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Non-linear Analysis of Stability in the Islamic Banking Industry

Hasan Kiaee
Faculty of Islamic Studies and Economics, Imam Sadiq University, Tehran, Iran.
Kiaee@isu.ac.ir

Abstract
Stability analysis is one of the most important fields of study in the Islamic banking and finance industry. For measuring stability in Islamic banking, we introduced, for the first time, an Islamic banking stability index (IBS) during 2013 to 2016 which use all CAMEL factors and so seems to be more comprehensive than Z-score stability index which dominantly used in the existing literatures. To find the macroeconomic determinants of Islamic banking stability on IBS index, we have developed Generalized Additive Models (GAMs) using smoothing splines. GAMs provide a general framework for extending a standard linear model by allowing non-linear functions of each of the variables, while maintaining additivity. The results show that the proposed models have more predictability when compared by a linear counterpart. It is also concluded that Money Growth and Domestic Credit as a percentage of GDP in each year are inversely related to the Islamic banking stability of the next year.

Keywords: Islamic Banking, Stability Analysis, Non-linear Analysis, Generalized Additive Model
JEL Classification:

1. Introduction

Stability analysis is one of the most popular fields of study in the banking industry especially after world financial crisis in 2007. In this regard, two important questions will rise; the first is about measuring stability and the second deals with the factors which affect the stability in the banking sector. About the later question, economic theories as well as experiences of financial crisis show that both real sector and monetary variables in the economy are important determinants of stability in the banking industry. Banks provide excessive loans during boom periods but when the situation reverses and asset price declines, loan repayments default due to low value of collaterals which create instability in the banking sector.

To respond to the first question, almost all of researchers have used balance sheet variables to measure stability level in banks while using different ways to combine these variables as integrated indices. Some of the pervious works combined balance sheet variables with different weighting schemes and developed a stability index while others have used Z-score index which includes two banking indicators: return on assets and capital asset ratio.

When we come to the Islamic banking stability analysis, dominant approach for measuring stability is Z-score index. As we will show in the next session, the problem with the Z-score is that it just uses two banking variables and the other important elements of the banking performance has no role in Z-score. So, in this paper, for the first time, we introduce an Islamic banking stability index (IBS) which uses all CAMEL[1] factors and is more comprehensive than Z-score. Then, we try to construct a model for analyzing the determinants of this newly proposed stability index.

The other contribution of the paper is that we have used a non-linear approach for modeling stability in the Islamic banking industry. When we use multiple linear regressions, it is assumed that there are some linear relations between the response and predictor variables. However, the linearity assumption might be violated in applied studies which could be detected easily using scatter plots. *Generalized Additive Models* (GAMs) provide a general framework for extending a standard linear model by allowing non-linear functions of each of the predictor variables included in the model in an additive form (Hastie & Tibshirani, 2000). While the existing literature have presented some kinds of linear models, we will develop GAMs using smoothing splines (James et al, 2013) to study the potential non-linear relations between IBS and macroeconomic variables in the top Islamic banking asset countries. Such model has more explanatory power when compared with the linear ones commonly used in the existing literature.

The rest of the paper is organized as follows. In Section 2, the related literature is reviewed. In Section 3, the Islamic banking stability index is proposed and reported for the selected Islamic countries. The exploratory data analysis is given in Section 4. The results of semi parametric model estimation are presented and interpreted in Section 5. Finally, concluding remarks are given in Section 6.

2. Literature Review

Among conventional banking researchers, Hanschel and Monnin (2005) tried for the first time to propose a stress index for Switzerland banking industry during 1987 to 2002. They combined four different types of variables: market price data, balance sheet data, non-public data of the supervisory authorities, and other structural variables. They also showed that the indices

[1] Capital, Asset, Management, Earning and Liquidity

which are based only on one single type of variable could not detect all stress episodes and so several variables should be incorporated in the stress index in order to capture the different ways a banking crisis could show up.

Illing and Liu (2006) believed that alternative measures of financial crisis suggested by the literature could not accurately reflect the Canadian experience, while what they have developed in their paper were more representative and better suited to a developed financial system. They conducted an internal survey for the Bank of Canada to determine which events over the past 25 years were most stressful for Canada's financial system. With the survey results in hand, variables were then selected and combined into indexes.

Stability measuring in banking industry entered in new era by De Nicoló et al. (2004) work. They introduced Z-score stability index and calculated it for 500 of the largest financial firms worldwide to show that consolidation and conglomeration were not associated with higher levels of the firm's stability. For a representative bank, the index is defined as follows:

$$Z - score_{\mathrm{t}} = \frac{ROA_{\mathrm{t}} + CAR_t}{\sigma(ROA)},$$

where ROA_{t} and CAR_t are respectively the return on the asset ratio and the capital to asset ratio of a bank at a specific time, t. Also $\sigma(ROA)$ is the standard deviation of ROA_{t} s over examining period of time. The best advantage of Z-score index is that it could be easily calculated based on the banks' accounting data. The Z-score measures the number of standard deviations a return realization has to fall in order to deplete equity, under the assumption of normality of banks' returns. So, a higher Z-score corresponds to a lower upper bound of insolvency risk (Cihak & Hesse, 2008). But the main problem of Z-score is that this index ignores other important banking aspects like liquidity, asset and management quality variables.

It is believed that the financial instability hypothesis of Minsky (1986) is one of the first theories about the potential influence of macroeconomic variables on the banking stability. According to this theory, good investment opportunities and high expected return during boom period in the economy, increase loan demand and push banks to provide excessive and risky loans to their customers. But, when economic situation gradually changes to recession, asset price comes down and the collateral value declines. At this time, banks would face default in their loans since customer's debt to the bank is higher than the value of loan collateral. This is exactly what Bernanke and Gertler (1989) explained as pro-cyclical nature of bank lending.

Another theoretical channel for banking stability to be affected by macroeconomic variables, is central bank monetary policy. When central bank decided to conduct expansionary or contractionary monetary policy, its primary transmission instruments are banks (Bernanke & Blinder, 1992). So, changing monetary variables in different cyclical situation, could bring instability in the banking industry. For this reason, some researchers like Bucher et al. (2013) focused on models which consider business cycle volatility as the main determinant of the instability in the banking sector.

With this theoretical background, many studies tried to find macroeconomic determinants of conventional banking stability. Bikker and Hu (2002) have studied 26 OECD countries from 1979 to 1999 and showed that the lending stability of banks is determined by economic variables such as GDP growth, inflation, unemployment and real money supply. Koetter and Poghosyan (2008) used the price-to-rent ratio as a key determinant of stability in German banks and Lorenzoni (2008) showed that the fixed investment as a representative of the real economic sector

had significant effect on the banking stability.

For the stability analysis of the Islamic banking, as will be reviewed later, none of the researchers have focused on the determining factors of the stability and instead they have just calculated the stability index for the Islamic banking system and compared it to the conventional ones. Cihak and Hesse (2008) in a famous study used data from 77 Islamic banks and 397 conventional banks during 1993 to 2004 to analyze the relative stability of Islamic and conventional banking systems. The study utilized Z-score indicator for banking stability and found that small Islamic banks are more stable than conventional banks but large Islamic banks are less stable than the conventional banks because of the complexity involved in regulating their credit risk and monitoring system.

