Araştırma Makalesi/*Research Article*
Başvuru/*Submission:* 08.03.2023
Kabul/*Acceptance:* 18.04.2023

ADAM AKADEMİ Sosyal Bilimler Dergisi, 14(1), 27-45
DOI: 10.31679/adamakademi.1261323

Crisis Duration Bias: A Multinomial Logit Approach for Islamic Banking

Ayşegül Aytaç EMİN*

Social Sciences University of Ankara

Abstract

In this study an early warning system (EWS) model is constructed for predicting the banking crisis (BC) of Islamic banks (IBs). To this aim, multinomial logit regression is employed regarding the levels of the explanatory variables are different in their tranquil and crisis/post-crisis levels which is called as the crisis duration bias (CDB). The analysis is conducted with three time windows. Accordingly, the IBs in each country experiences three states as tranquil period ($Y_{i,t}$=0), a pre-fragility period ($Y_{i,t}$=1) and post-fragility period ($Y_{i,t}$=2). The results address CDB problem and both macroeconomic and banking sector variables are crucial in determining the early warning indicators of the fragility of IBs. This study also draws attention to predictive performances of binomial logit approach and multinomial logit approach. According to the results, the overall predictive performance of the multinomial logit regression reveals superior results than binomial logit regression.

Keywords

Banking crisis; Islamic banking; Multinomial Logit Regression

* PhD, Lecturer, Rectorate Office, Social Sciences University of Ankara, aysegulaytac.emin@asbu.edu.tr, ORCID: 0000-0001-8086-0091

Kriz Zamanı Sapması: İslami Bankacılık için Çok Terimli Lojistik Regresyon Yöntemi

Öz

Bu çalışmada, İslami bankaların bankacılık krizlerini tahmin edebilmek için bir erken uyarı sistemi oluşturulmuştur. Bu amaçla, açıklayıcı değişkenlerin sakin ve kriz/kriz sonrası dönemlerde farklı seviyelerde olduğu göz önüne alınarak çok terimli lojistik regresyon kullanılmıştır. Analiz, üç zaman penceresi ile oluşturulmuştur. Buna göre, her ülkedeki İslami Bankalar sakin dönem ($Y_{i,t}$=0), kırılganlık öncesi dönem ($Y_{i,t}$=1) ve kırılganlık sonrası dönem ($Y_{i,t}$=2) dönemlerini deneyimlemektedir. Sonuçlar, kriz süresi sapma problemini ve makroekonomik ve bankacılık değişkenlerinin İslami bankaların bankacılık krizlerine karşı olan kırılganlıklarını açıklamada başarılı olduğunu göstermektedir. Bu çalışma aynı zamanda çok değişkenli regresyon ve ikili lojistik regresyon yönteminin genel tahmin başarısına dikkat çekmektedir. Sonuçlara göre, çok değişkenli lojistik regresyon, ikili lojistik regresyona kıyasla daha iyi başarılı tahmin performansı göstermektedir.

Anahtar Kelimeler

Bankacılık Krizi; İslami Bankacılık; Çok terimli Lojistik Regresyon

Introduction

Although its historical roots dates back to 1960s, Islamic banking sector has displayed a considerable momentum not only in Muslims countries but also on the global scale (Alaeddin et al.; 2021). Islamic banking has become a major competitor of the conventional banks (CBs). While the Islamic banking industry accounted for USD 1.68 trillion in 2017, it increased by 10% and reached to USD 1.84 trillion in 2020. Although the sector was affected by factors such as the COVID-19 pandemic and oil price fluctuations in 2020, the global Islamic banking industry witnessed a growth of 6.5%, which was higher than the growth rate of 4.3% in the previous year. Despite their different fundamental principles and modes of financing as financial intermediary activities and financial instruments, Islamic Banks (IBs) and conventional banks (CBs) share similar risk factors, objectives and financial functions. Therefore, IBs are fragile towards the impacts of BC, which is a natural element of global finance. For instance, the global financial crisis of 2008 inversely affects the performance of Islamic banks by several factors, such as their level of capital adequacy, profitability, credit risk, financial risk, operational efficiency and liquidity (Uddin et al., 1027; Hussein et al., 2019). The sukuk market also shrinks after the global financial crisis of 2008 (Azrak and Hazaa; 2019). For that reason, detecting early signs of an upcoming financial distress and taking early precautions is also crucial for IBs. In this regard, early warning systems (EWS) are designed to anticipate an upcoming BC by providing early warnings about the fragilities and weaknesses within the banking system. In this context, determining the significant indicators has received considerable critical attention. Although there exist substantial efforts in the related literature to determine the significant variables of BC, there is not certain list of determinants. In contrast to those efforts that focus on CBs, there is much less information about the early indicators of BC of IBs. The existing studies carried out on determining the indicators of IBs, on the other hand, are designed for country specific analysis (Kusuma and Duasa 2016; Anwar and Ali 2018). Motivated by those facts, this study primary attempt to reveal the significant variables of IBs fragility to BC. The outcomes of the current study provide a valuable contribution to the existing literature. The current study intends to investigate the early warning variables of banking sector fragility of IBs by covering data from 10 countries and 92 IBs. Accordingly, the present study seeks to obtain an EWS for IBs by considering leading countries regarding Islamic banking assets to address these research gaps. Furthermore, the

findings show significant macroeconomic and bank-specific variables of the BCs of IBs. Last but not least, the relevant study makes an important contribution by employing multinomial logit regression to construct and EWS model to predict the BCs of IBs. Since the BC are more persistent and permanent compared to currency crisis, healing period from the destructive consequences take longer and overhauling the banking systems are more expensive (Caggiano et al., 2014). For this reason, the levels of the explanatory variables are different in their tranquil and crisis/post-crisis levels which is called the crisis duration bias (CDB). In this study, the CDB is tackled by utilizing multinomial logit regression that reveals more than two outcomes as suggested by the literature (Bussiere and Fratzscher, 2006).

