

# Bank Stability Index for Selected Countries with Dual Banking Systems

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**Abstract:** A robust and comprehensive measure of bank stability is crucial to identify healthy banks and save troubled banks from deteriorating in order to avoid banking crises, hence prevented a systemic effect on the overall financial system of the country. The study aims to develop a comprehensive measure of bank stability for selected Organization of Islamic Cooperation (OIC) countries with dual banking systems. The measure is in the form of a composite index, comprehensively adopts relevant indicators from the existing literatures based on annual data from 1999 to 2015, obtained from the Bankscope database. The factor analysis method used by the Organization of Economic Co-operation and Development (OECD) is adopted to develop the index. The findings reveal the comprehensive measure of bank stability for all bank models. The policy implication for the regulatory is to use similar measure of bank stability in monitoring and reporting the stability of different bank models.

**Keywords:** Bank stability index, dual banking, Islamic bank, OIC Countries, factor analysis.

## 1. INTRODUCTION

The banking stability is acknowledged to have an important role in the stability of the overall financial system of the developing countries (Hartmann, Straetmans, & Vries, 2005; Popovska, 2014; Swamy, 2014). The banking sector, in the developing countries, is the most developed sector in the financial system, while the other sectors are less developed (Hartmann *et al.*, 2005; Popovska, 2014). Despite its importance, literature reviews on prevalent practices highlight that there is no internationally accepted framework and uniform measures of banking stability adopted by banks around the world (Segoviano and Goodhart, 2009; Gersl and Hermanek, 2010), specifically for the countries with the dual banking system.

Therefore, there is an urgent need to develop a measurement of the bank stability that could indicate the health of the banks, which is hope to highlight the healthy bank and warn potentially troubled banks from further experiencing bank failure. This study, therefore, attempts to fill this research gap by extending its discussion to include the measurement of bank stability for selected countries with the dual banking systems.

## 2. LITERATURE REVIEW

### 2.1. Banking Models in Dual Banking System

Most Muslim-majority countries have adopted an Islamic banking system, a conventional banking system

or a dual banking system (International Shari'ah Research Academy (ISRA), 2011). Islamic banking systems practice only Shari'ah-compliant financial systems, whereas conventional banking systems practices conventional or traditional financial systems that allow interest-based transactions. In addition, the OIC countries also have adopted the dual banking systems which allow Islamic and conventional banks to operate side by side (ISRA, 2011).

The overall financial system in dual banking systems, which can have five types of financial institutions or banking models: conventional banks, conventional banks with Islamic windows, conventional banks with Islamic subsidiary banks, subsidiary Islamic banks and Islamic banks (ISRA, 2011). ISRA (2011) defines a full-fledged Islamic bank as a bank that complies with Shari'ah and is either newly established or converted from a conventional bank. Subsidiary Islamic banks are either newly established or converted from existing Islamic windows.

Both Islamic windows and subsidiary Islamic banks comply with Shari'ah rules and regulations. However, an Islamic window has a single board of directors which consists of directors and Shari'ah advisors, while a subsidiary Islamic bank has a board of directors separate from the Shari'ah supervisory board. Conventional banks are defined as financial institutions that practice interest-based transactions. Conventional banks with Islamic subsidiary banks also engage in interest-based transactions but also are the holding company with a majority share (normally 100%) in its subsidiary Islamic banks. However, other researches

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simply identify banking models as Islamic banks and conventional banks (e.g. Srairi, 2009; Shafique, Hussain, and Hassan, 2013; Shahid, Rehman, Niazi, and Raoof, 2010; Hamza and Kachtouli, 2014; Ashraf, 2013).

## 2.2. Review of Bank Stability Measures

The review of literatures on bank stability measures include review of journal articles and practices by regulators across jurisdiction i.e. central banks and International Monetary Fund.

### 2.2.1. Prevalent Stability Measures across Jurisdictions: Central Bank Practices

A survey of prevalent stability measures reveals that the central banks of 10 countries, namely Bahrain, Bangladesh, Indonesia, Kuwait, Malaysia, Qatar, Turkey, Pakistan, Saudi Arabia and United Arab Emirates, are producing and publishing report(s) of similar nature (stability), while the central bank of Egypt

produces only report on general indicators for its financial soundness, on its website. From the reports, the countries with available reports, Bangladesh, Indonesia and Turkey have all the reports from 2010 to 2015. The next complete report is Malaysia with the available publication from 2010 to 2014, followed by Pakistan and Qatar while Saudi Arabia has only 2015 report available on the website. Table 1 shows the indicators used by the central banks of selected countries in reporting the stability of the financial system in the financial stability report.

### 2.2.2. Principle-Based Measures: International Monetary Fund

Historically, according to (Christopoulos, Mylonakis, & Diktapanidis, 2011; Roman & Şargu, 2013), in 1979, the bank regulatory agencies used financial ratios based on CAMEL to assess the soundness of banks in the USA. Later, these are extended and used as a tool to assess the soundness of banks for the supervisor

**Table 1: Survey of Indicators Used in Central Banks Financial Stability Report**

Overall Banking System Indicators		Islamic Banking System (separate)
ROA	Debt service / Income	Capital Adequacy Ratio
Capital Adequacy Ratio	Liquid asset / TA	Tier 1 capital
Tier 1 capital	Liquid asset/total deposit	Risk weighted capital ratio
Risk weighted assets	Debt to equity ratio	Asset/Capital
Asset/Capital	Current ratio	Capital / Risk weighted asset
NPL / Total loan	Liquid asset/ short-term liabilities	NPF / Total financing
ROA	Loan/ deposit	NPF as % gross loan
Tier 1 capital to risk weighted assets	Deposit from non-bank / total deposit	Prov as % NPF
NPL as % loan	Advance to deposit ratio	Real estate / construction exposure
Prov as % NPL	Call money rate	ROA
NPL to capital	Liquid assets / non-core deposits	ROE
Loan concentration	Cost to income ratio	Net impaired financing ratio
EBIT	Real estate / construction exposure	Total Asset (% entire banking system)
NPL	Net income	Total financing (% entire banking sys.)
ROE	Net fees and commission	Net fees and commission
Growth of credit	Operating expense/ Income	Operating expense/ Gross Income
Deposit growth	Gross impaired loan ratio	Liquid asset / TA
Net interest income	Capital base to risk weighted asset	Liquid asset/ short-term liabilities
	Provision Coverage ratio	Net mark-up / gross income
	Short / long term foreign debt	Non mark-up income/ gross income
		financing/ deposit
		Deposit from non-bank / total deposit

Source: Author's own tabulation based on central banks' report.

authorities from different countries (Roman & Şargu, 2013). International Monetary Fund (IMF) measures financial vulnerability and soundness, using handful indicators of Financial System Soundness with acronym CAMELS indicators signifies five major sections of a bank namely Capital adequacy, Asset quality, Management quality, Earnings ability and Liquidity (Roman & Şargu, 2013). Later it includes sixth component "S" to capture the sensitivity of market to include interest rate, foreign exchange and inflation risk which in overall capture the system risk (Chiaromonte, Croci, & Poli, 2015; Poghosyan & Čihak, 2011; Roman & Şargu, 2013). The IMF and the World Bank recommends the usage of CAMELS as the indicators for the financial soundness of the banking sector, according to Roman & Şargu (2013) and measures of the current health of financial institution (IMF, 2000). However, many regulatory bodies do not disclose this CAMELS rating to the public nor to the bank itself for the reason of avoiding systemic bank crisis (Roman & Şargu, 2013). Table 2 lists all these indicators.