Shahid and Abbas (2012) also calculated Z-score of 6 Islamic banks and top 10 conventional banks during 2006-2009 period to study the financial stability of Islamic banking in Pakistan. They found that small Islamic banks tend to be financially stronger than small conventional banks and large conventional banks tend to be financially stronger than large Islamic banks.

In a similar study Chakroun and Gallali (2015) used Z-score as an indicator of banking stability and regression analysis for a sample of 136 banks from the Persian Gulf countries (50 Islamic and 86 conventional banks) between 2003 and 2012. They showed that small Islamic banks tend to be financially more stable than small conventional ones but large conventional banks tend to be financially more stable than large Islamic banks.

Recently, Odeduntan, et al. (2016) analyzed the financial stability of Islamic banks in Malaysia. They also have showed that Islamic banks were more stable and financially viable and had the potentials to withstand any economic shocks.

3. Islamic Banking Stability Index

According to the Islamic Financial Services Board (IFSB) reports (2014 to 2017), after some years of rapid growth in Islamic banking before 2013, it reaches some mature point; since the total assets of Islamic banking in recent three years, 2014, 2015 and 2016 are respectively 1476, 1497 and 1493 million dollars. Figure 1 shows the Islamic banking assets in some major Islamic countries during 2013 to 2016 according to IFSB reports. So, it seems that the main concern of the Islamic banking at this point, is not growing faster but growing with more stability. Here, two important issues exist; first, measuring stability in Islamic banking and second, finding the determinants of stability in Islamic banking system.

One of the popular methods for analyzing the banking performance, to compare the stability of one banking system with others, is the CAMEL method. Financial ratios based on the CAMEL have been used to assess the soundness of banks in the USA since 1979. Later, these ratios have been used as a tool to assess the soundness of banks for the supervisory authorities in different countries (Roman & Şargu, 2013). In this approach, some related variables to the banking performance are selected as CAMEL factors including Capital, Assets, Management, Earning and liquidity.

Here, we use this approach to compare the performance of the Islamic banking in the selected Islamic countries. For Capital, we use capital adequacy ratios of Islamic banking in the selected countries during 2013 to 2016 (IFSB Report 2017). Figure 2 shows the variability of this ratio for some Islamic countries during 2013 to 2016. According to this figure, main Islamic countries have well capitalized Islamic banking and all, except Iran, have capital adequacy ratio larger than 15 percent.

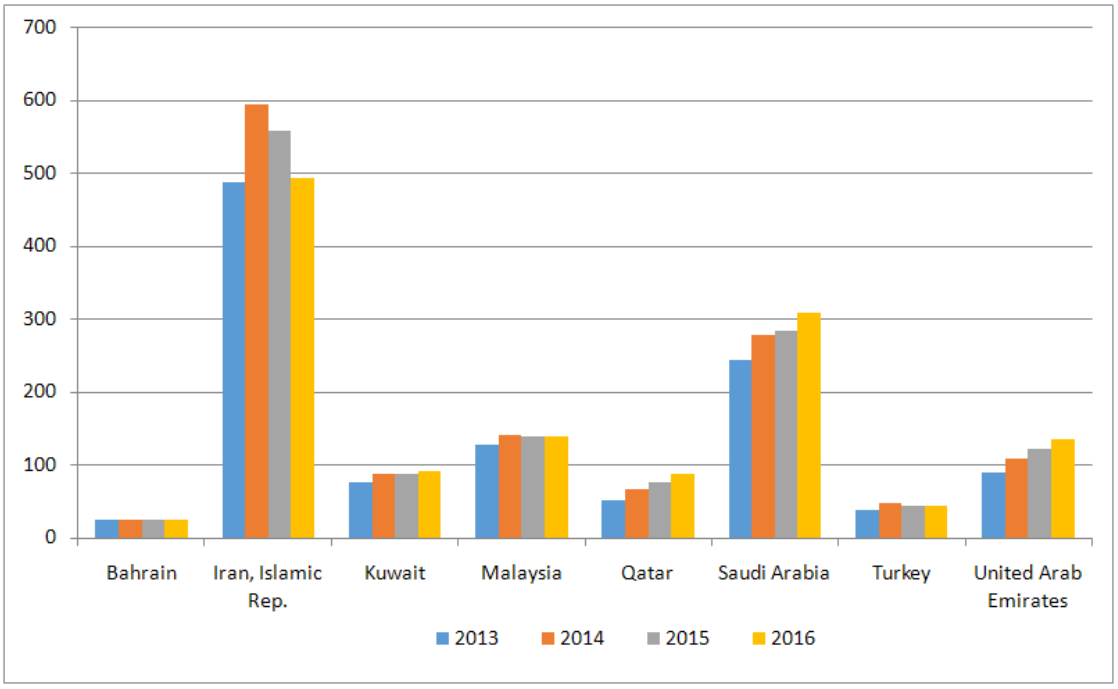

Figure 1: Islamic banking assets (Million $) during 2013-2016

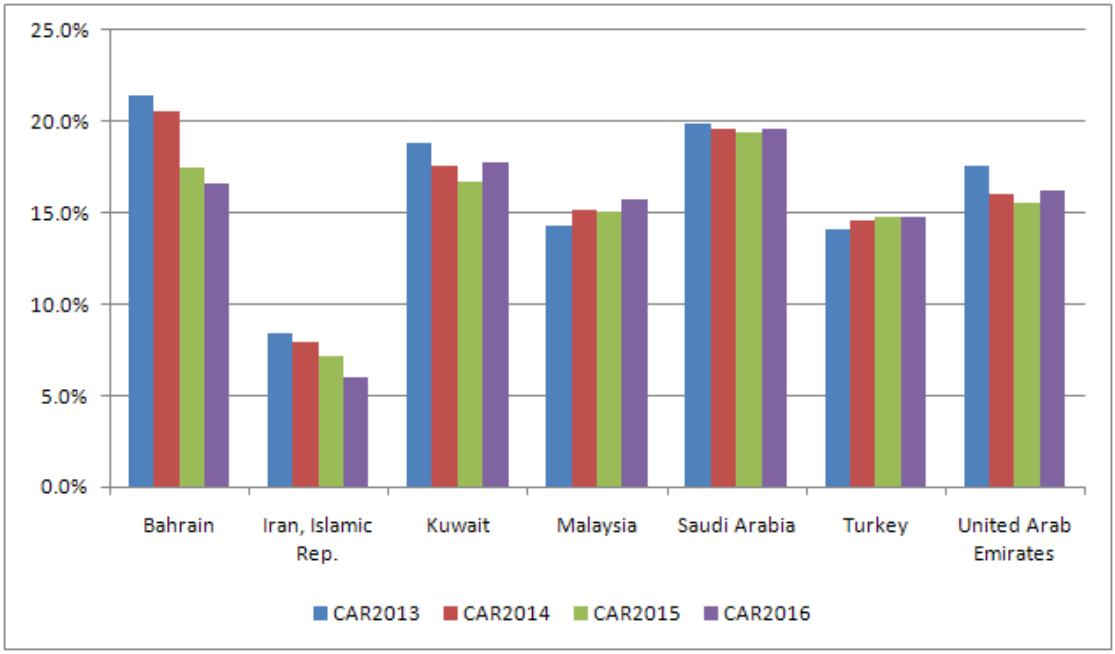

Figure 2: Capital adequacy ratio of Islamic banking in some selected countries during 2013 to 2016

To account for the Asset quality part of the CAMEL, we use the performing financing ratios of Islamic banking during 2013 to 2016 which are one minus non performing financing ratios (IFSB report 2017). Since we want to integrate this variable with the others to create a single stability index, and the higher values of all other variables show more stability in the banks, we could not use non-performing loan ratio. Figure 3 shows performing loan ratio for some selected Islamic countries during 2013 to 2016.

