Hacettepe University Graduate School of Social Sciences

Department of Economics

CONSTRUCTING FRAGILITY INDICES FOR ISLAMIC BANKS: DEFINITION IMPACT ON THE PREDICTIVE POWER OF AN EARLY WARNING SYSTEM

Ayşegül AYTAÇ EMİN

Ph. D. Dissertation

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ABSTRACT

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This study examines the Early Warning Systems (EWSs) based on banking sector fragility indices (BSFIs) for Islamic banks. To this aim, we construct various BSFIs for Islamic banks and detect EWS models which will produce substantial predictive power results for Islamic banking crises utilizing data from 81 banks in 12 countries over a recent time period 2008-2018. We provide solid BSFI definitions for Islamic banks by discovering the significant risk factors and their proxies to improve the predictive performance of the EWS models. We examine the impact of BSFI definitions on the predictive power of EWS models through constructing various indices. The definitions of BSFIs differ both in terms the risk factors that Islamic banks are exposed to and, the proxies to measure those risk factors. Our results suggest that different BSFI definitions identify different indicators of Islamic banking crises. The predictive power of an Early Warning System (EWS) for Islamic banks is highly sensitive to the definition of BSFIs.

Keywords

Early Warning Systems, Banking Crises, Islamic Banking, Banking Fragility

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INTRODUCTION

The role of the banks has become increasingly crucial and critical in the modern economic world. Banks carry out tasks as providing financial intermediation services offering various assets and liabilities with different features; creating different incentives for the efficient use of the resources and; providing different financial services as fund management, insurance and payment services. In this respect, the conventional banks and Islamic banks share the same objectives and financial functions. However, they perform their functions in different manners. The main differences between conventional and Islamic banking systems emerge on the methods of funding and the basic principles. While conventional banks perform their functions (such as lending and borrowing) based on interest on their assets and liabilities, Islamic banks are shaped in line with the main principles of *Shari'ah* (Islamic law). In this respect, Islamic banks fulfill their entire financial functions with respect to the prohibition of interest principle and they operate on the basis of profit and loss sharing (PLS).

In the Islamic banking system, receiving and giving any pre-determined or guaranteed income is forbidden and thus the debt is not used as a source of funding. Alternatively, equity financing is preferred over debt financing in lending transactions. Correspondingly, Islamic banks collect and distribute funds on the basis of profit and loss sharing (PLS) principle and provide funds with trade, partnership and leasing contracts as *Murabahah*, *Ijarah*, *Salam*, *Istisna'*, *Musharakah* and *Mudarabah*. Furthermore, in the conventional banking system, the risks are undertaken only by the entrepreneur and banks do not have any role in terms of how loans are invested. Regardless of whether the entrepreneur makes a profit or a loss, the bank continues to receive a pre-determined fixed return. In Islamic banking, however, the risk is shared fairly between the parties. This implies that, both parties of a financial transaction i.e. the entrepreneur and the financial capital provider are involved in the risk. Despite their differences on the form of financial intermediation, instruments and structure of the financial statements, conventional banks and Islamic banks share similar objectives, financial functions, procedures and, analytical framework for controlling and measuring their risk exposures (van Greuning and Iqbal, 2007).

In the context of the development process of Islamic banks, it is obvious that the Islamic financial system has become one of the fastest growing sectors of the global financial industry, where its modern history dates back to the 1960s. Islamic financial system includes Islamic banking, Islamic insurance, Islamic capital markets and other Islamic financial institutions (OIFIs). Following the rapid growth of Islamic finance industry, Islamic financial products are offered by the various banks across the world. The total Islamic finance assets grew by a compound annual growth rate (CAGR) of 6% by 2012 and reached US$ 2.88 billion in assets in 2019. On this basis, Islamic banking becomes the largest component of the Islamic finance sector. The Islamic banking assets accounted for US$ 1.760 billion in 2018 with a 5% CAGR between the years 2012 and 2018. The share of Islamic banking assets is 6% of the total global banking assets in 2018. Moreover, there are more than 80 countries and 526 Islamic banks across the world offering Islamic finance services (Standard, 2019).

