and non-profit institutions serving h.		AD06t + t*
RW	Rest of the world		AD06u + u*

The PSIFI database collects stability indicators for 24 jurisdictions. Not all jurisdictions provide the indicators that are of relevance here. It is possible to compile sectoral tables for the Islamic banks in 20 jurisdictions and for Islamic banking windows in seven jurisdictions.[127]

[127] One jurisdiction (AFG) provides only data for Islamic windows, and four jurisdictions (KWT, NGA, PAK, TUR) do not provide a breakdown of Sharī'ah-compliant financing by economic activity. One country (EGY) provides neither assets (financing) nor liabilities (funding) in absolute amounts, which is needed for the correspondence check; see below.

Appendix 3

Data Classification from PSIFIs Database

Source	Assets	Liabilities
Additional Prudential Islamic Financial Indicators (PIFIs) – **AD06**	(a) agriculture, forestry, hunting and fishing – NFC	
	(b) mining and quarrying – NFC	
	(c) manufacturing – NFC	
	(d) electricity, gas, steam and air-conditioning supply – NFC	
	(e) water supply; sewerage and waste managemen – NFC	
	(f) construction – NFC	
	(g) wholesale and retail trade; repair of motor vehicles and motorcycles – NFC	
	(h) transportation and storage – NFC	
	(i) accommodation and food service activities – NFC	
	(j) information and communication – NFC	
	(k) financial and insurance activities – OFI	
	(l) real estate activities – NFC	
	(m) professional, scientific and technical activities – NFC	
	(n) administrative and support service activities – NFC	
	(o) public administration and defence; compulsory social security – GOV	
	(p) education – NFC	
	(q) human health and social work activities – NFC	
	(r) arts, entertainment and recreation – NFC	
	(s) other service activities (export) – NFC	
	(t) activities of households as employers – H-H	
	(t*) other financing of households – H-H	
	(u) activities of extraterritorial organisations and bodies – ROW	
	(u*) financing to non-residents – ROW	
Structural Islamic Financial Indicators (SIFIs) – **ST03**	*Ṣukūk* holdings – ICM	
	Other Sharī'ah-compliant securities – ICM	
	Interbank financing – IB	
Structural Islamic		Profit-sharing investment accounts (PSIA) – OFI?

Financial Indicators (SIFIs) – **ST04**		Other remunerative funding *(murābaḥah,* commodity *murābaḥah,* etc*.)* – H-H?
		Non-remunerative funding (current account, *wadīʿah*) – H-H?
		Ṣukūk issued – ICM
		Other Sharī'ah-compliant securities issued – ICM
		Interbank funding/liabilities – IB