As it could be seen in this figure, Islamic banking in the Saudi Arabia, Malaysia and Kuwait had best asset qualities during 2013 to 2016 and in contrary, Islamic banking in Bahrain and Iran had more than 10 percent non performing financing and some

problems with asset quality in the Islamic banking system.

For the Management quality part of the camel approach, we use the cost to income ratios for Islamic banking in the selected Islamic countries during 2013 to 2016 (IFSB report 2017). This ratio shows the management performance in the sense that for earning one unit of income how much cost is applied by the managers. The greater this ratio, the lower the quality of management in the Islamic banking system. Figure 4 shows the cost to income ratio for Islamic banking in some selected Islamic countries during 2013 to 2016. According to this figure, in the Islamic banking of Saudi Arabia and Malaysia, managers spend less than 40 percent of the bank's income as the costs while in Iran and Bahrain, in 2016, the cost of operation of Islamic banks are more than 60 percent of their incomes.

For the Earning part of CAMEL method, we have used the return on the asset ratios of Islamic banking in the selected Islamic countries during 2013 to 2016 (IFSB report 2017). These ratios are shown in Figure 5 for the Islamic banking system of some selected Islamic countries. Again, Islamic banking of Saudi Arabia had the best performance since their ROA ratios are more that 2 percent in all years and Islamic banks of Iran with negative ROA ratio in 2016 had the weakest performance.

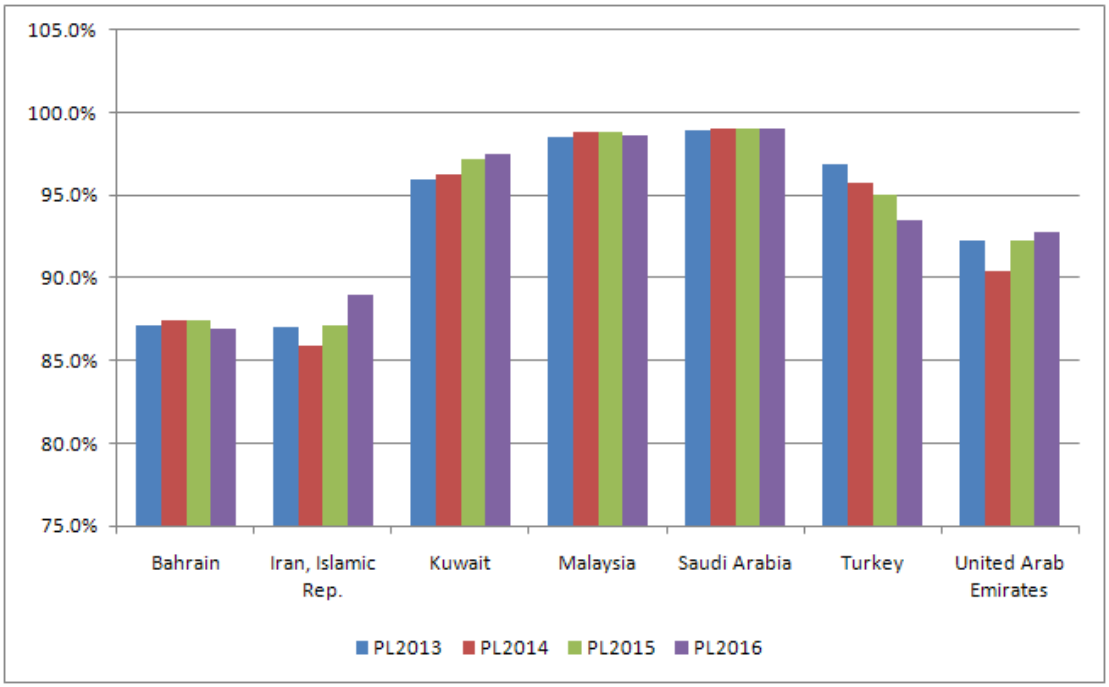

Figure 3: Performing financing ratio of Islamic banking in some selected countries during 2013 to 2016

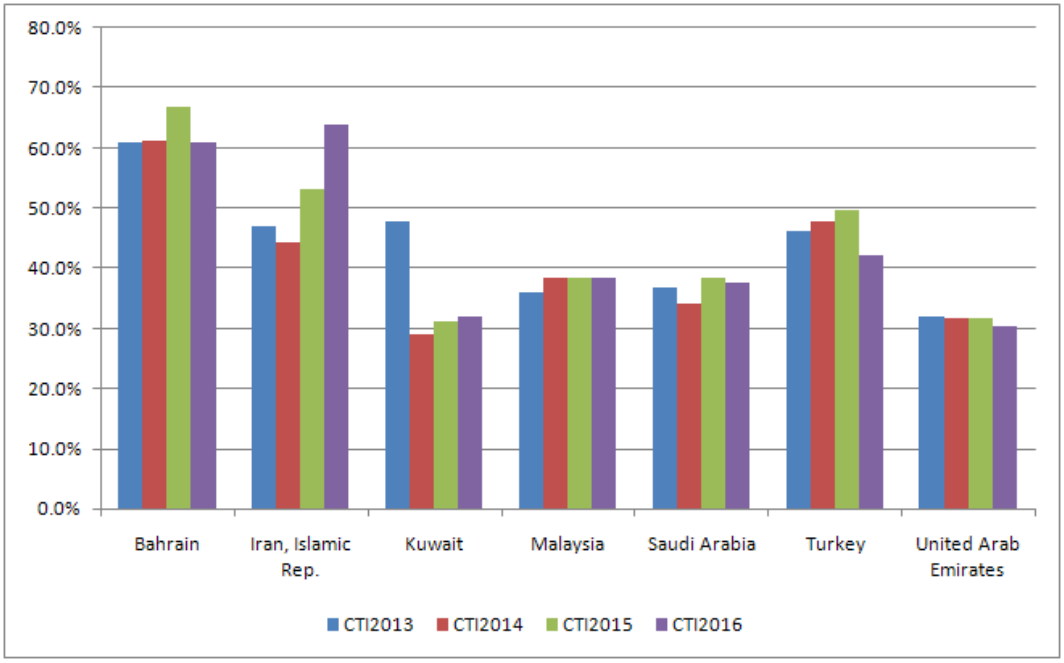

Figure 4: Cost to Income ratio of Islamic banking in some selected countries during 2013 to 2016