Besides the rapid growth of the Islamic banking particularly in recent years, the global financial crisis in 2008 brought the conventional banking system into question and accelerated the attention towards the Islamic banking. The 2008 financial crisis, which is accepted as the second most serious breakdown since the Great Depression, is originated from U.S and turn into a global recession by causing destructive outcomes. As a result of the crisis, while a number of banks exited from the market, the survived banks lowered their lending where the borrowers' ability to repay debts weakened. The imbalances in banks' balance sheets, forced banks to cut loans further. Loss of intermediation services in banks and decreasing credit volumes had a wide-ranging impact on economies.

The global breakdown of 2008 triggered the efforts to examine the impact of the crisis on Islamic banks as well. In this context, there are three different views in the literature regarding the performance of the conventional and Islamic banks during the global crisis. According to the first view, there is no significant difference between Islamic banks and conventional banks in terms of the impact of the financial crises on banking soundness and profitability, since Islamic banks mimic the commercial strategies of conventional banks and diverge from the theoretical business models of Islamic banking (Sehrish et al., 2012; Bourkhis and Nabi, 2013). Second view claims that Islamic banks perform

better than conventional banks in terms of stability, efficiency, return and asset quality (Ansari and Rehman, 2011; Zehri et al., 2012). For example, during the crisis period, financing growth of the Islamic banks were higher than the lending growth of the conventional banks. With respect to the third view, although Islamic banks do not seem to be affected by the negative impacts of the crisis, this was limited with the first year of the crisis first. From 2009, with the spread of the crisis to the developed and developing countries and due to the intense pressure of the crisis on the real economy and the weak risk management; the profitability of the Islamic banks was affected more severely compared to conventional banks (Hasan and Dridi, 2011; Hidayat and Abduh, 2012).

Based on the related research, Islamic banks cannot be seen as completely safe against the negative impacts of possible financial crises regardless of where the crises emerge from. Considering the fact that they carry the similar risk factors and financial functions as conventional banks, Islamic banks can also be affected negatively from financial distress periods and experience banking crises. While contagious crises in financial system are accepted as a natural element in the modern global economic environment, detecting the weaknesses and vulnerabilities and taking early precautions against any upcoming crisis become a necessity for the Islamic banking system as well. At this point, Early Warning Systems (EWS) are used in order to anticipate whether and when the system and countries may experience a financial crisis. Researchers and policymakers attempt to construct Early Warning Systems in order to predict the potential future crises and their early indicators. EWSs are significant tools in monitoring the crisis risk by providing an opportunity to prevent the crisis or take precautions to minimize the loss in situations where it is not possible to prevent the crisis. That is, the main purpose of an EWS model is to provide early signals about the weaknesses and fragilities within the financial system that may pose a crisis risk for an economy. These models give an opportunity to detect possible future crises by offering the relevant crisis indicators, revealing specific predictive power rates indicating how correctly the models predict the crisis and non-crisis episodes.

The technical specifications to build EWS models depend on the common criteria such as; definition of the crisis event, the set of explanatory variables, estimation methodology

and country and time coverage. The crisis definition is the dependent variable of an EWS model, where identification of significant early warning indicators and measuring the predictive power rates directly depend on this definition. In the existing literature, there is no consensus for the definition of banking crisis however it is possible to categorize the banking crises definitions under two approaches as event-based and index-based definitions. The event-based approach accepts the combination of events as solvency, bank runs, bankruptcy, high level of nonperforming loans (NPL), bank holidays, large-scale nationalizations, deposit freezes, closures, merges and rescue operations as banking crisis (Caprio and Klingebiel, 1997; Demirgüç-Kunt and Detragiache, 1998). In index-based approach, on the other hand, the banking crisis is defined via a banking sector fragility index (BSFI) constructed upon various economic and financial variables.

Due to the data concerns and the complication of designing a BSFI, the event-based approach is widely used in the empirical studies of EWS (Lindgren et al., 1996; Kaminsky,1998; Demirgüç-Kunt and Detragiache, 1998). However, as Von Hagen and Ho (2007) explain the event-based approach incur several problems in successfully determining the timing of the banking crisis since the cost of the rescue operation is observable only after the banking crisis has occurred and spread into the economy (Caprio and Klingebiel, 1996). Further, the event-based approach determines the banking crisis only when the impact on the market events is felt seriously (Van Hagen and Ho, 2007). Due to these deficiencies of the event-based approach, the attempts towards constructing BSFIs in defining banking crises have accelerated recently in the related literature on EWS both for conventional and Islamic banking systems.