### 2.2.3. Principle Based Measures: Islamic Banks Resilience Indicators by Islamic Financial Services Board

The Islamic Financial Services Board (IFSB) functions as an international standard-setting body of regulatory and supervisory agencies that aims to safeguard the soundness and stability of the Islamic financial system including banking, capital market and takaful.

In assessing the resilience of Islamic financial system including banking, capital market and takaful,

the IFSB initially, there were five dimensions namely profitability, financing to deposit ratios, non-performing financing, capitalization and rating comparison (Islamic Financial Services Board, 2013). The IFSB later standardised these into seven dimensions namely profitability, liquidity, financing exposures, asset quality, capitalization, structure funding and leverage (Islamic Financial Services Board, 2014, 2015, 2016).

The first dimension, profitability, is measured by indicators like return on asset, return on equity, average net profit margin and average cost to income (Islamic Financial Services Board, 2014, 2015, 2016). The second dimension, liquidity, is measured by financing to deposit ratio and lower short-term asset-liability ratios (SALRs) (Islamic Financial Services Board, 2014, 2015, 2016). The third dimension is financing exposures (Islamic Financial Services Board, 2014, 2015, 2016). The fourth dimension, asset quality, is measured by non-performing financing (Islamic Financial Services Board, 2014, 2015, 2016). The fifth dimension, capitalization, is measured by average capital adequacy ratio (CAR) and tier-1 capital adequacy ratio (CAR) (Islamic Financial Services Board, 2014, 2015, 2016). The sixth dimension, structure funding, is measured by foreign currency deposit share to total deposits, net foreign exchange open position to capital, profit-sharing investment account share to total deposits (Islamic Financial Services Board, 2014, 2015, 2016). The seven dimension, leverage, is measured by leverage multiples (Islamic Financial Services Board, 2014, 2015, 2016).

**Table 2: Components of CAMELS**

Component	Definition
Capital Adequacy	Capital adequacy is evaluated on the basis of both the bank's sizes as well as the composition of its assets and liabilities and used as a measure of its financial strength and stability.
Asset Quality	Examiners assess the credit risks in the various loans in the bank's portfolio and classify these loans as: good, substandard, doubtful, or loss.
Management Efficiency	Examiners attempt to gauge not only the bank's management but also its board of directors. Competence, management acumen, integrity, and willingness to comply with banking regulations are some of the factors assessed.
Earning and Profitability	There is an evaluation of the earnings as well as their level relative to peers. One objective is to assess the impact on the bank's capital of internally generated funds
Liquidity	Regulators assess liquidity by examining credit conditions, deposit volatility, loan commitments, and other contingent claims against the bank, capital, current stock of liquid assets, and the bank's perceived ability to raise funds on short notice.
Sensitivity to market risks	Regulators assess how sensitive the bank's asset, liability and net worth values are to changes in market condition like interest

Sources: Adapted from (Greenbaum & Thakor, 2007); (Olalekan & Adeyinka, 2013).

**2.2.4. Theoretical-Based Measures: Z-Score**

The theory of bank soundness or stability can be traced back as early as in 1952. It was developed by A.D. Roy based on a principle called as ‘Safety First’. The principle of ‘Safety First’ was developed based on Roy’s dissatisfaction over the simple rule of maximizing return and also his traumatic wartime experience (Sullivan, 2011). The application of the principle of Safety First means that when having a wide range of possible actions, including disasters, the gross return should not be less than some quantity (Roy, 1952). In the application of Principle of Safety First, identified variable ‘m’ representing the quantity and ‘σ’ representing the standard deviation of m, are the only quantities given the individual’s knowledge of past. Roy (1952) identified that there is a functional relationship between ‘m’ and ‘σ’, also calculate the probability of final return, using the calculation of ‘upper bound’ of this probability.

Bourkhis & Nabi (2013) and Beck, Demirgüç-Kunt, & Merrouche (2013) used bank’s soundness focusing on Z-score ratio as the indicator for bank’s soundness. Hsieh, Chen, & Lee (2013) used z-score and called it z-index as one of the proxies for bank stability. The z-index is actually calculated manually by the author based on data from Bankscope, using the formula  $z\text{-index} = ROA + E/TA / \sigma_{ROA}$  where ROA is the ratio of return to total assets, E/TA is the equity to total assets, and  $\sigma_{ROA}$  is standard deviation of return on assets as a proxy for return volatility, using a 3-year moving average (Hsieh et al., 2013). The bank-level Z-index means a larger value indicates higher stability and less overall bank risk (Hsieh et al., 2013).

**2.3. Bank Stability Measures: Bank Stability Index**

Seven components of bank stability are aggregated into an index called Bank Stability Index (BSI). An index, or composite indicator, is an aggregate of individual indicators and variables and implies the set of properties underlying its aggregation composition (Nardo, Saisana, Saltelli, Tarantola, Giovannini, Hoffmann, 2008).

When the components are aggregated, the latent variable or construct is bank stability. Latent variables are defined as ‘unobserved variables’ or ‘constructs’ that are the main focus or interested of a study, in this case, measurements bank stability (Harrington, 2009). Seven sub-constructs (latent factors) represent bank stability and are the components of bank stability identified: the z-score’s minimising risk, capital adequacy, asset quality, management efficiency, earnings and profitability, liquidity and sensitivity to the market. Each latent factors also has observed variables, defined as variables that can be measured and referred to as ‘indicators’ or ‘items’ (Harrington, 2009).

The literature review identifies 153 indicators used to measure bank stability. However, from these 153 indicators, 74 indicators are eliminated due to similarities in CAMELS indicators, Islamic banks resilience indicators and prevalent stability measures. In addition, data are unavailable for 28 indicators (16 CAMELS indicators, 9 prevalent stability measures and 3 Islamic bank resilience indicators).

Thus, the present study uses the remaining 51 available indicators, which consist of 41 CAMELS indicators including those similar to Islamic bank resilience indicators, 9 prevalent stability measures including those similar to Islamic bank resilience indicators and 1 indicator from the z-score. Figure 1 shows the framework for constructing the index based on the 7 latent factors measured by 51 indicators: 12 indicators of asset quality, 10 indicators of management efficiency, 8 indicators of earnings and profitability, 10 indicators of liquidity, 4 indicators of sensitivity to market risk, 6 indicators of capital adequacy and 1 indicator of risk-minimising z-scores.

Based on the above literatures, the hypotheses are developed in Table 4 while the model for bank stability index is presented in Figure 1.

**3. RESEARCH METHODOLOGY**

The samples selected consisted of 11 selected countries with dual banking systems with a total of 382

**Table 3: Definition of Principle of Safety First’s Z-score**

Principle of Safety First	Definition
Minimising risk (z-score)	The z-score is a measure of the distance-to-default, which measures the market value of a bank’s assets in relation to the book value of its liabilities. Thus, the higher is z-score, the less likely of probability of insolvent and hence, the stable is the bank.

Source: Adapted from (Rajhi & Hassairi, 2013).

Table 4: List of Hypothesis

Latent Factor / Dimension	Hypothesis
Z-score from the Principle of Safety First	H1: Z-score is a measure of bank stability.
Capital Adequacy	H2: Capital Adequacy is a measure of bank stability
Assets Quality	H3: Asset quality is a measure of bank stability.
Management Efficiency	H4: Management efficiency is a measure of bank stability.
Earnings and Profitability	H5: Earning and profitability are the measures of bank stability.
Liquidity	H6: Liquidity is a measure of bank stability.
Sensitivity to Market Risk	H7: Sensitivity to market risk is a measure of bank stability.