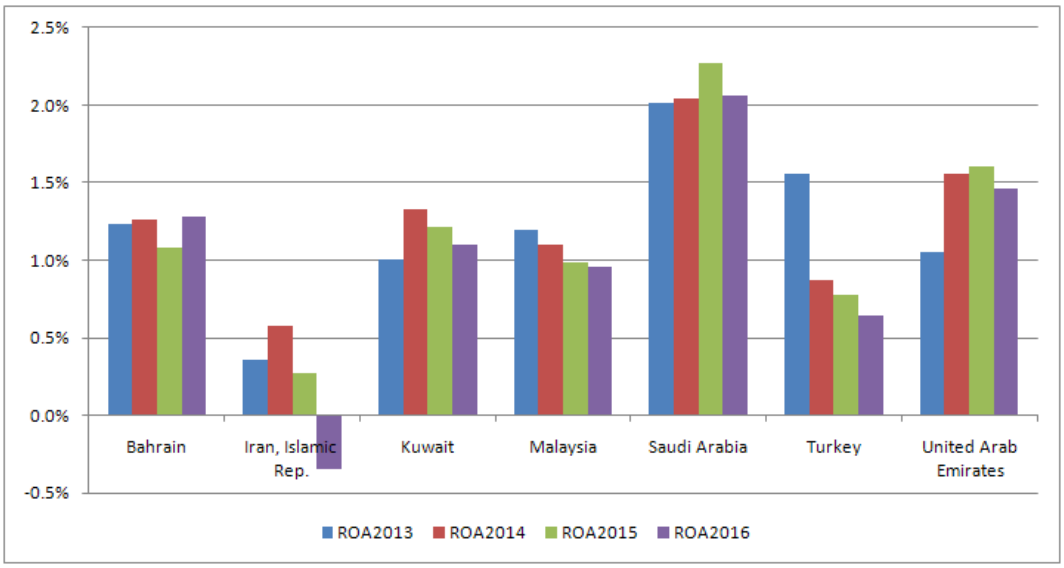

Figure 5: Return on Assets ratio of Islamic banking in some selected countries during 2013 to 2016

Finally, for the Liquidity part of the CAMEL method, we use the liquid asset to total asset ratio of Islamic banks during 2013 to 2016 in the selected Islamic countries (IFSB Report 2017). These ratios are shown in Figure 6 for some Islamic countries. According to this figure, Islamic banks in Iran had less than 10 percent liquid assets which could make them very unstable. Islamic banks in Malaysia had some improvement in the liquidity ratio during 2015 and 2016 and Islamic banks in Turkey had the best performance of the liquidity ratio.

Now, for constructing a model to analyze the determinants of Islamic banking stability, we should first combine all CAMEL variables into one single index and show the variations of Islamic banking stability during 2013 to 2016 in selected Islamic countries. As was mentioned in the previous session, major parts of the literature focused on the Z-score for evaluating the banking stability. But the problem with this index is that in its calculation just two variables are used: return on the asset and capital to asset ratio. So, in Z-score index, just capital and

earning factors are involved and the other CAMEL factors have no role.

Since the range of values for the CAMEL factors are different, to construct an index, first we should make them comparable with unifying their scale. For this purpose, we have used the min-max transformation for all CAMEL factors as follows,

$$x^* = \frac{x - \min(x)}{\max(x) - \min(x)}$$

The resulting factors would be transformed in tothe closed interval between 0 and 1.

So, for constructing Islamic Banking Stability Index, IBSI, after scaling all five CAMEL variables between 0 and1, we have used similar weights (20 percent for each variable), and calculated IBSI for each country in each year. Table 1 shows the changing behavior of the Islamic Banking Stability Index for the selected Islamic countries during 2013 to 2016.

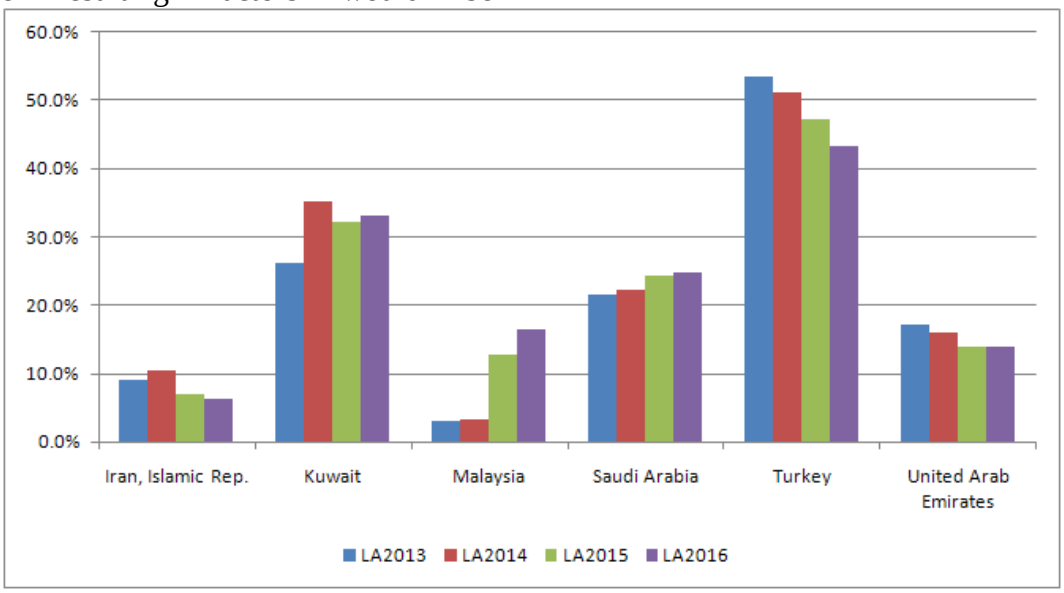

Figure 6: Liquid assets to Total Assets ratio of Islamic banking in some selected countries during 2013 to 2016

Table 1: Islamic Banking Stability Index for selected Islamic countries during 2013 to 2016 (Author's calculations)

Country Name	IBS2013	IBS2014	IBS2015	IBS2016
Bahrain	0.41	0.36	0.26	0.33
Bangladesh	0.54	0.55	0.56	0.54
Brunei Darussalam	0.58	0.61	0.66	0.74
Egypt, Arab Rep.	0.45	0.54	0.57	0.59
Indonesia	0.59	0.45	0.35	0.33
Iran, Islamic Rep.	0.31	0.29	0.18	0.12
Jordan	0.69	0.67	0.71	0.74
Kuwait	0.54	0.61	0.62	0.63
Malaysia	0.51	0.51	0.52	0.54
Nigeria	0.57	0.52	0.58	0.47
Oman	0.56	0.49	0.46	0.50
Pakistan	0.52	0.47	0.43	0.46
Saudi Arabia	0.60	0.62	0.64	0.66
Sudan	0.56	0.58	0.65	0.73
Turkey	0.63	0.57	0.54	0.53
United Arab Emirates	0.47	0.46	0.48	0.48

4. Exploratory Data Analysis

The dependent variable that we will use in our model is the proposed IBS index which was calculated in the previous section. For selecting predictor variables, we should refer to the theoretical bases of macroeconomic determinants of banking stability. As were reviewed in Section 2, two important channels are introduced by economic theories. The first one is the financial instability hypothesis of Minsky (1986) which believes that the monetary and real sector macroeconomic variables which show boom and boost cycle in the economy could affect the banking stability and the second one is what Bernanke and Blinder (1992) pointed out about the power of central bank monetary policy on the banking stability. Considering these theoretical background, we choose Gross Domestic Product (GDP) growth, money growth and domestic credit to private sector as percentage of GDP as predictor variables in the model. The fact that other studies like Bikker and Hu (2002) used these variables as independent variables in their stability model could support our perception that these variables could represent both cyclical and monetary policy channel of banking stability.