The remainder of the study is structred as follows. Section 2 summarizes the background literature. In Section 3, the data and methodology are presented. The Section 4 reports the results which is followed by Section 5 that concludes the current study.

Literature Review

Although the literature of BC is vast, it is still on the agenda due to the considerable number of experienced BC and their destructive consequences to the economies. According to World Bank data, the various economies in the world has experienced 364 BCs between the period of 1990 and 2017[1] which cause excessive social, political and economic losses. For instance, between those periods, the BC cause the annual GDP rate of the countries to decrease 15-20% in those periods (Hoggarth et al., 2002). As BCs are essential component of economies and IBs have become a significant part of the banking systems, taking early measures against the negative consequences against those crises have become vital for IBs as well. Furthermore, along with the global breakdown of 2008 and its destructive impact on the conventional banking sector, IBs has attracted substantial interest. However, the studies show that the IBs is not riskless towards the adverse impacts and consequences of BCs (Hasan and Dridi, 2010; Rashwan, 2012). Therefore, the necessity for an EWS is also crucial for IBs as well. In this context, studies have been conducted to develop various econometric models in order to reveal the effects and determinants of the crises. For instance, Kaminsky and Reinhart (1999) signal extraction approach and investigate the movements of different macroeconomic variables (MVs) to investigate the significant variables of the BCs between 1970 and 1995. Their results show that real effective exchange rate (REER), M2 multiplier, real interest rate, the ratio of domestic credit to GDP, terms of trade, stock prices and financial liberalization are the significant variables of the BC. To examine the determinants of BC, Demirgüç-Kunt and Detragiache (1998) use a binomial logistic approach. Their dataset covers 20 developed

1 World Bank, *World Development Indicators*.

and developing countries from the period 1980 and 1994. According to the results, economic growth, interest rate, inflation and deposit insurance are the significant variables of the BC. Furthermore, the authors investigate that while economic growth is negatively related with the crisis occurrence, interest rate, inflation rate and deposit insurance increase the probability of the BCs.

Hardy and Pazarbaşıoğlu (1998) identify the episodes of significant banking sector problems and BC separately. In other words, the authors distinguish the significant distress episodes from BC episodes by covering 38 countries between the years 1980 and 1997. For the analysis, macroeconomic, banking sector and real sector variables are considered to determine their impacts on probability of BC. The findings show that, decreasing real GDP growth, credit expansion and the fluctuations in the REER are significant indicators of BC.

As one of the most pioneering study in the literature, Bussiere and Fratzscher (2006) develop a novel EWS by employing multinomial logit model to solve the post-crisis bias. According to the authors, the econometric outcomes of the binomial logistic EWS models suffers from post-crisis bias since the estimation results are conducted without making any distinction between the tranquil episodes and post crisis episodes. Therefore, instead of separating the episodes as tranquil and crisis episodes, the authors use three regimes as tranquil regime, a pre-crisis regime, and post-crisis/recovery regime and predict the financial crises for 20 emerging markets between 1993 and 2001. The results reveal that multinomial logit model reveal better predictive power than binomial logit model. To compare the outcomes of multinomial logit model and signal approach Davis and Karim (2008), set up a comprehensive EWS over the time period 1979 and 2003. The authors use large sample of countries and consider 105 countries in total. Their results reveal while multinomial logit model reveals superior results for global EWS, signal extraction method increases the predictive ability of the EWS for country-specific analyses. Regarding the significant variables, on the other hand, the authors suggest that real GDP growth and terms of trade are leading indicators of BC.

Following Bussiere and Fratzscher (2006), while Caggiano et al. (2014) draw attention to post-crisis bias, the authors make a major contribution to the literature by constructing an EWS for 35 low income countries in Sub-Saharan Africa to predict the BCs. The authors emphasize that the empirical results and predictive power of the EWS model of the binomial logit regression suffer from post-crisis bias since the average length of the crisis episodes in those countries takes more than one year. More precisely, according to the authors, since the binomial logit approach has two outcomes as crisis and non-crisis/tranquil episodes, the crisis years other than the first year is considered as non-crisis episode or eliminated from the sample. This causes ignoring the years after the onset of the crisis, affecting crisis signals and false alarms by

revealing misleading results. For this reason, the problem of post-crisis bias is solved by conducting multinomial logit approach by separating the crises episodes to three regimes as the first-year crisis regime, the crisis regime for crisis years subsequent to the first year of the crisis and the tranquil regime. According to the results, decreasing GDP, liquidity and broadening currency mismatches in the balance sheets of the banks are significant variables of the BC. In addition, the authors highlight multinomial logit approach gives superior predictive power results compared to binomial logit approach.

Although the literature on constructing an EWS to predict BCs is vast, there is limited studies that are mainly focus on IBs. For instance, Kusuma and Asif (2016) construct an EWS for Indonesia and analyze the behavior of the ratio of M2 to growth of reserves, domestic credit growth, REER and inflation rate by conducting an extraction signal approach. The authors suggest that those MVs are significant in predicting the BC. To observe the significant indicators of BCs of CBs and IBs in Indonesia and to identify the longest period of crisis for both of the banking system, Nurfalah et al. (2018) construct an EWS by employing Markov Switching approach. The authors employ monthly data set over the time period of January 2004 and March 2017. According to their results, increasing domestic credit, higher level of interest rate and decreasing level of M2 decreases the stability of CBs. The stability of IBs, on the other hand, positively related with the increasing bank deposits and the ratio of current account to GDP. While the conventional banks experience the longest BC period as between April 2013 and March 2017, for IBs the period of crisis takes places between January and October 2008. The authors also compare the performances of both banking systems. The results reveal that IBs is more resistant to financial shocks compared to CBs.