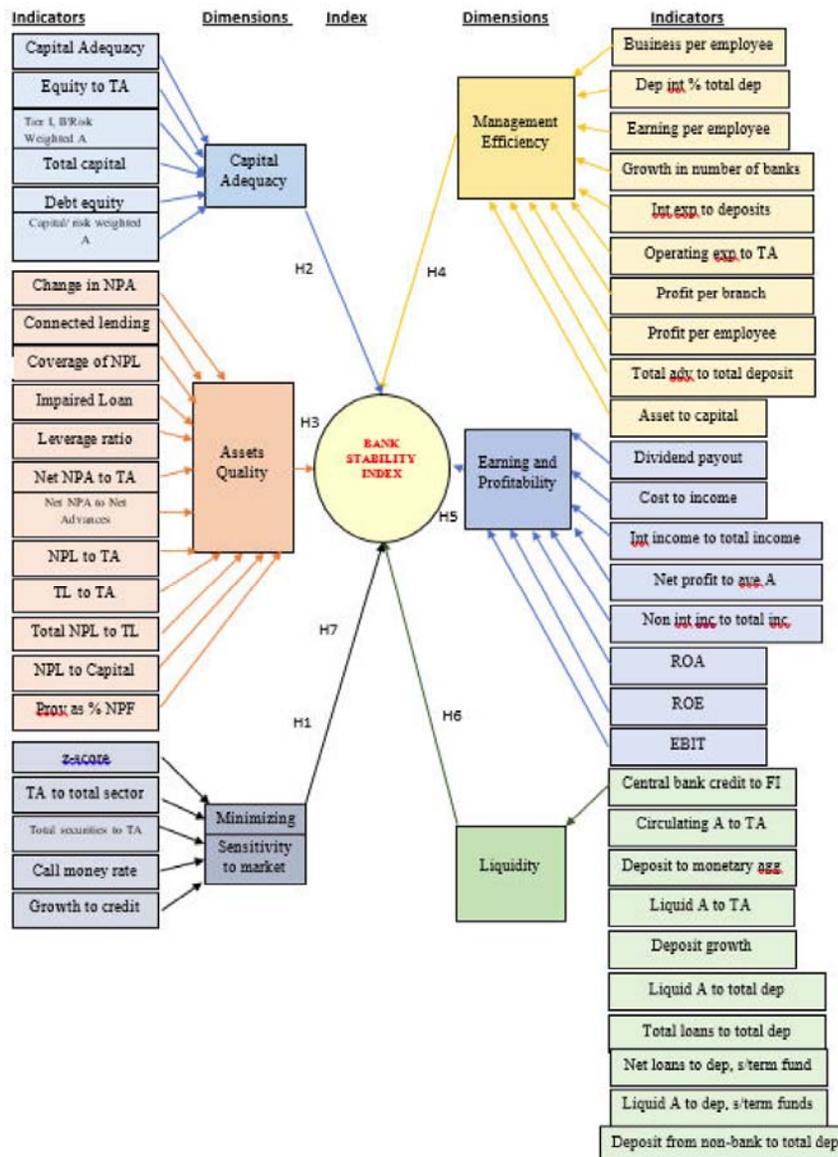


Figure 1: Model of Bank Stability Index.

banks which consists of 85 Islamic Banks, 261 conventional banks, 18 conventional banks with subsidiary Islamic banks and 18 subsidiary Islamic

banks for a period from 1999 to 2015, can be considered as good. These 11 countries such as Bahrain, Bangladesh, Egypt, Indonesia, Kuwait,

Malaysia, Pakistan, Qatar, Saudi Arabia, Turkey and the United Arab Emirates are selected because they have more than 0.5% of total global Islamic banking assets (IFSB, 2015). The period of 1999 to 2015 are selected as it included many local crises such as 1997 Asian Financial Crisis and crisis in UAE and 2007-2009 Global Financial Crisis (Laeven and Valencia, 2013).

From a review of the literature on the i) theoretical based measures, ii) principles based measures and iii) prevalent measures of bank stability, there is a total of 146 variables used in developing the bank stability index (Karim & AlHabshi, 2017).

Based on the bank stability index developed by Karim & AlHabshi (2017), the study adapted the method as in The Handbook on Constructing Composite Indicators: Methodology and User Guide, published by Organization for Economic Co-operation and Development (OECD), the method of factor analysis reduced to the best indicators (Nardo *et al.*, 2008). The linear summation of these indicators form the bank stability index. The main data source is BankScope database produced by the Bureau van Dijk. BankScope reports the data in the original currencies of the respected dual banking countries and provides a choice to convert data in any other currencies, including the US Dollar (Hassan, Mohamad and Bader, 2009).

#### 4. DEVELOPMENT OF THE BANK STABILITY INDEX

Four measures of bank stability are used to develop the BSI: the z-score, CAMELS, central banks' measures and Islamic banks resilience indicators. First, the z-score serves as the one indicator for the theoretical-based measures. Second, the principle-based CAMELS measures have 85 indicators. Third, the prevalent stability measures used by the 11 selected countries have 38 indicators for overall banking and 22 indicators for Islamic banking. Fourth, the IFSB uses 7 Islamic bank resilience indicators.

These 4 sources use 153 indicators, of which 74 indicators are eliminated due to similarities. Of these,

28 indicators are not available in the Bankscope database (16 CAMELS indicators, 9 prevalent stability measures and 3 Islamic bank resilience indicators). Thus, 51 indicators are available to construct the BSI: 41 CAMELS indicators (including similar indicators), 9 from prevalent stability measures and 1 from the safety-first principle (the z-score).

Factor analysis is run several times until the best fit and most significant model is obtained. Pallant (2005) and Tabachnick and Fidell (2007) recommend that studies experiment with different numbers of factors until a satisfactory solution is found. For data to be considered suitable for factor analysis, the correlation matrix should show at least some correlations of 0.3 or greater. Data without any correlations of 0.3 are eliminated, and the factor analysis is run without that data. According to Tabachnick and Fidell (2007), multicollinearity is not a problem in factor analysis, but singularity or extreme multicollinearity is a problem. The present study, therefore, excludes data with singularity or extreme multicollinearity problems and runs the factor analysis again without data with singularity problems.

The factor analysis results reveal that only 26 indicators satisfy the correlation of more than 0.3 and less than 0.9. The Kaiser-Meyer-Olkin returns a sampling adequacy score of 0.740, more than the recommended level (0.6), indicating adequate correlations and factorability of the data; therefore, the factor analysis is adequate. Bartlett's test of sphericity is statistically significant ( $p=0.000$ ), supporting that factor analysis is appropriate.