Since there is no such modeling in the Islamic banking literature, we could not compare our selected predictor variables with the other models but we expect that the same as conventional banking, Islamic banking, is also vulnerable from real and monetary shocks, and so the selected variables could explain the stability variation of Islamic banking in the model.

The required data needed for calculating predictor variables have been extracted from the World Bank Data Bank for all selected Islamic countries (Available at: http://databank. worldbank.org). Since we are interested in the stability analysis, we calculate the difference of these variables during 2013-2016 with their 15 years' average and call them GDP, MG and LTG in our analysis hereafter.

To study the changing patterns of IBS over the period 2013-2016, we have done a clustering among 16 available Islamic countries in the sample. We do this via a best-known clustering approach: namely *K-means clustering*. *K*-means clustering is a simple and elegant approach for partitioning a data set into *K* distinct, non-overlapping clusters. To perform *K*-means clustering, we must first specify the desired number of clusters *K*; then the *K*-means algorithm will assign each observation to exactly one of the *K* clusters. Figure 7 shows the results obtained from performing *K*-means clustering on the sample's IBS over time, using *K=3*. According to this Figure, Iran and Bahrain are included in the third cluster and accounted as less stable Islamic banking countries. Sudan, Jordan, Saudi Arabia, Kuwait and Brunei are included in the first cluster with more stable situations. The remaining countries had medium IBS over the period. Also, the changing pattern of the clusters' centers over time is illustrated in Figure 8.

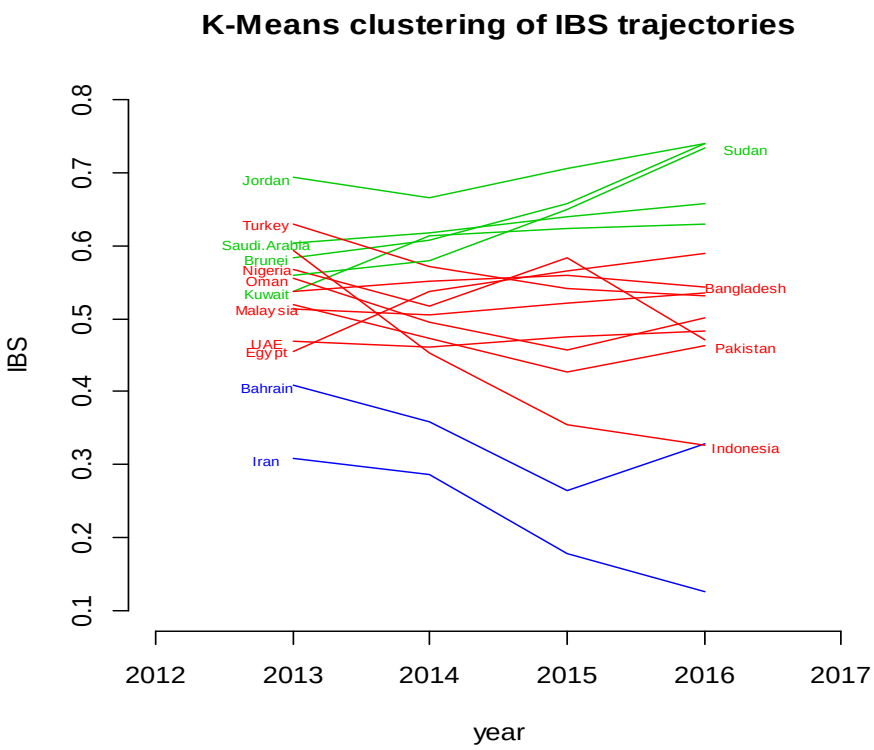

Figure 7: K-Means Clustering of IBS trajectories during 2013-2016

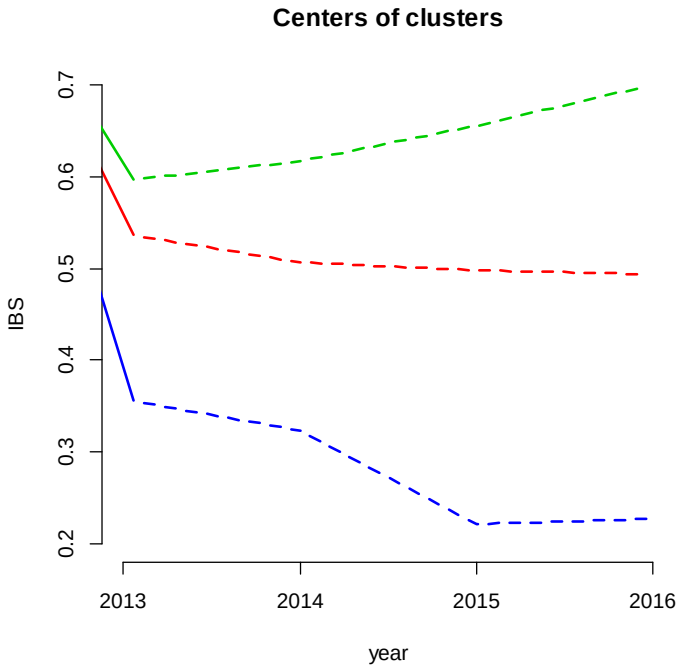

Figure 8: Centers of 3 Clusters of IBS trajectories during 2013-2016

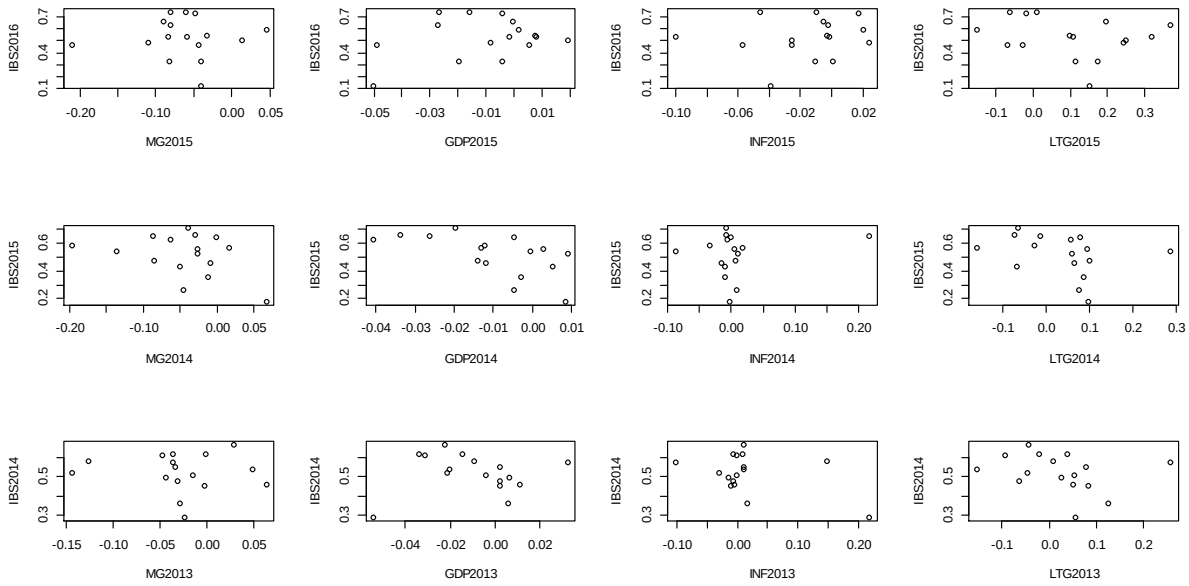

Figure 9: Scatter plots of IBS against MG, GDP, INF, LTG for the previous year during 2014-2016