Motivated by the above-mentioned facts and the literature, this thesis focuses on the EWS models based on banking sector fragility indices for Islamic banks relying on index-based definitions. To this aim we construct various BSFIs for Islamic banks and detect EWS models which will produce substantial predictive power results for banking crises of Islamic banks for 81 banks from 12 countries over a recent time period 2008-2018. While the predictive power rates of the models and significant indicators of the crises are expected to differ from model to model, this study tries to provide solid BSFI definitions for Islamic banks by discovering the significant risk factors and their proxies to improve

the predictive power of the EWS models. To examine the impact of BSFI definitions on the predictive power of EWS models for Islamic banking, we develop twenty-five different indices. BSFIs are defined as the average standardized values of the main risk factors of Islamic banks i.e. the credit risk, liquidity risk, market risk and profitability risk. The BSFIs differ both in terms the risk factors incorporated and the proxies to measure these risk factors. On this basis, the liquidity risk is proxied by bank deposits. For the credit risk, domestic credits to private sector and non-performing loans are considered. Market risk is measured by using banks' real foreign liabilities and time interest earned ratio proxies. Furthermore, apart from the existing literature, we include profitability as a new risk factor into some of our crisis definitions which we measure by return on equity ratio.

In this thesis, our ultimate aim is to develop EWS models for Islamic banks through investigating how different BSFI definitions impact the predictive power performances of EWS for Islamic banks. In particular, in order to make robust analyses of whether the credit, market, liquidity and profitability risk factors play significant roles on the predictive power of the EWS models, we alternately include and exclude these risk factors in alternating indices. Based on these definitions, we develop twenty-five different EWS models in total where the models differ in those definitions. Moreover, we examine the indicators of banking crises of Islamic banks by showing how different BSFI definitions change the significance of these indicators. The analyzes of all of the EWS models are conducted with the same methodology, explanatory variable set, country coverage and time period.

Our contribution to the related literature on EWS models and Islamic banks is manifold. Although there is a wide range of studies to identify banking crises with EWS models these studies mostly consider conventional banks. The limited number of studies particularly investigating Islamic banks and EWS, on the other hand, focus on the identification and comparison of the signaling indicators and their estimation methodology fail to consider the construction of an explicit crisis definition (see Al-Huneiti and Al-Ghani 2016; Kusuma and Duasa 2016; Anwar and Ali 2018). Furthermore, the existing literature on Islamic banking and EWSs are designed and

carried out as country specific studies. Hence, this study contributes to the related literature in immensely many ways by closing various gaps. First of all, we establish of a comprehensive early warning system for Islamic banking system covering all the leading countries in terms of Islamic banking assets. Relatedly, one part of our results reveals significant determinants of the crises that Islamic banks may experience, where we examine a wide range of bank-specific and macroeconomic explanatory variables rather than focusing only single type of variables as opposed to the existing literature. Therefore, we contribute to the literature by detecting the significant indicators of Islamic banking crises by figuring out how these indicators can vary with respect to the definition of crisis event. Next, apart from the existing studies, we investigate the predictive power of EWS models for Islamic banks through various banking sector fragility indices discovering a new and important element impacting on the performance of EWS. To the best of our knowledge, no prior related study has investigated the impact of BSFI variations on the predictive power of EWS models for Islamic banking. Last but not least, different from the existing literature we incorporate profitability risk as an additional risk factor for Islamic banks and explore whether it has a significant impact on the predictive power of EWS models.

This thesis is organized as follows: Chapter 2 explains the banking crises where the concept, theoretical background and experiences of banking crises is provided. Chapter 3 illuminates the essential steps to construct an EWS model and presents the background literature. In this chapter, further, the Islamic financial system is introduced by explaining the fundamental principles of Islamic finance and the main risk factors in Islamic banking. Chapter 4 presents data and methodology employed, providing detailed information on the BSFIs as well. In Chapter 5 the empirical results on the significant indicators of Islamic banking crises, BSFI construction and predictive power performances of related EWS models are presented. The last chapter concludes.