The method of factor extraction is principal component analysis. The results based on scree plots, as shown in Figure 2, suggest that the shape of the curve changes direction and becomes horizontal at 8 latent factors. However, the results based on Kaiser's criterion with an eigenvalue of more than 1 (Table 6) indicate that 7 factors explain 68.73% of the variance. This suggests that 7 factors explain BSI. However, based on the literature review and theoretical development, the number of factors is constrained to 6

**Table 5: Kaiser-Meyer-Olkin and Bartlett's Test**

Kaiser-Meyer-Olkin measure of sampling adequacy.		0.740
Bartlett's test of sphericity	Approx. Chi-Square	70654.688
	df	325
	Sig.	0.000

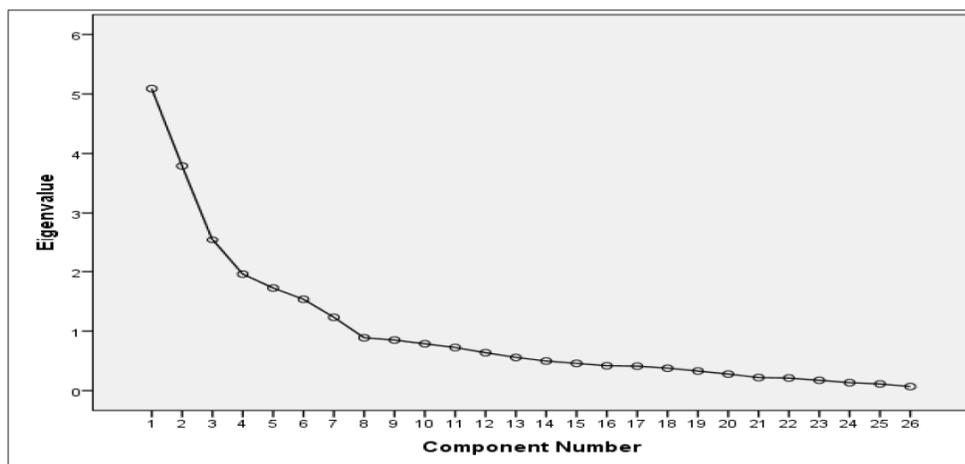


Figure 2: Scree plot.

latent factors. The results show that the cumulative percentage of variance in the top 6 latent factors is 63.99%, indicating that these 6 identified factors explain 63.99% of the variance in bank stability.

Based on the literature, these 6 latent factors are capital adequacy, asset quality, management efficiency, earnings and profitability, liquidity and sensitivity to market risk. For all the constrained 6 latent factors, the eigenvalues are greater than the required level of 1.0. In Table 6, the results show that factor 1 (liquidity) has the highest eigenvalue of 5.09, explaining 19.58% of variance. Liquidity, therefore, can be regarded as the most important factor in bank stability. It is followed by earnings and profitability (eigenvalue: 3.79, variance: 14.58%), asset quality (eigenvalue: 2.54, variance: 9.78%), capital adequacy (eigenvalue: 1.96, variance: 7.53%), management efficiency (eigenvalue: 1.72, variance: 6.63%) and, finally, sensitivity to market risk (eigenvalue: 1.54, variance: 5.90%). The result support that these 6 underlying latent factors are relevant in developing the BSI.

These latent factors are rotated by applying varimax rotation with Kaiser normalisation. The 26 individual indicators are grouped with the highest factor loadings into an intermediate composite index representing the latent factors. The factor analysis results in the “rotated component matrix table” are transformed into Table 7 to obtain the weights and later aggregate each latent factor and intermediate composite index.

Before aggregation of the 6 intermediate composite indices, the weights are assigned based on the calculated sum of the squared factor loadings. Table 7 includes 6 individual indicators: liquid assets to total

assets with a normalised squared factor loading of 0.176; deposits in relation to monetary aggregates with a normalised squared factor loading of 0.129; deposits from non-banks to total deposits with a normalised squared factor loading of 0.126; deposit growth with a normalised squared factor loading of 0.101; circulating assets to total assets with a normalised squared factor loading of 0.099; and loans to total deposits with a normalised squared factor loading 0.079. These normalised squared factor loadings are the weightage for the individual indicators that form the intermediate composite index (latent factor) for Liquidity. The model for the liquidity (intermediate) composite index, therefore, is as follows:

$$L_{it} = 0.176(I26)_{it} + 0.129(I25)_{it} + 0.126(I46)_{it} + 0.101(I47)_{it} + 0.099(I24)_{it} + 0.07(I29)_{it} \quad (1)$$

The next highest weight is on earnings and profitability, which has 5 individual indicators. These indicators are ROAA with a weightage of 0.247; net profits to average assets with a normalised squared factor loading of 0.244; efficiency of operational activity costs to income with a normalised squared factor loading of 0.182; return on average equity with a normalised squared factor loading of 0.180; and a z-score with a normalised squared factor loading of 0.042. According to the literature review, a z-score is assigned to sensitivity to market risk as it measures the risk of insolvency and instability. However, the results of factor analysis reassigned this indicator to earnings and profitability. This is also consistent with the nature of this indicator that includes the component of ROAA (ROAA + Earnings to TA/SD of ROAA). The model for the earnings and profitability (intermediate) composite index, therefore, is as follows.

**Table 6: Eigenvalues and Total Variance Explained**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.090	19.578	19.578	5.090	19.578	19.578	4.655	17.905	17.905
2	3.791	14.581	34.159	3.791	14.581	34.159	3.258	12.530	30.435
3	2.542	9.775	43.934	2.542	9.775	43.934	2.525	9.713	40.148
4	1.958	7.529	51.463	1.958	7.529	51.463	2.208	8.492	48.640
5	1.724	6.632	58.095	1.724	6.632	58.095	2.128	8.184	56.824
6	1.535	5.902	63.998	1.535	5.902	63.998	1.865	7.174	63.998
7	1.231	4.736	68.734						
8	.888	3.414	72.148						
9	.850	3.269	75.416						
10	.787	3.026	78.442						
11	.724	2.785	81.227						
12	.637	2.450	83.677						
13	.557	2.144	85.822						
14	.497	1.912	87.734						
15	.458	1.760	89.493						
16	.418	1.608	91.101						
17	.411	1.580	92.681						
18	.377	1.450	94.131						
19	.329	1.266	95.397						
20	.278	1.069	96.466						
21	.220	.845	97.311						
22	.212	.814	98.125						
23	.173	.667	98.792						
24	.134	.514	99.306						
25	.112	.431	99.736						
26	.069	.264	100.000						

Extraction Method: Principal Component Analysis.

$$E_{it} = 0.247(e21)_{it} + 0.244(e19)_{it} + 0.182(e17)_{it} + 0.18(e22)_{it} + 0.042(s52)t_{it} \tag{2}$$

The third highest weight is on the latent factor of asset quality, which has 5 individual indicators. These indicators are net NPA to total assets with a normalised squared factor loading of 0.285; net NPA to net advances with a normalised squared factor loading of 0.261; total impaired loans to total assets with a normalised squared factor loading of 0.176; NPL to capital with a normalised squared factor loading of 0.151; and the impaired loan ratio with a normalised squared factor loading of 0.099. The model for the

asset quality (intermediate) composite index, therefore, is as follows:

$$A_{it} = 0.285(a6)_{it} + 0.261(a7)_{it} + 0.176(a8)_{it} + 0.151(a50)_{it} + 0.099(a4)_{it} \tag{3}$$

The fourth latent factor, management efficiency, has 3 individual indicators: business per employee with a normalised squared factor loading of 0.404; profits per employee with a normalised squared factor loading of 0.373; and profit per branch with a normalised squared factor loading 0.151. The model for management efficiency (intermediate) composite index, therefore, is as follows.