Figure 9, illustrates the scatter plots of the IBS in each year against MG, GDP, INF, LTG of the previous year. According to these plots, there are some non-linear relations between the IBS variable and the predictors of the previous years. In the next section, we will apply GAM approach instead of linear models to capture the existing non-linearity.

5. Modelling IBS using GAM

Let y_i and x_{ij}, respectively denote response and j[th] predictor variable for the i[th] sample unit. The multiple linear regression model (LM) has the following form,

$$y_i = \beta_0 + \sum_{j=1}^{p} \beta_j x_{ij} + \epsilon_j$$

A natural way to extend LMs in order to allow for non-linear relationships between each predictor x_{ij} and the response y_i is to replace each linear component $\beta_j x_{ij}$ with a (smooth) nonlinear function $f_j(x_{ij})$. We would then write the model as:

$$y_i = \beta_0 + \sum_{j=1}^{p} f_j(x_{ij}) + \epsilon_j \qquad (1)$$

This is called an *additive* model because we calculate a separate $f_j()$ function of each x_j , and then add together all of their contributions.

One can apply different basis functions as $f_j()$ s in equation (1). We will use smoothing splines as basic functions. Therefore, in fitting a smooth curve to a set of data, what we really want to do is finding some function, say $f_j(x_{ij})$, that fits the observed data well. A natural approach is to find the function $f_j(x_{ij})$ that minimizes

$$\sum_{i=1}^{n} \left(y_i - f_j(x_{ij})\right)^2 + \lambda \int f_j''(t)^2 dt \qquad (2)$$

where λ is a nonnegative *tuning parameter*. The function $f_j(x_{ij})$ that minimizes (2) is known as a *smoothing spline*.

Equation (2) takes the form "Loss+Penalty". The first term on the left is a *loss function* that encourages $f_j(x_{ij})$ to fit the data well, and the second term is a *penalty term* which prevents overfitting.

The tuning parameter λ controls the roughness of the smoothing spline. For an intermediate value of λ, $f_j(x_{ij})$ will approximate the training observations but will be somewhat smooth. Actually λ controls the bias-variance trade-off of the smoothing spline (James et al, 2013).

Some advantages of a GAM over LM are:

- GAMs allow us to fit a non-linear

$f_j(x_j)$ to each x_j, so that we can automatically model non-linear relationships that standard linear regression will miss. This means that we do not need to manually try out many different transformations on each variable individually.

- The non-linear fits can potentially make more accurate predictions for the response variable, y.
- Because the model is additive, we can still examine the effect of each x_j on y individually while holding all of the other variables fixed. Hence, if we are interested in inference, GAMs provide a useful representation.

The gam() function in R software is used to fit GAMs using smoothing splines, via an approach known as back fitting. This method fits a model involving multiple predictors by repeatedly updating the fit for each predictor in turn, holding the others fixed. The beauty of this approach is that each time we update a function, we simply apply the fitting method for that variable to a partial residual (Hastie & Tibshirani, 2000).

The results of the selected GAM when assessing the effect of MG, LTG and GDP of 2015 on the logarithm of IBS2016 are given as partial plots in Figure 10. The left-hand panel indicates that holding GDP2015 and MG2015 fixed, IBS2016 tends to decrease when LTG2015 is less than 0.2. Remembering again that LTG2015 is the distance between LTG in Islamic countries in 2015 with their 15 years' average, we could say that when the LTG is near its long term average, there is a negative relationship between LTG and IBS but when LTG goes more than 20 percent of its long term average, increasing the LTG will increase IBS.

The center panel indicates that holding MG2015 and LTG2015 fixed, IBS2016 tends to increase when GDP2015 increases. So, when the GDP growth of Islamic countries go beyond their long term average, their Islamic banking stability will increase too. It shows that the Islamic banking operation is positively linked with real sector of economy.

The right-hand panel indicates that holding GDP2015 and LTG2015 fixed, IBS2016 tends to decrease with MG2015. It means that increasing money growth beyond its long term average will decline stability of Islamic banking in the selected Islamic countries. This shows the effects that excessive growth in money sector could bring to the stability of Islamic banking.

Also, the results of selected GAM when assessing the effect of MG, LTG and GDP of 2014 on logarithm of IBS2015 are given as partial plots in Figure 11. According to the figure, the effects of LTG and MG is the same as previous model and they have reversing impact on the IBS while the result for GDP in this model shows that when GDP goes beyond its long term average in 2014, the Islamic banking stability in 2015 declines. When we look at the GDP of selected Islamic countries in 2014, we see that almost all of them are below their long term average and this dominant recession in GDP of Islamic countries may be the reason for this adverse result.

The results of selected GAM when assessing the effect of MG, LTG and GDP of 2013 on logarithm of IBS2014 are given as partial plots in Figure 12. As we can see in the figure, the LTG has negative effect on the Islamic banking stability the same as two previous models, GDP has positive effect on IBS the same as 2016 model and MG has no significant effect on the IBS.

The ANOVA results related to the three fitted GAMs along with the Shapiro-Wilk test of normality for the corresponding residuals are given in Table 2. Based on the results, the normality assumption holds for all models. Also GDP and MG are significant determinants of IBS in 2016 and 2015.