CHAPTER 1

BANKING CRISES

Banks are considered as the most fundamental and essential financial institutions of the economy. To be able to identify the banking crises, it is important to explain the role and functions of the banks. A conventional banking system carries out the following basic tasks as; providing financial intermediation services such as diverting funds from ultimate savers to ultimate borrowers; providing other financial services such as payment services, insurance and fund management; offering various assets and liabilities with divergent maturity, type of return generated and risk sharing aspects and; creating different incentives for the efficient use of the resources (Iqbal and Molyneux, 2004). Similar to the conventional finance system, Islamic banks provide the same role and financial functions. The main differences between the conventional and Islamic banks emerge in the context of accomplishing these functions and financial instruments where Islamic banks perform those functions in accordance with the Islamic rules. Islamic banking is a system that is shaped in line with the basic principles of *Shari'ah* (Islamic law) and consists of financial transactions and services in accordance with its rules and principles. On this basis, the most distinguishing features of Islamic banks are the *prohibition of interest* and the *principle of profit and loss sharing* (PLS). For instance, while conventional banks offer the financial intermediation opportunities to customers in return for interest rate, Islamic banks collect and distribute funds on the basis of profit and loss sharing (PLS) where they provide funds with methods such as trade, partnership and leasing.[1] They perform their financial obligations by keeping their liquidity and profitability at optimum levels and adopting a risk management to maintain the safety of the bank. In this regard, both Islamic banks and conventional banks face various risk factors as credit risk, liquidity risk and market risk (Van Greuning and Iqbal, 2007). Although the operation methods and principles are different, both conventional and Islamic banks serve similar purposes and share similar risk factors. Since banks are inherently fragile, the problem of an individual bank can spread and affect the entire

[1] The main funding methods of Islamic banking are *Murabahah, Ijarah, Salam, Istisna', Musharakah* and *Mudarabah*. See Section 3.5 for detailed explanations on this context.

banking system (Claessens and Kose, 2013). Therefore, as a part of the banking sector, Islamic banks cannot be completely isolated from a possible financial crisis and are affected by its negative consequences.

The reasons behind the banking crises have been a subject of research for a long time. Although each crisis is emerged in different forms, they share some common elements (Claessens and Kose, 2013). In this regard, the causes of the banking crises are mainly associated with the bank runs or panics, poorly managed regulatory reforms and financial liberalization processes, as well as macroeconomic imbalances, asset price bubbles, credit booms, institutional weaknesses or factors such as sudden runs or contagion.

1.1. FIRST GROUP OF BANKING CRISES THEORIES

In this regard, different theories are developed in attempt to explain the banking crisis. According to early theories explaining banking crises, bank runs and depositor panic caused by the sudden withdrawal of deposits are the main causes of the crisis (Friedman and Schwartz, 1963). When the expectations of the people against the banks or the general economic situation in the country get into a negative atmosphere, the attack on the banks begins and people start to withdraw their money from the banks. Banks are in trouble of liquidity in such panic environment and cannot fulfill their most important task of lending.

These situations force banks to liquidate their assets in exchange for large losses. Severe liquidity pressures force the banks to dispose of their assets at low prices. These sudden changes in the assets and liabilities of banks cause the bank's capital to change, thus the fragility of banks increases (Goldstein and Turner, 1996). Moreover, depositors may worry that others will withdraw their deposits as well. In addition, the situation could turn into a threat not only for the bank under pressure, but for the entire financial system that is interconnected. In this environment, a bank run can cause widespread loss of trust in other banks that lead to the spread of the massive withdrawals to the entire banking system. In this case, bankruptcies are inevitable as there is a lack of liquidity in banks. Bank runs are also affected by the economic instabilities. The worsening economic situations and negative expectations also cause sudden deposit withdrawals by leading

severe liquidity pressure and bankruptcy of banks (Diamond and Dybvig, 1983). Furthermore, it causes huge economic losses as decrease in the money supply and therefore in economic activity.

Bank attacks and panics occurred in various economies throughout the history. For instance, in the 1800s and during the Great Depression, bank runs were frequent in the United States. Friedman and Schwartz (2017) emphasize that one of the most important element in the transformation of a serious recession into the Great Depression of the 1930s was the bank runs.