Table 7: Weighting: Process of Assigning Weight for Intermediate Composite Indices and Bank Stability Index

Interpretation	Factor 1			Factor 2			Factor 3			Factor 4			Factor 5			Factor 6		
	Liquidity			Earnings and profitability			Asset quality			Capital adequacy			Management efficiency			Sensitivity to market risk		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Liquid asset to TA (I26)	-906	.821	.176	-036	.001	.000	.038	.001	.001	-.156	.024	.010	.001	-.035	.001	-.014	.000	.000
Deposits in relation to monetary aggregates (I25)	-775	.600	.129	.041	.002	.001	.039	.001	.001	.271	.073	.031	.002	-.058	.003	-.055	.003	.002
Deposit from non-bank to total deposit (I46)	-766	.587	.126	.066	.004	.001	.068	.005	.002	-.097	.009	.004	.002	.046	.002	.052	.003	.001
Deposit growth (I47)	.685	.469	.101	-.028	.001	.000	.027	.001	.000	.038	.001	.001	.006	-.112	.013	-.154	.024	.013
Circulating asset to total asset (I24)	.681	.463	.099	-.088	.008	.002	-.075	.006	.002	.380	.144	.061	.002	-.048	.002	-.106	.011	.006
Loans to total deposits (I29)	-607	.369	.079	-105	.011	.003	-.072	.005	.002	.380	.144	.061	.002	-.025	.001	.147	.022	.012
Return on average asset (e21)	.155	.024	.005	.896	.804	.247	-.020	.000	.000	.105	.011	.005	.006	.117	.014	.015	.000	.000
Net profit to average asset (e19)	.164	.027	.006	.891	.794	.244	-.010	.000	.000	.079	.006	.003	.002	.068	.005	-.006	.000	.000
Efficiency of operational activity-cost to income (e17)	.188	.035	.008	-.770	.593	.182	-.010	.000	.000	.065	.004	.002	.002	-.174	.030	.026	.001	.000
Return on average equity (e22)	-.132	.018	.004	.766	.586	.180	-.040	.002	.001	-.080	.006	.003	.002	.021	.000	-.052	.003	.001
zscore (moving avg) (s52t)	-.005	.000	.000	.371	.138	.042	-.098	.010	.004	.044	.002	.001	.002	.187	.035	.019	.000	.000
Net NPA to TA (a6)	.014	.000	.000	.018	.000	.000	.848	.719	.285	.007	.000	.000	.000	-.003	.000	-.022	.000	.000
Net NPA/Net Advances (a7)	.017	.000	.000	.080	.006	.002	.812	.659	.261	.019	.000	.000	.000	.017	.000	-.101	.010	.006
Total impaired loans to TA (a8)	-.072	.005	.001	-.086	.007	.002	.667	.445	.176	-.099	.010	.004	.002	.102	.010	.429	.184	.099
NPL to capital (a50)	-.249	.062	.013	-.205	.042	.013	.618	.382	.151	-.179	.032	.014	.002	-.030	.001	.074	.005	.003

Impaired Loan ratio (impaired loans/gross loans) (a4)	.401	.160	.034	-.313	.098	.030	.499	.249	.099	.164	.027	.011	-.117	.014	.006	-.101	.010	.006
Equity/TA (c12)	.811	.657	.141	.094	.009	.003	-.014	.000	.000	.389	.151	.064	.026	.001	.000	-.011	.000	.000
Capital to risk weighted asset (c44)	.374	.140	.030	-.034	.001	.000	-.036	.001	.001	.763	.582	.247	-.001	.000	.000	-.002	.000	.000
Capital Adequacy Ratio (c11)	.382	.146	.031	.014	.000	.000	-.107	.011	.005	.671	.450	.191	.078	.006	.003	.071	.005	.003
Debt equity (c15)	.207	.043	.009	-.095	.009	.003	-.022	.000	.000	-.654	.428	.181	-.022	.000	.000	.086	.007	.004
Business per employee (m31)	.003	.000	.000	.026	.001	.000	.042	.002	.001	.013	.000	.000	.928	.860	.404	.015	.000	.000
Profit per employee (m38)	.034	.001	.000	.266	.071	.022	.025	.001	.000	.077	.006	.003	.892	.796	.374	-.012	.000	.000
Profit per branch (m37)	-.093	.009	.002	.264	.070	.021	-.034	.001	.000	-.016	.000	.000	.567	.322	.151	.085	.007	.004
Interest expenses/deposits (m35)	-.051	.003	.001	-.019	.000	.000	-.046	.002	.001	-.056	.003	.001	-.043	.002	.001	.822	.676	.363
Deposit interest exp as a percentage of total deposits (m32)	-.115	.013	.003	.040	.002	.000	.139	.019	.008	-.186	.035	.015	.033	.001	.001	.699	.489	.262
Total securities to TA (s41)	-.051	.003	.001	-.032	.001	.000	-.042	.002	.001	.235	.055	.023	.087	.007	.004	.635	.403	.216
Total (4)		4.655			3.258			2.525			2.359			2.128			1.865	
Total (5)		3.310	.711	2.154	2.913	.894	3.444	2.454	.972	1.169	1.612	.683	2.387	1.979	.930	2.156	1.568	.841
Total (6)		9.622	5.031															
Weight (7)		-.176	.239	.141	.224	.178	.358	.177	.193	.122	.117	.136	.248	.143	.185	.224	.113	.167
Weight of BSI		0.239			0.211			0.177			0.117			0.143			0.113	

(1) Factor loading based on related component matrix

(2) Squared factor loading (SFL)

(3) Normalized squared factor loadings = (2) / (4)

(4) Sum of all in column (2)

(5) Total high loadings of indicators for each factor - cross loading

(6) Sum of (5) for factor 1+factor 2+factor 3+factor4+factor5+factor6

(7) (5) / (6)

$$M_{it} = 0.404(m31)_{it} + 0.374(m38)_{it} + 0.151(m37)_{it} \quad (4)$$

Fifth, the latent factor of capital adequacy has 4 individual indicators. This latent factor shares the loading of equity to total assets with the latent factor of liquidity. However, according to the literature, the equity to total assets should be assigned, so in this study, it is assigned to the latent factor of capital adequacy rather than liquidity. Thus, the individual indicators for capital adequacy are equity to total assets with a normalised squared factor loading of 0.064; capital to risk-weighted assets with a normalised squared factor loading of 0.247; the capital adequacy ratio with a normalised squared factor loading of 0.191; and debt equity with a normalised squared factor loading of 0.181. The model for the capital adequacy (intermediate) composite index, therefore, is as follow.

$$C_{it} = 0.064(c12)_{it} + 0.247(c44)_{it} + 0.191(c11)_{it} + 0.181(c15)_{it} \quad (5)$$

The least weight is assigned to the latent factor of sensitivity to market risk. It has 3 individual indicators, ordered by weight: interest expenses to deposits (weight 0.363), deposit interest expenses as a percentage of total deposits (weight 0.262) and total securities to total assets (weight 0.216). The model for the sensitivity to market risk (intermediate) composite index, therefore, is as follows:

$$S_{it} = 0.363(m35)_{it} + 0.262(m32)_{it} + 0.216(s41)_{it} \quad (6)$$

The weightage for each indicator is multiplied by each indicator from Bankscope to give the value of the intermediate composite index for bank i at time t. The intermediate composite indices are then multiplied with the weight of the intermediate composite index to form the BSI. The weightage for the intermediate composite indices are obtained by summing the squared factor

loadings divided by the total sum of the squared factor loadings.

The weightage for the liquidity intermediate composite index is calculated by summing the squared factor loadings of all the indicators of liquidity (0.821 + 0.60 + 0.587 + 0.469 + 0.463 + 0.369 = 3.31) divided by total sum of all weights (13.836), which equals 0.239. This weight of 0.239 is the highest weight, giving importance to liquidity in the construction of the BSI. The total summation of all weights is 13.836, with the sum of the weight of liquidity (3.31) added to the weight of earnings and profitability (2.913) added to the weight of asset quality (2.454) added to the weight of capital adequacy (1.612) added to the weight of management efficiency (1.979) added to the weight of sensitivity to market risk (1.568).