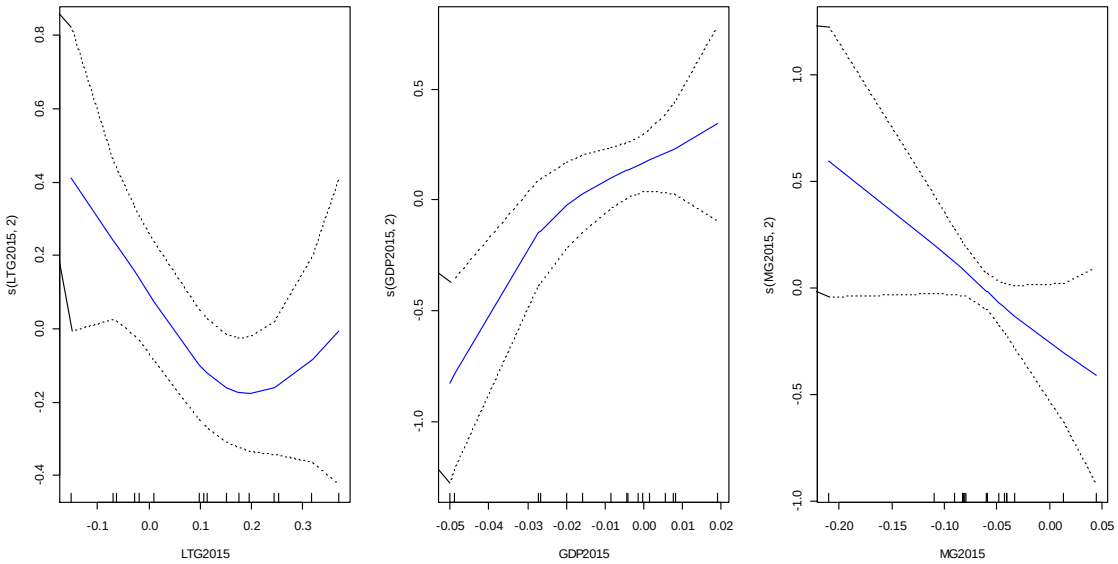

Figure 10: ***Each plot displays the fitted function $f_j(x_j)$ and point wise standard errors for 2015 predictors on IBS2016.***

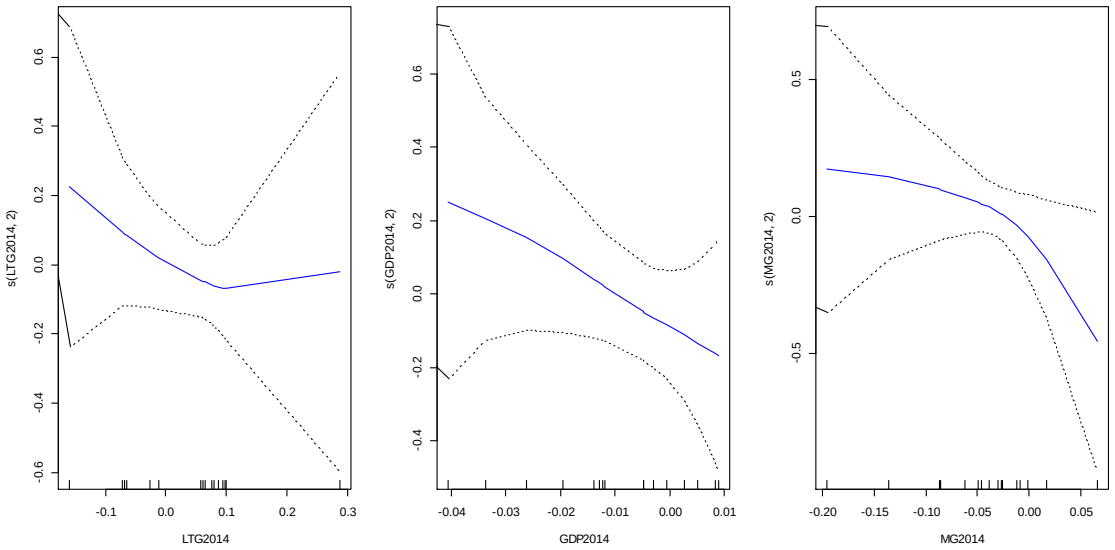

Figure 11: Each plot displays the fitted function $f_j(x_j)$ and pointwise standard errors for 2014 predictors on IBS2015.

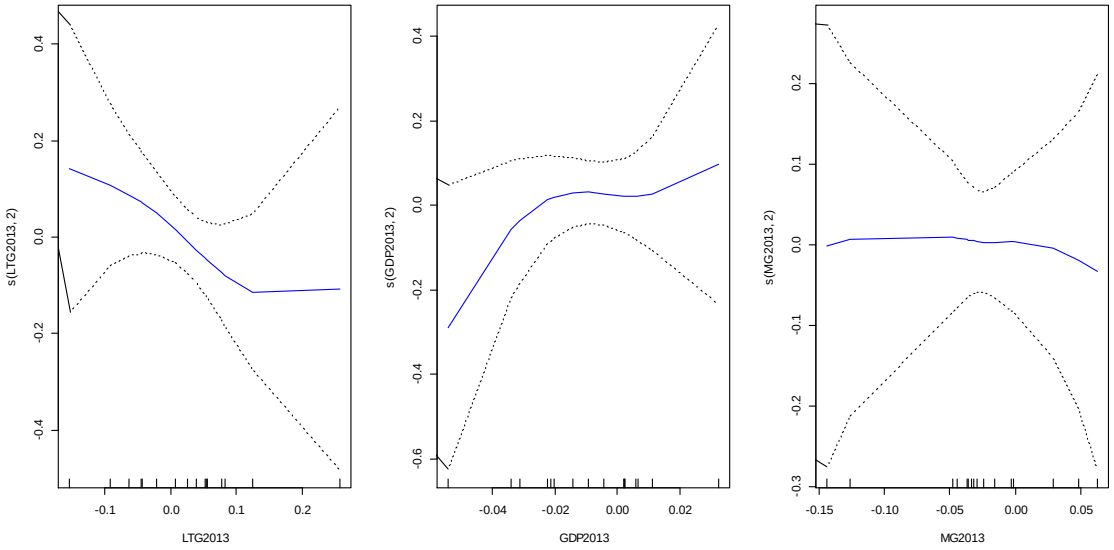

Figure 12: Each plot displays the fitted function $f_j(x_j)$ and pointwise standard errors for 2013 predictors on IBS2014.

Table 2: ANOVA Tables and Normality tests for three GAMs (R analysis results)

Predictors of previous year	GAM for IBS 2016		GAM for IBS 2015		GAM for IBS 2014	
	F-value	P-value	F-value	P-value	F-value	P-value
LTG	1.0117	0.34077	1.3352	0.27763	0.4863	0.5032
GDP	5.8460	0.03875	3.8566	0.08114	1.0859	0.3246
MG	4.9904	0.05236	2.0755	0.18355	0.0194	0.8924
Normality Test P-value	0.3882		0.7796		0.2424	