Du Plessis (2022), on the other hand, conduct a comprehensive EWS study on BCs including 49 developed and emerging countries between the time span of 1971 and 2017. The crisis periods are separated to three regimes as pre-crisis, crisis and post-crisis periods. According to the results, GDP growth is significant in the entire crisis periods. In addition, deterioration of consumption spending, fixed capital formation and fixed capital formation result from credit boom are the early signals of an upcoming BC. While depreciation of exchange rate is significant variable for crisis period, decreasing real interest rate, increasing imports and deposits are significant variables of recovery period. Furthermore, to compare the results, the estimation is also conducted by employing probit approach and machine learning methods. According to the results, the multinomial logit regression gives reveals better predictive power results compared to several probit model and machine learning methods as artificial neural networks, gradient boost, k-nearest neighbors and random forests.

Consequently, although there is a considerable amount of literature that recognizes the importance of constructing an EWS for BCs by considering different country sets, time periods and explanatory variable set and comparing

different econometric methodologies; these studies are specific for the conventional banking system. More precisely, the studies on the Islamic banking system are very limited. Moreover, the relevant studies on IBs, on the other hand, are country-specific studies that fail to comprise a global EWS for IBs. Accordingly, this study aims to construct a global EWS that comprise top countries in terms of Islamic banking assets for a recent time span. Furthermore, the outcomes of the study are crucial for IBs since this is the first attempt towards constructing an EWS by employing multinomial logit approach for BC of IBs.

Data and Methodology

Data

The data comprised of annual observations over the time period 2008-2018. The country set includes the most developed countries in IBs in terms of holding the highest share in global Islamic banking assets ratio (IFSB, 2021). In 2021, the global Islamic banking assets grew by 6.5% and CAGR of 2.4% with respect to previous year and reach to US$ 2.1 trillion. Accordingly, Iran is the largest Islamic finance market by assets which is followed by Saudi Arabia. The total Islamic banking assets in Malaysia reached to US$ 252 billion in 2020. In addition, while UAE ranked as fourth globally with Islamic banking assets of US$ 191 billion, Kuwait reached to US$ 127 billion. Considering data availability and excluding the banks that stopped banking activities before 2018, the final dataset covers 92 IBs from 10 countries as Bahrain, Bangladesh, Indonesia, Iran, Kuwait, Malaysia, Qatar, Saudi Arabia, Turkey and UAE. Thereby, the country set includes the countries that represent a large part of the sector which is helpful to construct a model that reveals the indicators in anticipating the fragility of IBs. In this respect, Countries selected for the analysis constitute 94 percent of the total global Islamic banking assets. More precisely, the share of global Islamic banking assets by each country can be given as follows: Iran (28.6%), Saudi Arabia (24.9%), Malaysia (11.1%), UAE (8.7%), Kuwait (6.3%), Qatar (6.1%), Turkey (2.6%), Bangladesh (2.1%), Indonesia (2%), Bahrain (1.8%).

Bank specific variables data is retrieved from Bankscope database. The MVs, on the other hand, are derived from World Bank and IMF databases. The explanatory variables are grouped as banking sector variables and MVs for the analysis[2]:

[2] The explanatory variables used in this study is determined with respect to the relevant literature following Bussiere and Fratzscher (2006), Hasan and Dridi, 2010; Beck et al. (2013); Caggiano et al. (2014). While the banking sector variables reflects the credit, liquidity, exchange rate riskiness of the banking sector, the macroeconomic variables include the financial liberalization, current account, capital account, real sector and fiscal variables that are categorized in Kaminsky and Reinhart (1999).

a) Banking Sector Variables: Total loans, return on assets, total assets, growth in total assets, the ratio of liquid assets to total assets, the ratio of net loans to total assets, net interest margin, cost to income ratio, the ratio of equity to total assets, total capital adequacy ratio.
b) Macroeconomic Variables: GDP growth (annual %), GDP per capita, inflation, exports/imports of goods and services (% of GDP), real interest rate (%), the ratio of M2 to GDP, current account balance (% of GDP), real effective exchange rate (REER), foreign direct investments (% of GDP), domestic credit to private sector (% of GDP), unemployment, government debt (% of GDP).

Methodology

The binary dependent variable of the model, the BC, is constructed by using a banking sector fragility index (BSFI) following Kibritçioğlu (2003). The author explains the economic risk factors of bank as credit risk (CR), liquidity risk (LR) and exchange rate/market risk (MR) and constructs an index based on these risk components. Accordingly, BSFI is defined by considering bank deposits, bank credits to domestic private sector and foreign liabilities of banks to measure the LR, CR and MR factors respectively. Furthermore, Kibritçioğlu (2003) designs two alternative indices. In the first alternative index, the bank deposits variable (LR factor) is excluded from the original index to observe if bank runs is crucial in triggering the BCs. In this respect, the first alternative index is constructed with BC and FL variables. On the other hand, the second alternative index is defined by omitting FL variable (exchange rate/market risk factor) and defines the index with BC and DEP variables in order to test the significance of the MR factor in BC. The author finds that for some countries excluding DEP variable (LR factor) is not essential in the determination of BC. With respect to the findings, the author investigates LR do not have a significant role in provoking the BCs. Accordingly, in this study to be able to predict the BCs for IBs, the index is the average standardized values of non-performing financing (NPF), the real foreign liabilities of banks (FL)[3].

In addition, since the operations of IBs are based on profit and loss sharing principle, their returns are more sensitive to profitability risk (Elgari 2003; Kozarevic e al., 2014). Therefore, in the current study the profitability risk factor, measured by return on equity (ROE), is included into the BSFI. The banking sector fragility index is defined with nonperforming loans (NPL), the foreign liabilities of banks and ROE variables in order to measure CR, MR and profitability factors respectively. To solve the (CDB), the analysis is conducted

[3] Since CR is crucial for Islamic banking and primarily associated with the NPF and it is directly connected with Islamic Bank specific contracts such as murabahah, ijarah, salam, itisna, musharakah and mudarabah, NPF is considered to measure the CR proxy (Salim et al., 2016; Fakhrunnas et al. 2021). Furthermore, considering ROE is a well-accepted indicator of bank's profitability (Ekinci and Poyraz, 2019), it is used to measure the profitability risk.

by adopting multinomial logistic regression with three outcomes (Bussiere and Fratzscher, 2006). The post-crisis bias, defined by Bussiere and Fratzscher (2006), emerged from lack of separation between tranquil periods and post-fragility periods. More precisely, the economic indicators are strong and stable in the tranquil episode. In the post-crisis episode, on the other hand, the indicators are encounter an adjustment period and return to their steady levels. As a result, the same probability of experiencing a tranquil episode and post crisis episode is attributed for both of the periods that cause erroneous results. The post-crisis bias is the result of the binomial logit EWS and it can be solved by adopting multinomial logit regression.