The next highest weight is on earnings and profitability, at 0.211. Similarly, this weightage is calculated by summing the squared factor loadings of all the indicators of earnings and profitability (0.804 + 0.794 + 0.593 + 0.586 + 0.138 = 2.913) divided by total sum of all the weights (13.836), which equals 0.211. Next, the weightage for the asset quality intermediate composite index is calculated by summing the squared factor loadings of all the indicators of asset quality (0.719 + 0.659 + 0.445 + 0.382 + 0.249 = 2.454) divided by total sum of all the weights (13.836), which equals 0.177.

The weightage for the capital adequacy intermediate composite index is calculated by summing of the squared factor loadings of all the indicators of capital adequacy (0.151 + 0.582 + 0.450 + 0.428 = 1.612) divided by total sum of all the weights (13.836), which equals 0.117. Similarly, the weightage for the management efficiency intermediate composite is

**Table 8: Factorability of the Data: Measure of Sampling Adequacy and Test of Sphericity**

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
	Liquidity	Earnings and profitability	Asset quality	Capital adequacy	Management efficiency	Sensitivity to market risk
<b>Selection criteria</b>						
Eigenvalues	5.09	3.79	2.54	1.96	1.72	1.54
Total variance explained	63.99%					
Test-statistics						
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			0.74			
Bartlett's Test of Sphericity		Chi-Square	70654.688			
		df	325			
		Sig.	0.000			

calculated by summing the squared factor loadings of all the indicators of management efficiency (0.86 + 0.796 + 0.322 = 1.979) divided by the total summation of all the weights (13.836), which equals 0.143.

Finally, the weightage for market-sensitivity risk intermediate composite index is calculated by summing the squared factor loadings of all the indicators of sensitivity to market risk (0.676 + 0.489 + 0.403 = 1.568) divided by the total summation of all the weights (13.836), which equals 0.113. The model of the BSI, therefore, is as follows:

$$BSI_{it} = 0.117C_{it} + 0.177A_{it} + 0.143M_{it} + 0.211E_{it} + 0.239L_{it} + 0.113S_{it} \quad (7)$$

$BSI_{it}$  - BSI for bank  $i$  and time  $t$ .

$C_{it}$  - capital adequacy intermediate composite index for bank  $i$  and time  $t$  (obtained from manual calculation in the first-level linear aggregation).

$A_{it}$  - asset quality intermediate composite index for bank  $i$  and time  $t$ .

$M_{it}$  - management efficiency intermediate composite index for bank  $i$  and time  $t$ .

$E_{it}$  - earnings and profitability intermediate composite index for bank  $i$  and time  $t$ .

$L_{it}$  - liquidity intermediate composite index for bank  $i$  and time  $t$ .

$S_{it}$  - sensitivity to market risk intermediate composite index for bank  $i$  and time  $t$ .

After assigning weights to each individual indicator and thus contributing to the weightage for latent factors, the next stage is to aggregate the weightage for all six latent factors to construct the BSI. However, before aggregation, 12 indicators need to be reinterpreted as more-is-better or more-is-stable type indicators and thus are simply converted into the opposite sign of negative/positive indicators. These 12 indicators are deposits in relation to monetary aggregates, loans to total deposits, debt equity, interest expenses to deposits, deposit interest expenses as a percentage of total deposits, total securities to total assets, efficiency of operational activity cost to income, total impaired loans to total assets, net NPA to total assets, net NPA to net advances and NPL to capital and impaired loans.

Upon converting and standardising the data to reflect more-is-better or more-is-stable type indicators,

all 25 individual indicators are grouped together based on highest factor loadings to form 6 latent factors. The next process is the summation of weighted and normalised individual indicators using the method of linear aggregation. The 26 individual indicators for 4,901 observations of 373 banks over a 17-year period over 17 years are repeated for aggregation to form latent factors and BSI.

## 5. PARTIAL ILLUSTRATION OF LINEAR AGGREGATION OF INTERMEDIATE INDICES AND BANK STABILITY INDEX

This section presents a sample to illustrate the aggregation of the individual indicators (Table 9) and the aggregation of latent factors (Table 10). In Table 9, the data for each individual indicator for AB Bank Ltd in the year 2015 are multiplied with the respective weight of the individual indicator. For example, in the year 2015, the bank's liquid assets to total assets ratio is 0.83, the deposits in relation to monetary aggregates ratio is -0.97, the deposits from non-banks to total deposits ratio is 1.00, the deposit growth ratio is 0.00, the circulating assets to total assets ratio is 15.21, and the loans to total deposits ratio is -1.08.

From the factor analysis, the weights for these indicators are 0.176, 0.129, 0.079, 0.126, 0.101 and 0.099, respectively. Thus, the aggregations are 0.146, -0.125, -0.085, 0.126, 0.00 and 1.506, respectively. The summation of these aggregations is 1.567, which is the value of liquidity for the year 2015. These aggregation and summation processes are also applicable to and repeated for the other individual indicators to produce the values of the other latent factors: capital adequacy (0.985), sensitivity to market risk (-0.075), earnings and profitability (-7.567), management efficiency (-0.151) and asset quality (-0.350).

Before aggregation of the individual indicators, these latent factors are aggregated to form the BSI. In Table 10, the values obtained in Table 9 are multiplied with the weight for each latent factor to produce the value for each latent factor. For example, the value of the aggregated individual indicators for the latent factor of liquidity is 1.567. This value is multiplied with the weight of liquidity (0.239) to produce the value of liquidity (0.375). This process of multiplying the value of the aggregated indicators for each latent factor with the weight of the latent factor to produce the value of latent factor is repeated for the other latent factors (capital adequacy, sensitivity to market risk, earnings and profitability, management efficiency and asset quality).

**Table 9: First-Level Linear Aggregation Forming Intermediate Composite Indices (Latent Factors) for AB Bank Ltd**

Individual Indicator / Intermediate Composite Index / Latent Factor	2015 (1)	Weight (2)	Aggregation (1) X (2)
Liquid asset to TA (l26)	0.830	0.176	0.146
Deposits in relation to monetary aggregates (l25)	-0.970	0.129	-0.125
Deposit from non-bank to total deposit (l46)	1.000	0.126	0.126
Deposit growth (l47)	0.000	0.101	0.000
Circulating asset to total asset (l24)	15.210	0.099	1.506
Loans to total deposits (l29)	-1.080	0.079	-0.085
<b>LIQUIDITY</b>			<b>1.567</b>
Return on average asset (e21)	0.560	0.247	0.138
Net profit to average asset (e19)	1.200	0.244	0.293
Efficiency of operational activity-cost to income (e17)	-53.180	0.182	-9.679
Return on average equity (e22)	6.700	0.180	1.206
Z-score (moving average) (s52t)	11.312	0.042	0.475
<b>EARNINGS AND PROFITABILITY</b>			<b>-7.567</b>
Net NPA to TA (a6)	-0.010	0.285	-0.003
Net NPA/Net Advances (a7)	-0.010	0.261	-0.003
Total impaired loans to TA (a8)	-0.020	0.176	-0.004
NPL to capital (a50)	-0.310	0.151	-0.047
Impaired Loan ratio (impaired loans/gross loans) (a4)	-2.970	0.099	-0.294
<b>ASSET QUALITY</b>			<b>-0.350</b>
Equity/TA (c12)	8.350	0.064	0.534
Capital to risk weighted asset (c44)	8.920	0.247	2.203
Capital Adequacy Ratio (c11)	11.300	0.191	2.158
Debt equity (c15)	-21.610	0.181	-3.911
<b>CAPITAL ADEQUACY</b>			<b>0.985</b>
Business per employee (m31)		0.404	0.000
Profit per employee (m38)		0.374	0.000
Profit per branch (m37)	-0.999	0.151	-0.151
<b>MANAGEMENT EFFICIENCY</b>			<b>-0.151</b>
Interest expenses/deposits (m35)	-0.080	0.363	-0.029
Deposit interest expenses as a percentage of total deposits (m32)	-0.070	0.262	-0.018
Total securities to TA (s41)	-0.130	0.216	-0.028
<b>SENSITIVITY TO MARKET RISK</b>			<b>-0.075</b>