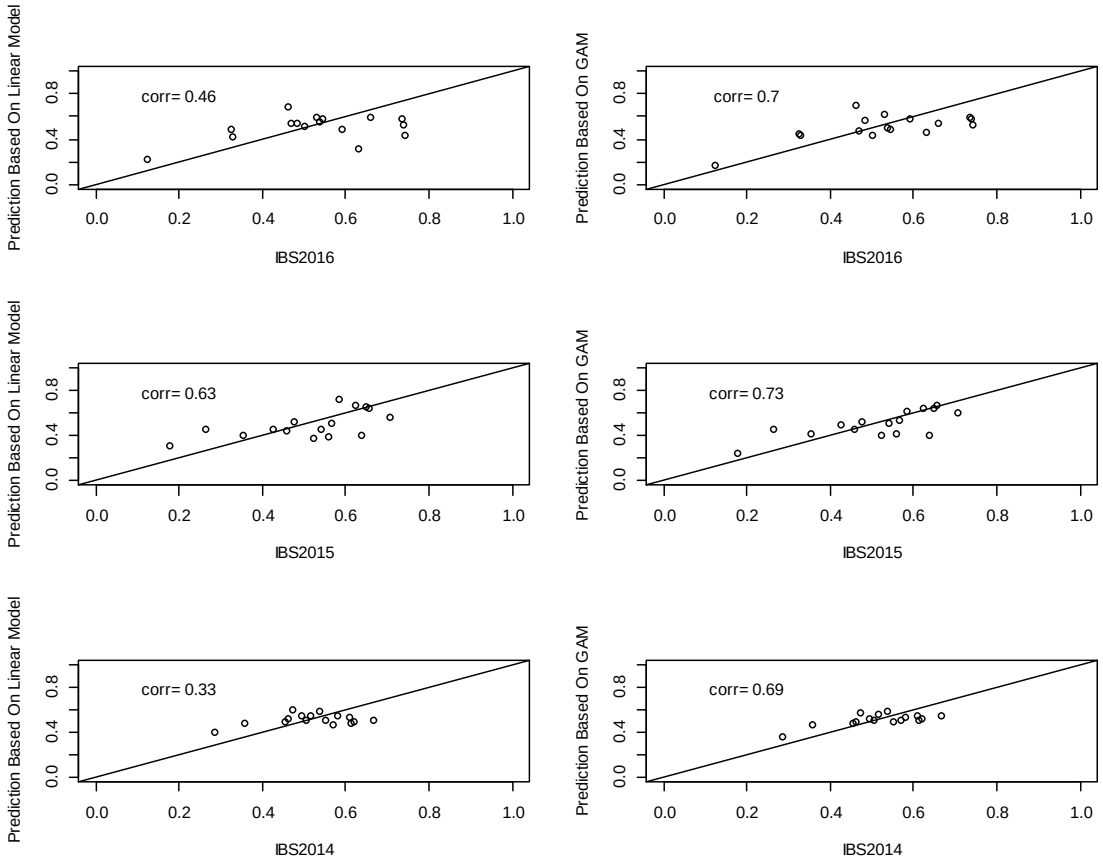

Figure 13: Predicted versus Observed IBS of 2014, 2015 and 2016. Left panels based on ML and Right panels based on GAM.

To compare prediction accuracy of linear models and GAMS in three years of the study, Figure 13 is given. Accordig to this Figure, the predictions based on GAMs have less errors and are sufficeintly improved over standard linear models. Also, the pearson correlations between predicted and actual IBS values given in each plot, confirms this result as well.

6. Conclusion

Although it is believed, by some Islamic economists, that Islamic banks are more stable than conventional banks, but it is still needed to have some tools for measuring the stability of Islamic banks during time and also to have some quantitative models for finding the factors that affects the Islamic banking stability. For measuring stability in Islamic banking, we introduced, for the first time, an Islamic banking stability index (IBS) which uses all CAMEL factors and so is more comprehensive than Z-score index mostly applied in the existing literature for measuring stability of banking system. Then, we developed a Generalized Additive Model (GAM) using smoothing splines to study potential non-linear relations between IBS and macroeconomic variables in selected Islamic countries. Such models have more predictability when compared by linear ones commonly used in the stability analysis literature.

To construct IBS index, first we have scaled all five CAMEL variables of the Islamic banking between 0 and 1 using the min-max method, then we have used equal weights (20 percent for each variable), and calculate IBS for each selected Islamic country during 2013 to 2016. For predictor variables, we have used the macroeconomic variables GDP growth, Money Growth and Domestic Credit provided to private sector from World Bank database during 2012 to 2015. But since we were interested in

stability analysis, we have used the difference of these variables from their long term average (15 years) in each year as predictors of the next year IBS.

The results of selected GAM when assessing the effect of MG, LTG and GDP on the next year IBS shows that for all models when LTG goes beyond its long term average, the Islamic banking stability declines. Models also showed that except for year 2014, when almost all selected Islamic countries has low GDP growth, increasing GDP more than its long term average growth would increase stability of Islamic banking in the selected Islamic countries. Also, the results showed that there is a negative relationship between money growth and Islamic banking stability in almost all years. Since we have used previous year indicators for modeling the next year's Islamic banking stability index, the fitted models in the paper enable us to easily predict the next year's stability of Islamic banking.

References

1. Bernanke, B. & Blinder, A.S. (1992), The federal funds rate and the channels of monetary transmission, *American Economic Review*, 82 (4), 901–21.
2. Bernanke, B. & Gertler, M. (1989), Agency costs, net worth, and business fluctuations, *American Economic Review*, 79 (1), 14–31.
3. Bikker, J.A. & Hu, H. (2002), Cyclical patterns in profits, provisioning and lending of banks and pro-cyclicality of the new Basel capital requirements, *Banca Nazionale Del Lavoro Quarterly Review*, 55 (221), 143–75.
4. Bucher, M., Dietrich, D. & Hauck, A. (2013), Business cycles, bank credit and crises, *Economics Letters*, 120 (2), 229–31.
5. Chakroun, M. A. & Gallali, M. I. (2015), Islamic Banks and Financial Stability: An Empirical Analysis of the Gulf Countries, *International Journal of Business and Commerce*, Vol. 5, No. 03: pp 64-87.
6. Cihak M. & Hesse H. (2008), Islamic Banks and Financial Stability: An Empirical Analysis. *IMF Working Paper*, No. 08/16.
7. De Nicoló, G., Bartholomew, P., Zaman, J. & Zephirin, M. (2004), Bank consolidation, internalization, and conglomeration, *IMF Working Paper*, No. 03/158.
8. Hanschel, E., & Monnin P. (2005), Measuring and forecasting stress in the banking sector: evidence from Switzerland, *BIS Papers*, No. 22.
9. Hastie, T. & Tibshirani, R. (2000), Bayesian backfitting (with comments and a re-joinder by the authors), *Statist. Sci.*, Vol. 15, 196–223.
10. Illing, M. & Liu Y. (2006), Measuring financial stress in a developed country: An application to Canada, *Journal of Financial Stability*, Vol. 2, 243-265.
11. Islamic Financial Services Board (2014-2017), *Islamic Financial Services Industry Stability Report*, Bank Negara Malaysia.
12. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning*, New York: springer.
13. Koetter, M. & Poghosyan T. (2008), Real Estate Markets and Bank Distress, *Deutsche Bundesbank Discussion Paper*, Series 2, No. 18.
14. Lorenzoni, G. (2008), Inefficient Credit Booms, *Review of Economic Studies*, Vol. 75, issue 3, 809-833.
15. Minsky, H. (1986), *Stabilizing an Unstable Economy: A Twentieth Century Fund Report*, New Haven, CT: Yale University Press.
16. Odeduntan, A. K., Adewale, A. A. & Hamisu, S. (2016), Financial Stability of Islamic Banks: Empirical Evidence, *Journal of Islamic Banking and Finance*, Vol. 4, No. 1, 39-46.
17. Roman, A., & Şargu, A. C. (2013), Analyzing The Financial Soundness of the Commercial Banks in Romania: An Approach Based On The CAMELS Framework, *Procedia Economics and*

Finance, Vol. 6, No. 13, 703–712.
18. Shahid, M. A. & Abbas, Z. (2012), financial stability of Islamic banking in Pakistan: An empirical study, *African Journal of Business Management*, Vol. 6(10), 3706-3714.