The post-crisis bias is crucial in predictive power of EWS models as the independent variables behave differently in tranquil and post-fragility periods. Accordingly, rather than separating the episodes by two outcomes as crisis and tranquil as it is in binomial logistic regression, multinomial logit model underlines the probability of different crisis stages over the crisis development (Du Plessis, 2022).

Accordingly, the IBs in each country experiences three regimes as tranquil period ($Y_{i,t}$=0), the pre-crisis period ($Y_{i,t}$=1) and crisis/post-crisis period ($Y_{i,t}$=2). The pre-crisis period is a year preceding the crisis. Namely, it is twelve months before the onset of the crisis/post crisis period. Since the recovery period of a crisis devotes time, the economy of each country experiences a recovery period after the crisis periods. For this reason, crisis/post-crisis period is the crisis years following initial year of crisis where the country has experienced a crisis stage and continue to unfold[4].

Each country i=1,…n experience three periods, j+1=3 as tranquil episode (j=0), pre-crisis episode (j=1) and crisis/post-crisis episode (j=2). The probability of each country *i* at time period *t* is estimated to experience tranquil, pre- crisis and crisis/post-crisis periods can be given as:

$$\Pr\left(Y_{i,t}=0|X_{i,t}\right)=\frac{1}{1+e^{\left(X_{i,t-1}\beta^{1}\right)}+1+e^{\left(X_{i,t-1}\beta^{2}\right)}} \quad (1)$$

$$\Pr\left(Y_{i,t}=1|X_{i,t}\right)=\frac{1+e^{\left(X_{i,t-1}\beta^{1}\right)}}{1+e^{\left(X_{i,t-1}\beta^{1}\right)}+1+e^{\left(X_{i,t-1}\beta^{2}\right)}} \quad (2)$$

$$\Pr\left(Y_{i,t}=2|X_{i,t}\right)=\frac{1+e^{\left(X_{i,t-1}\beta^{2}\right)}}{1+e^{\left(X_{i,t-1}\beta^{1}\right)}+1+e^{\left(X_{i,t-1}\beta^{2}\right)}} \quad (3)$$

where $X_{i,t}$ is a vector of explanatory variables and β demonstrates the vector of coefficients. The log-likelihood ratio is maximized as:

[4] To define the crisis and post-crisis stages, Markov-switching model is applied to each of the sample country in the dataset following Bussiere and Fratzscher (2006). The stages are examined regarding BSFI as given in Eq. (1). Accordingly, if BSFI of country *i* return to its tranquil level in time *t*, then the country is stated as experiencing a crisis/post-crisis period.

$$LnL = \sum_{i=1}^{n} \sum_{j=0}^{J} lnPr(Y_{i,t} = j|X_{i,t}\beta_{j,t}) \quad (4)$$

The tranquil regime ($Y_{i,t}$=0) is set as the base outcome for the multinomial logit regression. The j=2 log-odds ratio is given as:

$$\frac{\Pr(Y_{i,t}=1)}{\Pr(Y_{i,t}=0)} = e^{(X_{i,t-1}\beta^1)} \quad (5)$$

$$\frac{\Pr(Y_{i,t}=2)}{\Pr(Y_{i,t}=0)} = e^{(X_{i,t-1}\beta^2)} \quad (6)$$

$\beta^1 and\ \beta^2$ reveals the marginal effect of $X_{i,t-1}$ on the probability of experiencing pre-crisis and crisis/post-crisis period relative to probability of experiencing tranquil period respectively.

The form of the estimated multinomial logit model, on the other hand, is:

$$Y_{i,t} = BC_{[Country\ =i,Time\ =t]} = \alpha + \beta_1 X_{i,t-1} + \beta_2 Z_{i,t-1} + \varepsilon_{i,t} \quad (7)$$

where $Y_{i,t}$ denotes the BC in country i in time t. To remedy unobserved heterogeneity among different countries, the explanatory variables are lagged by one year. While $X_{i,t-1}$ represents the vector of bank specific explanatory variables, $Z_{i,t-1}$ is the vector of macroeconomic explanatory variables. $\varepsilon_{i,t}$ is the error term.

Results

Results of the Multinomial Logit Regression Estimation

Prior to obtain the indicators of Islamic banking fragility, the final explanatory variable set is eliminated by following several steps. As the primary stage of empirical analysis, the multinomial logit model is employed for each of the explanatory variable separately to obtain only the significant variables that has ability to explain the probability of the regimes. Following the first step, the group-wise multinomial logit regression is employed with those variables that are significant in the first stage[5]. In the last stage, the final variable set is constituted with the significant indicators obtained in each step and enter to the final regression.

5 The MVs are grouped based on Laeven and Valencia (2008) categorization.

Table 1. Estimation outcomes of multinomial logit regression.