Next, the values of these latent factors—liquidity (0.375), capital adequacy (0.115), sensitivity to market risk (-0.009), earnings and profitability (-1.597), management efficiency (-0.022) and asset quality (-0.062)—are summed to yield the BSI of -1.199 for AB Bank Ltd for the year 2015. These processes are repeated for the other selected banks in the sample of the sampling period of 1999–2015 for a total of 4,901 observations.

From the factor analysis, 26 indicators have significant correlations, which can be group into six factors. Based on this analysis, the results of the hypothesis testing are summarized in table. All the hypotheses are supported.

## 5. ROBUSTNESS TEST: SENSITIVITY ANALYSIS

According to Nardo *et al.* (2008), the development of an index and its intermediate composite indices

**Table 10: Second-Level Linear Aggregation Forming the Bank Stability Index for AB Bank Ltd**

Intermediate Composite Index / Latent factor Composite Index	2015 (1)	Weight (2)	Aggregation (1) X (2)
Liquidity	1.567	0.239	0.375
Earnings and profitability	-7.567	0.211	-1.597
Asset Quality	-0.350	0.177	-0.062
Capital adequacy	0.985	0.117	0.115
Management efficiency	-0.151	0.143	-0.022
Sensitivity to market risk	-0.075	0.113	-0.009
<b>Bank stability index</b>			<b>-1.199</b>

Hypothesis No	Hypothesis Statements	Results
H1	Z-score is a measure of bank stability.	Supported
H2	Capital Adequacy is a measure of bank stability	Supported
H3	Asset quality is a measure of bank stability	Supported
H4	Management efficiency is a measure of bank stability.	Supported
H5	Earning and profitability are the measures of bank stability.	Supported
H6	Liquidity is a measure of bank stability.	Supported
H7	Sensitivity to market risk is a measure of bank stability.	Supported

involves many subjective judgements, including the treatment of missing values and the weights of the indicators. The assessment of these uncertainties is important to ensure the quality of the index grounded on sound assumptions. Thus, sensitivity analysis is performed to study the variations and uncertainties in output and quantify the different sources of variations in the assumptions. This sensitivity analysis is aimed at gauging the robustness of the index and increasing its transparency by highlighting cases or samples that are strengthened or weakened under certain assumptions (Nardo *et al.*, 2008).

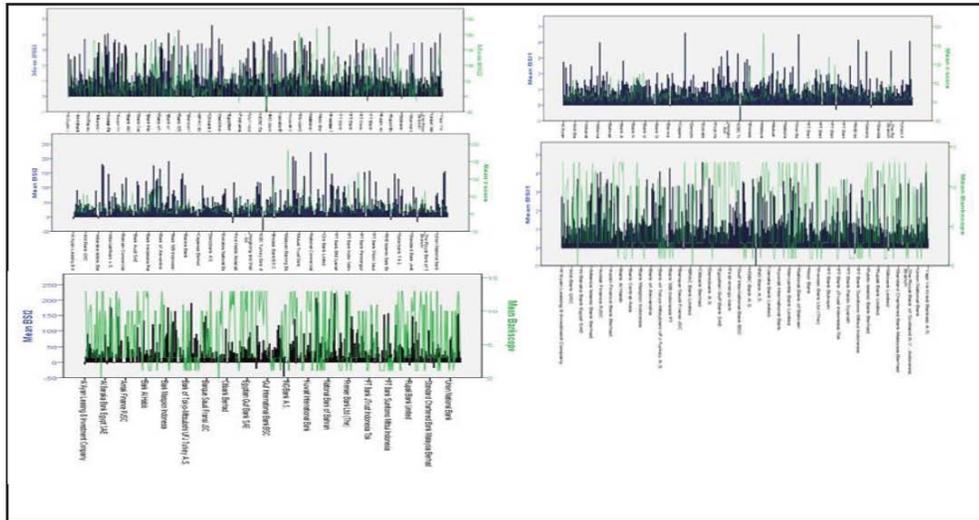
Adapting and modifying the sensitivity analysis developed by Nardo *et al.* (2008), this analysis compares the BSI developed in this study (BSI1) with several others, such as the BSI, based on listwise deletion to eradicate missing values, as well as equal weightage, z-scores and Bankscope ratings for the year 2015. In this sensitivity analysis, the graphs for each method are compared to determine the better performance.

The first sensitivity analysis develops a new BSI (BSI2) without missing values. For BSIW, factor analysis is run without imputation, in other words, applying the list-wise deletion. The results of this factor analysis dramatically reduce the total observations

from 4,901 cases to 111. This result produces the necessary weights for the index but embeds it with correlation and factorability problems. Consequently, the Kaiser-Meyer-Olkin measure of sampling adequacy, which measures the adequacy of correlations and the factorability of the data, cannot be produced. Neither can Bartlett's test of sphericity be produced. The adequacy and appropriateness of the results from this factor analysis, therefore, cannot be verified.

Next, the sensitivity analysis continues without factor analysis, and the data are run as it is. All the cases with at least 1 value are included in the analysis, while cases with 100% missing values are excluded. None of the cases has 100% missing values, so all 4,901 cases are retained in the analysis. However, the weight for cases with only 1 value is adjusted compared to cases with no missing values; in other words, the weight is pro-rated based on the number of completed values. These values are summed using linear summations to form intermediate composite indicators that measure the latent factors. Finally, the weights of these latent factors are also linearly summed for the BSI (BSI2).

Figure 3 shows the graphs comparing the mean of the BSI from the factor analysis used in the study



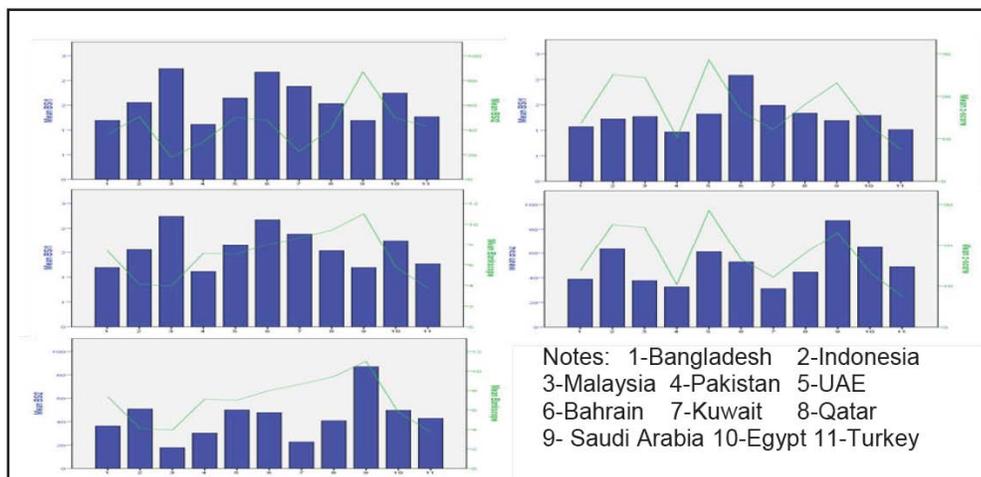
**Figure 3:** Sensitivity Analysis of BSI using same weight (BSI2), weight from factor analysis (BSI1), z-score and Bankscope at bank level for year 2015.