Explanatory Variables	**Pre-crisis period ($Y_{i,t}$=1)**	**Crisis/post-crisis Period ($Y_{i,t}$=2)**
Net Loans to Total Assets	0.376*** (3.46)	0.381*** (3.77)
REER	1.225*** (2.15)	-0.115** (-2.55)
M2 to GDP	0.130** (2.14)	0.134** (2.17)
GDP Growth	-0.752*** (-3.01)	-0.633*** (-2.61)
Cost to Income Ratio	0.0525 (1.50)	0.0619* (2.02)
Inflation	0.497 ** (2.21)	0. 583** (2.58)
Return on Assets	-1.507 ** (-2.41)	-1. 621** (-2.54)

*Number of Observations is 110 and Pseudo R^2 is 0.250. White's heteroscedasticity consistent standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

The results of the multinomial logit model are presented in Table 1. The first part of the table shows the probability of entering to the crisis episode of the IBs. The second part, on the other hand, indicate the likelihood of crisis and remaining in the crisis episode (post-crisis episode).

The results show that, economic growth is highly significant in both pre-crisis and crisis/post-crisis episodes of BC of IBs. Accordingly, IBs are more prone to BC if GDP growth falls one year prior to the BC. Furthermore, depressed economic growth increases the probability of remaining in the crisis/post-crisis stages. Similar to CBs, higher GDP growth make IBs less fragile to BC (Demirgüç-Kunt and Detragiache, 1998; Angkinand and Willett, 2011). As an indicator of strong and safe financial system, GDP growth decreases financial sector difficulties and by increasing the asset prices, enhancing demands for financial transactions and ensuring better credit quality. Furthermore, it is positively related with the fragility of IBs (Bashir, 2003; Srairi; 2009; Wasiuzzaman and Tarmizi, 2010; Tabash and Anagreh, 2017). More precisely, GDP growth increases the loan demands that attracts the profit and loss sharing (PLS) loans of IBs. In addition, the high profits along with economic growth triggers the demand for financial services by strengthening the cash flows and non-interest earnings and lowers the default risk on PLS loans (Bashir, 2003).

Rate of return is a crucial risk factor for IBs since it is not possible to reprice the Murabahah contracts. Following the related literature, the performance of IBs is measured by return on assets (Moin 2008; Srouji et al. 2013; Tok and Yesuf, 2022). ROA, the ratio of net income to total assets, reflects the ability of bank to generate profits per dollar of its assets. ROA is found as negatively

correlated and significant indicator of BC of IBs. The results show that decreasing ROA signals an upcoming BC for the IBs with a lead of 12 months. Furthermore, high ratio of ROA indicates high profitability of the IBs that decreases the likelihood of the IBs to remain in crisis/post-crisis period.

The ratio of M2 to GDP can be defined as "*money and quasi money that is, sum of currency outside banks, demand deposits, time, savings and foreign currency deposits in ratio to Gross Domestic Product*" (Arora, 2012, pp. 196). The ratio of M2 to GDP reflects the financial development of the economy. According to the estimation results, high ratio of M2 to GDP is statistically significant and which reflects the total volume of the financial intermediary services. Moreover, the variable is positively related with the probability of pre-crisis and crisis/post-crisis episodes of IBs. In other words, increasing M2 to GDP ratio signals the BC episode for IBs in the year preceding the crisis. Furthermore, the high level of the indicator also increases the likelihood of IBs to remain in the crisis/post-crisis stages.

With respect to the existing literature, the relationship regarding inflation rate and its impact on banking sector is ambiguous. For instance, according to Revell (1979) the effect of inflation on the profitability of the banking sector is related with the wages and other operating expenses. In this respect, the author suggest that inflation rate has an adverse relationship with the profitability of the banks if wages and other costs increase more than the inflation rate. Furthermore, Bourke (1989) identifies that inflation has positively related with the profitability of the CBs since higher levels of inflation gives rise to loan rates and raises revenues of the banks. In addition, Perry (1992) suggest that if the inflation rate can be completely foreseen, then the interest rates can be adjusted accordingly. As a result, the banks can enhance its revenues relative to operating expenses by giving rise to their profits. According to Heffernan and Fu (2010), inflation has an adverse impact on the performance of the banks since the household expenditures and firm borrowings deteriorated during the high inflation periods by rising the default rates. Regarding the IBs, on the other hand, Abduh et al. (2011) states that inflation rate has a negative influence on the consumption behaviors of the consumers thus has destructive effect on bank deposits of IBs. In the same vein, Chowdhury and Rasid (2016) finds that the inflation rate negatively affects the performance of IBs. In this vein, since IBs are more engage wit real estate transactions, inflation generates higher risk for IBs compared to CBs (Rehman and Rashid, 2022). Furthermore, inflation rate erodes the value of banks assets and increases non-performing finances. Furthermore, as Bashir (2003) reveals, the inflation rate is positively related with the profitability of IBs even if the profits of IBs is generated largely from direct investments, shareholding and other business activities as murabahah. In this study, it is found that high level of inflation has significant impact on the likelihood of BC of IBs. More precisely, increasing inflation rates signals a BC period of IBs in 12 months in advance. Moreover, high inflationary environment increases the probability of remaining in the crisis/post-crisis period of BC of IBs.

In this study, following the literature the liquidity position of the IBs is measured using loan to asset ratio (Hays et al., 2009, Ansari and Rehman, 2012). The loan to asset ratio shows the share of bank's assets that are financed with loans. As riba on loans (any predetermined return or interest that is paid on loans of money) is forbidden by the Shari'ah, the loans of the IBs represent the PLS or equity financing. As Bashir (2003) highlights, while interest received on loans are the main source of income for the CBs, the performance of loans of the IBs are highly sensitive to the economic anticipations. In other words, the banks earns more profit in the periods of economic growth since the default risk of PLS loans are lower. During the weak economic conditions, on the other hand, Islamic banking sector encounters higher default risk as more borrowers not being able to repay their debts. The higher loan to asset ratio indicates lower liquidity position of the bank. In other words, higher loan to assets ratio indicates higher default risk; thus, higher probability of BC. According to the estimation results, the ratio of net loans to total assets is significant variable of BC of IBs. The liquidity position of the IBs deteriorates in the year preceding to the crisis. Furthermore, it increases the likelihood of remaining in the crisis/post-crisis period of IBs.

The competitiveness of the economy is associated with exchange rate appreciation since it has an impact on the output growth and thus profitability of the banks. According to Al Sharif (2021), as appreciating exchange rates triggers imports by reducing the exports thus led to a decrease in domestic investment, bank deposits and facilities of IBs by reducing the ROE. In addition, IBs are more prone to exchange rate risk compared to CBs that causes higher impact on growth, profitability and stability of the banking sector (Rehman and Rashid, 2022). Furthermore, the authors investigate that high volatility in exchange rates makes countries more prone the BC as it deteriorates the financial and economic stability. According to Solarin et al. (2018), on the other hand, rising exchange rates triggers the bank deposits in the banks by positively influencing the countries' economy since it increases the productivity and competitiveness through the enhancing gains from imports and exports. The empirical results show that an increasing REER increases the probability of IBs experiencing a BC with a lead period of one year. When the results of pre-crisis episodes and crisis/post-crisis episodes are compared, the coefficients and signs of the variables vary between those periods which address the post-crisis bias (Bussiere and Fratzsche, 2006). Accordingly, the sign of REER changed in the second panel indicating that rapid fluctuations in the exchange rate increase the probability of remaining in the crisis episode for IBs.

Following the literature, the efficiency of the IBs is measured by cost to income ratio (Beck et al., 2013; Asutay and Izhar, 2007). The ratio represents the overhead cost of IBs with respect to the gross revenues. According to Beck et al. (2003), IBs has higher cost to income ratio compared to CBs which is

primarily based on its modes of finance. More precisely, since in Islamic banking equity financing is permitted rather than debt financing in lending operations with respect to the Shari'ah principles, depositors are prevented from sudden withdrawals[6]. This poses the risk of poor controlling of the borrowers by increasing the risk of assets. In addition, IBs cannot use some risk management tools as swaps to hedge their risk. Furthermore, due to their more complex structure and young age, the cost to income ratios of IBs to be higher than CBs. The estimation results show that, apart from the first panel, the cost to income ratio is found as a statistically significant and increasing value of this variable increases the likelihood of IBs remain in the crisis/post-crisis episode.

Predictive Performances

In this study, the EWS model is constructed for BC of IBs following Bussiere and Fratzscher (2006) by employing multinomial logit approach. The predictive power of the model shows the ability of the model correctly predict the tranquil, crisis and crisis/post-crisis episodes of IBs.

Table 2 presents the predictive performances of the model. Accordingly, while the tranquil periods are correctly called by 73%, the crisis episodes and crisis/post-crisis episodes are correctly predicted by 78% and 82% respectively. In this context, the type I error of the model is 19.7 and type II error is 26.6%. Therefore, the predictive performance of the model is 78%.

Table 2. Predictive Power Performance of Multinomial Logit Model.

	Correctly predicted	*Failed*	*Total*
$Y_{i,t} = 0$	11	4	15
$Y_{i,t} = 1$	36	10	46
$Y_{i,t} = 2$	41	9	50
% of correctly predicted crisis episodes			78
% of correctly predicted crisis/post-crisis episodes			82
% of correctly predicted tranquil episodes			73
% of correctly predicted observations			78

For the robustness test, binomial logistic model is estimated and predictive performances of the models are compared. In this respect, the BSFI is transformed into the binary dependent variable with two outcomes. Accordingly, the binary variable takes the value 1 in case of a BC and takes the value zero otherwise[7]. With respect to the outcomes of the binomial logit model, correctly predicted tranquil and crisis periods are 66% and 70% respectively. The total predictive ability of the binomial logit model is 68%. The outcomes demonstrate that the multinomial logit model reveals higher predictive performance compared to binomial logit model as expected.

6 Partnership that are based on PLS between two parties.

7 As well as the country is still experiencing a banking crisis.

Conclusion

This study constructs a comprehensive EWS for predicting the BC of IBs. Different from the existing country-specific efforts on IBs and EWS, the top global asset holder countries in Islamic banking are considered for the time period 2008 and 2018. In addition, this study draw attention to CDB that influence the predictive power of the EWSs. In particular, as countries are exposed to BCs for longer periods of time than currency crisis, it takes longer for countries to recover from the outcomes of the crisis (Frydl, 1999; Babecky´ et al., 2013). In addition, the behavior of the indictors is different in tranquil and crisis/post crisis periods. In other words, the value of the explanatory variables does not return to their tranquil levels after the onset of a BC. Accordingly, it takes time for the variables to reach their pre-crisis levels. For this reason, in order to eliminate the bias of the estimation results which is stem from the binomial logit regression, the tranquil and crisis episodes are separated into three outcomes as tranquil, crisis and crisis/post-crisis episodes. Therefore, present study contributes to the related literature as being the first attempt to employ multinomial logit approach in an EWS model of BCs of IBs. The analysis is conducted with three outcomes following Bussiere and Fratzscher (2006) and Caggiano et al. (2016). Particularly, the IBs in each country experiences three states as tranquil period (Yi,t=0), a pre-fragility period (Yi,t=1) and post-fragility period (Yi,t=2). The dataset consists of annual observations over a time period 2008 and 2018 that covers 92 IBs.

As expected, the estimation results show that the coefficients and marginal effects of the explanatory variables are different indicating the (CDB). According to the analysis, modelling the EWS with net loans to total assets ratio, the ratio of M2 to GDP, cost to income ratio, inflation rate, economic growth, return on assets and exchange rate allow policymakers to monitor and anticipate the BC of IBs. To be more precise, increasing net loans to total assets ratio, a high ratio of M2 to GDP and high inflation increase the likelihood of BC of IBs. On the other hand, increasing economic growth, high return on assets and a negative exchange rate deviation decrease the likelihood of BC of IBs. Additionally, higher level of cost to income ratio raises the likelihood of being in the crisis/post-crisis period for IBs. Furthermore, employing multinomial logit regression enhance the predictive ability of the model than binomial logit regression.