(BSI1) to the BSI with the same weight (BSI2), z-score and Bankscope rating as the measures of bank stability for the year 2015. The sampling period of 1999–2014 is not included as Bankscope ratings are not available for other years. The results show that BSI1 differs from BSI2, as indicated where the black (BSI1) and green lines (BSI2) separate in the graph, depicting mean BSI1 versus mean BSI2. Comparing the z-scores of BSI1 and BSI2, it is noted that BSI1 has fewer peak points where the green line is higher than the black lines. However, both BSI1 and BSI2 are very different from the Bankscope ratings as there are many green lines not accompanied by any black lines.

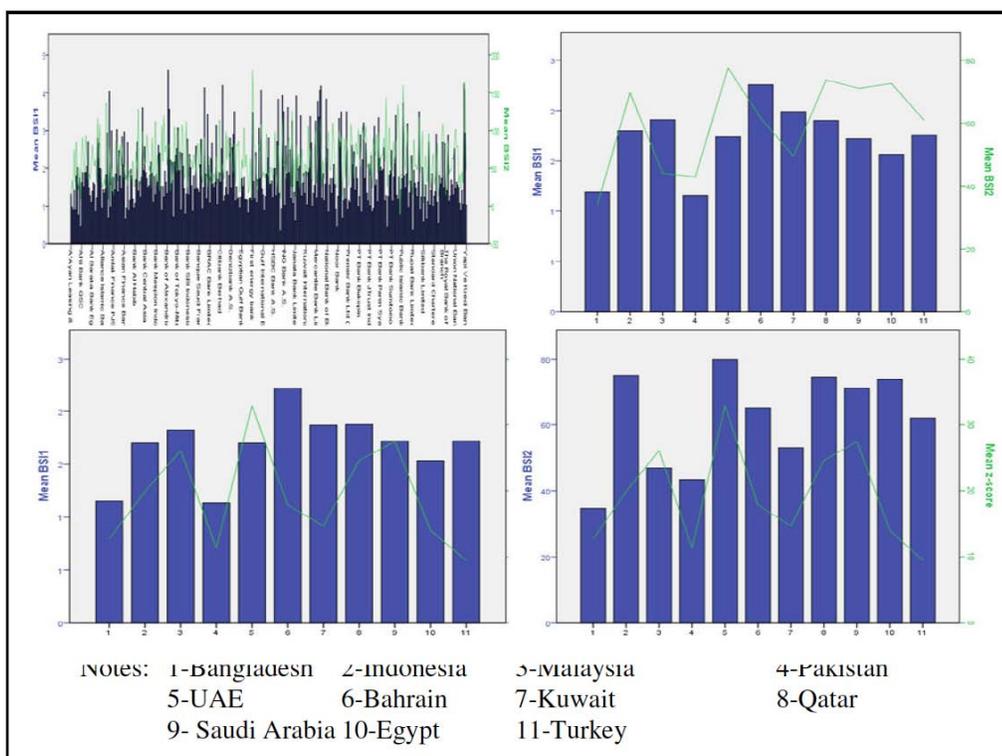
values than BSI1. In the means ranking, BSI1 ranks country 3 (Malaysia) the highest, while BSI2 ranks country 9 (Saudi Arabia) the highest rank. BSI1 gives the lowest rank to country 4 (Pakistan), and BSI2 to country 3 (Malaysia). Comparing the z-scores of BSI1 and BSI2, BSI1 records better predictions, with more countries with similar trends in the z-score: countries 4 (Pakistan), 7 (Kuwait), 10 (Egypt) and 11 (Turkey). In the other comparison between BSI2 and z-scores, a number of countries also have similar patterns. When comparing bankscope (bscope) with BSI1 and BSI2, BSI1 performs better with more countries with similar trends to bankscope.

Figure 3 is overcrowded with information but is meant to show only the trend analysis only. Figure 4 simplifies the BSI at the country level. BSI2 has larger

Another sensitivity analysis scrutinises BSI2 in all the sampling periods from 1999 to 2015, as in Figure 5. On the bank level, BSI2 has a larger scale than BSI1.



**Figure 4:** Sensitivity Analysis of BSI using same weight (BSI2), weight from factor analysis (BSI1), z-score and Bankscope at country level for year 2015.



**Figure 5:** Sensitivity Analysis of BSI using same weight (BSI2), weight from factor analysis (BSI1), z-score and Bankscope for year 1999-2015.

Other comparisons between BSI1 and BSI2 are mixed. Some banks exhibit similar trends in BSI1 and BSI2, while others have opposite trends. The countries with similar trends are Bangladesh (1), Indonesia (2) and Pakistan (4), while the countries with opposite trends are Malaysia (3), the UAE (5), Bahrain (6), Kuwait (7) Qatar (8), Saudi Arabia, Egypt (10) and Turkey (11). Comparing z-scores in BSI1 and BSI2, the UAE has the highest both.

**6. CONCLUSIONS**

Earlier researches compare various segregated variables but the comparison of CAMELS indicators and the z-score do not yield meaningful inferences about banks themselves. According to Doumpos, Hasan and Pasiouras (2017), it is very difficult to draw conclusions about banks’ overall financial health using this approach. The banking industry, therefore, needs a more comprehensive and robust, single measure of bank stability. The BSI thus enriches the current literature on the measures of bank stability. The BSI is a comprehensive measure of bank stability as it merges all the important indicators of bank stability. The BSI uses the z-score based on the theory of the safety-first principle, the principles-based CAMELS measures and adapts some of the prevalent bank

measures and practices of the central banks in the selected countries with dual banking systems. The BSI incorporates all the important indicators from three different measures of bank stability and thus is a more comprehensive, robust measure of bank stability. It can support more meaningful inferences and substantial conclusions about banks’ overall financial health. The BSI is intended to provide a tool to distinguish troubled banks from healthy ones. Doing so is crucial prior and during global and local crises. Understanding bank health in term of stability could help bank management and regulatory bodies avoiding banking crises such as that in 2007–2009. Various precautionary measures could be implemented to avoid more serious impact from crises and systemic risk in the banking industry.

The implementation of the BSI to the selected countries with dual banking systems generates a few implications for existing banking regulation and policies. At the level of regulatory bodies, the central banks of these selected 11 countries with dual banking systems monitor and report on not only conventional banks but also other banking models, including full-fledged Islamic banks, subsidiary Islamic banks and conventional banks with Islamic subsidiary bank. The central banks record their monitoring and reporting in periodically publications of financial stability reports.

The stress test in the financial stability reports can also cover the effects of crises using the proposed dynamic panel data GMM to reflect the dynamic nature of bank stability. This will ensure that all aspects of financial stability, including bank stability, are included in timely and adequate monitoring and reporting.

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