Last but not least, in this study, the dataset has been limited to the year 2018 due to two reasons. Firstly, due to the difficulty in accessing current and reliable Islamic banking and macroeconomic data for some countries the dataset was limited to 2018. On the other hand, the other reason is related to the effects of the COVID-19 pandemic. The global economy contracted by 3.1% in 2020 due to the impact of the COVID-19 pandemic. Furthermore, pandemic has caused labor shortages and logistical challenges that have further impacted the functioning of supply chains which led rising inflation rates in the

global scale. The size of the banks, money supply growth, banking risks are also adversely affected by the pandemic. Therefore, in order to obtain results that are not affected by the effects of the pandemic the dataset has been limited to 2018 for this study. In other words, including these periods in the study could significantly alter the results and compromise the main objective of the study to reach sound conclusions. The impact of the pandemic will be examined with different variables in another study.

References

Abduh, M., Omar, M. O. & Duasa, J. (2011), The Impact of Crisis and Macroeconomic Variables Towards Islamic Banking Deposits. *American Journal of Applied Sciences*, 8, 1413-1418.

Abduh, M. & Idrees, Y. (2013). Determinants of Islamic Banking Profitability in Malaysia. *Australian Journal of Basic and Applied Sciences*, 7, 204-210.

Alaeddin, O, Dakash, M. Al &Azrak, T. (2021). Implementing the Blockchain Technology in Islamic Financial Industry: Opportunities and Challenges. *Journal of Information Technology Management*. 13, 99-115.

Al Sharif, B. M. (2021). Impact of Real Exchange Rate and Real Interest Rate on Islamic Bank' Performance: An Empirical Study. *Indian Journal of Economics and Business*, 20, 445- 460.

Amba, M. S. & Almukharreq, F. (2013). Impact of the Financial Crisis on Profitability of the IBs vs Conventional Banks- Evidence from GCC. *International Journal of Financial Research*, 4, doi: 10.5430/ijfr.v4n3p83.

Angkinand, A. P. & Willett, T. D. (2011). Exchange Rate Regimes and BCs: The Channels of Influence Investigated. *International Journal of Finance and Economics*, 16, 256–274.

Ansari, S., & Rehman, A. (2012). Financial Performance of Islamic And Conventional Banks in Pakistan: A comparative study. In *8th international conference on Islamic economics and finance*, 11, 2017.

Anwar, S. & Hasan, M. (2018). Anns-Based Early Warning System for Indonesian IBs. *Buletin Ekonomi Moneter dan Perbankan*, 20, 326-342.

Arora, R. U. (2012). Financial Inclusion and Human Capital in Developing Asia: The Australian Connection. *Third World Quarterly*, 33, 179-199.

Asutay, M. & Izar, H. (2007). Estimating the Profitability of Islamic Banking: Evidence from Bank Muamalat Indonesia. *Review of Islamic Economics*, 11, 17-29.

Azrak, T. & Hazaa, H. (2019). The Profit/Gain from Islamic Law of Contract Perspective and The Issue of Ownership Risk (Daman al-Milkiyyah). *Journal of Islamic Finance*, 10, 111-116.

Babecký, J., Havránek, T., Matějů, J., Rusnák, M., Šmídková, K., & Vašíček, B. (2012). Leading Indicators of Crisis Incidence Evidence from Developed Countries. *Working Paper Series No 1486*, European Central Bank, Frankfurt.

Bashir, A. H. (2003). Determinants of Profitability in IBs: Some Evidence from the Middle East. *Islamic Economic Studies*, 11, 31-57.

Beck, T., Demirgüç-Kunt, A. & Merrouche, O. (2013). Islamic vs. conventional banking: Business model, efficiency and stability. *Journal of Banking & Finance*, 37, 433-447.

Bourke, P. (1989). Concentration and Other Determinants of Bank Profitability In Europe, North America And Australia. *Journal of Banking & Finance*, 13, 65-79.

Bussiere, M. & Fratzscher, M. (2006). Towards A New Early Warning System of Financial Crises. *Elsevier Journal of International Money and Finance*, 25, 953-973.

Caggiano, G., Calice, P. & Leonida, L. (2014). Early Warning Systems and Systemic BCs in Low Income Countries: A Multinomial Logit Approach. *Journal of Banking & Finance*. 27, 258-269.

Chowdhury, M.A.F. & Rasid M.E.S.M. (2016). *Determinants of Performance of IBs in GCC Countries: Dynamic GMM Approach.* Emerald Group Publishing Limited, Bingley.

Davis, E. P. & Karim, D. (2008). Comparing Early Warning Systems for BCs. *Journal of Financial Stability,* 4, 89–120, doi:10.1016/j.jfs.2007.12.004.

Demirgüç-Kunt, A. & Detragiache, E. (1998). The Determinants of BCs in Developing and Developed Countries. *IMF Staff Papers*, 45, 81–109.

Drehmann, M. & Juselius, M. (2014). Evaluating Early Warning Indicators of BCs: Satisfying Policy Requirements. *International Journal of Forecasting*, 30, 759-780.

Du Plessis, E. (2022). Multinomial Modeling Methods: Predicting Four Decades of International BCs. *Economic Systems*, doi: 10.1016/j.ecosys.2022.100979

Ekinci, R. & Poyraz, G. (2019). The Effect of Credit Risk on Financial Performance of Deposit Banks in Turkey. *Procedia Computer Science*, 158, 979–987.

Elgari, M. A. (2003). Credit Risk in Islamic Banking and Finance. *Islamic Economic Studies*, 10, 1-25.

Fakhrunnas, F., Tumewang, Y. K., & Anto, M. B. H. (2021). The Impact of Inflation on IBs' Home Financing Risk: Before and During the Covid-19 Outbreak. *Banks and Banks Systems*, 16, 78-90

Frydl, E. J (1999). The Length and Cost of BCs. IMF Working Paper, *International Monetary Fund*, New York, NY.

Grier, W. A. (2012). Credit Analysis of Financial Institutions, Euromoney Books, London.

Hardy, D.C. & Pazarbaşıoğlu, C. (1998). Leading Indicators of BCs: Was Asia Different?" IMF Staff Papers, 46, 247-258.

Hasan, M. & Dridi, J. (2011). The Effects of the Global Crisis on Islamic and Conventional Banks: A Comparative Study. *Journal of International Commerce, Economics and Policy*, 02, 163–200, doi:10.1142/s1793993311000270.

Hays, H., De Lurgio, A. & Gilbert, A. (2008). Efficiency Ratios and Community Bank Performance. *Journal of Finance and Accountancy*, 1, 1-15.

Heffernan, S. A. & Fu, X. (2010). Determinants of Financial Performance in Chinese Banking. *Applied Financial Economics*, 20, 1585-1600.

Hoggarth, G., Reis, R., & Saporta, V. (2002). Costs of Banking System Instability: Some Empirical Evidence. *Journal of Banking and Finance*, 26, 825–855, doi:10.1016/S0378-4266(01)00268-0.

Hussien, M. E., Alam, M.M., Murad, M.W., & Wahid, A.N.M. (2019). The Performance of Islamic Banks during the 2008 Global Financial Crisis: Evidence from the Gulf Cooperation Council Countries. *Journal of Islamic Accounting and Business Research, 10*(3), 407-420.

Kaminsky, G. L., & Reinhart, C. M. (1999). The Twin Crises: The Causes of Banking and Balance-Of-Payments Problems. *American Economic Review*, 89, 473–500. doi:10.1257/aer.89.3.473.

Khan, T. & Ahmed, H. (2001). Risk Management: An Analysis of Issue in Islamic Financial Industry, Occasional Papers 91, *The Islamic Research and Teaching Institute (IRTI)*, Jeddah.

Kibritçioğlu, A. (2003). Monitoring Banking Sector Fragility. *The Arab Bank Review*, 5, 51-66.

Kindleberger, C. & Aliber, R. (2005). *Manias, Panics and Crashes A History of Financial Crises*, Palgrave Macmillan, London.

Kozarevic, E., Nurikic Barakovic, M., & Nuhanovic, S. (2014). Specifics of Risk Management In Islamic Finance And Banking, With Emphasis On Bosnia And Herzegovina. *Çankırı Karatekin University Journal of The Faculty of Economics and Administrative Sciences*, 4, 151-166.

Kusuma, D. B. & Duasa, J. (2016). Building an Early Warning Towards: The Resilience of Islamic Banking In Indonesia. *Al-Iqtishad: Journal of Islamic Economics*, 9, 13-32.

Moin, M. S. (2008). Performance of Islamic Banking and Conventional banking in Pakistan. *International Journal of Innovative and Applied Finance*, 3, 419-433.

Nurfalah, I., Rusydiana, A.S., Laila, N. & Cahyono, E.F. (2018). Early Warning to BCs in the Dual Financial System in Indonesia: The Markov Switching Approach. *JKAU: Islamic Economics*, 31, pp. 133-156.

Pereira Pedro, C., Ramalho, J. J. S. & Da Silva, J. V. (2018). The Main Determinants of BCs in OECD Countries. *Review of World Economics*, 154, 203–227.

Perry, P. (1992). Do Banks Gain or Lose from Inflation?. *Journal of Retail Banking*, 14, 25-30.

Rashwan, M.H (2012). How did listed Islamic and traditional banks Perform: Pre and post 2008 financial crisis?" *Journal of Applied Finance and Banking,* 2, 149-175.

Rehman, R. & Rashid, A. (2021). Impacts of Bank-Specific and Macroeconomic Risks on Growth and Stability of Islamic and Conventional Banks: An Empirical Analysis from Pakistan. *Journal of Asian Finance, Economics and Business*, 9, doi: 10.13106/jafeb.2022.vol9.no2.0001.

ICD - Thomson Reuters Islamic Finance Development Report (2021). *Islamic Finance Development Report 2021: Advancing Economies*. Thomson Reuters.

Salim, R., Arjomandi, A. & Dakpo, K. H. (2017). Banks' Efficiency and Credit Risk Analysis Using By-Production Approach: The Case of Iranian Banks. *Applied Economics*, 49, 2974–2988.

Solarin, S. A., Hammoudeh, S. & Shahbaz, M. (2018). Influence of Economic Factors on Disaggregated Islamic Banking Deposits: Evidence with Structural Breaks in Malaysia. *Journal of International Financial Markets, Institutions, and Money*, 55, 13–28.

Srouji, A.F., M.S.Ab. Halim, Z. Lubis & Hamdella, M. (2015). Assessment of IBs Profitability Ratios-Evidence from Jordan. *International Journal of Recent Advances in Multidisciplinary Research*, 2, 887-891.

Srairi, S. A. (2009) Factors Influencing the Profitability of Conventional and Islamic Commercial Banks in GCC Countries, *Review of Islamic Economics, 13*(1), 5-30.

Tabash, M. I. & Anagreh, S. (2017). Do IBs Contribute to Growth of the Economy? Evidence from United Arab Emirates (UAE). *Banks and Bank Systems*, 12, 113–118.

Tok, E. & Yesuf, A. J. (2022). Embedding Value-Based Principles in the Culture of IBs to Enhance Their Sustainability, Resilience, and Social Impact. *Sustainability*, 14, doi: 10.3390/su14020916.

Uddin, A., Chowdhury, M.A.F., & Islam, M. N. (2019). Resiliency Between Islamic and Conventional Banks In Bangladesh: Dynamic GMM and Quantile Regression Approaches. *Journal of Islamic Accounting and Business Research*, *10*(4), 657-676.

Von Hagen, J. & Ho, T. K. (2007). Money Market Pressure and The Determinants of BCs. *Journal of Money, Credit and Banking*, 39, 1037–1066.