In addition, Radalet and Sachs (1998) argue that panics are the essential factor of the Asian crisis. For instance, in 1997 and 1998, the bank runs and panics worsened the situation when there was already a crisis environment and the countries experienced the worst banking crisis in its history (Simorangkir, 2012). During the crisis in Argentina in 1989, monthly deposit withdrawals reached 26% in a single month (Laeven andValencia, 2008). However, bank runs have been rare since the introduction of deposit insurance for banking transactions (Claessens and Kose, 2013; Laeven and Valencia, 2018). Deposit insurance was created as a solution to bank runs and their spillover effect. The purpose of the insurance is to ensure trust and stability in the banking system and in cases where banks go bankrupt for any reason, it provides the depositors with the assurance that their funds will be protected within the limit and prevent bank runs.

The deposit insurance was first applied by the US in 1934 in response to the Great Depression. Accordingly, it has become an increasingly used tool by governments to stabilize banking systems and protect bank depositors from incurring major losses due to bank runs and failures. Although deposit insurance is widely used among policy makers, it is discussed by many economists who point to the relevant moral hazard issues (Demirgüç-Kunt and Kane, 2002). Moral risk takes place since deposit insurance reduces the sensitivity of both depositors and banks to risk and thus the general risk level in the market increases. In other words, deposit insurance encourages excessive risk taking, as it reduces the motivation of the depositors to monitor banks. Therefore, banks provide high interest rates in order to attract the depositors and obtain money to pay these high

interest rates by allowing high-risk loans in return. In this way, both banks and depositors are subject to imprudent banking practices, but can assure them knowing that their deposit insurance protects their principal if high-risk loans are not paid. Thus, moral hazard is included within the scope of the subject. In such environment, those who take out deposit insurance to protect themselves from the negative consequences of the risks may be encouraged to take greater risks (Demirgüç-Kunt and Kane, 2002, p. 176). Therefore, while deposit insurance aims to protect banks against bank panics and attacks, it also carries the risk of causing banking crisis risks (Demirgüç-Kunt and Detragiache, 2002).

1.2. SECOND GROUP OF BANKING CRISES THEORIES

The second group of theories suggests that the banking crises arise from the deterioration of the asset structure of banks rather than the bank runs. For instance, as Laeven (2011) explains, while the economy is booming, the investors become more optimistic about the future. Accordingly, the credit increases dramatically with easing banks' credit standards. On the other hand, the slowdown in economic conditions causes a decrease in credit. This cyclicality of the financial system causes fragility which make the system vulnerable to crises (Laeven, 2011). According to Minsky (1982) and Gorton (1988) the bank losses arise from worsening of the asset quality of banks which is due to macroeconomic instabilities, government intervention practices with poorly managed regulatory reforms and financial liberalization processes as well as fraud or corruption.

Government interventions such as poorly managed financial liberalization processes and weak regulatory policies have an important role in the banking crisis occurrence. For instance, as Bhattacharya and Thakor (1988), Hovakimian et al. (2003) and Laeven (2011) explain, government may intervein the banking sector by providing deposit insurance. In this context, the underpriced deposit insurance encourages banks to have excessive risk which cause moral hazard problem and bank failures. The institutional factors as management, insufficient infrastructure, poor banking supervision asymmetric information and moral hazard problems have also significant role in banking sector problems. While the regulations in banking activities made as the management of the banking system prevent banks from taking risks, inadequate regulation and unsuccessful

management can lead banks to bankruptcy. The efficiency of financial markets is conditioned on the fact that the actors in the market have the same knowledge about the functioning of the market. On the other hand, asymmetric information occurs when the information held by the parties in a financial contract is different. Related to this, the borrower has an advantage over the lender since it has more information than the lender about the investment projects they want to undertake. In this case, the lender faces an uncertainty about the credibility of the borrower. According to Mishkin (1999), due to such asymmetric information, crises emerges where the flow of information in financial markets is disrupted leading the financial markets cannot fulfill their duties (Mishkin, 1999a). That is, financial markets cannot effectively channel funds into the most efficient investment opportunities. As a result, there is a decrease in investments and a contraction in economic activities.

One of the most important reasons of the banking crises in the early 1980s to the 1990s are that countries made a series of reforms in order to liberalize their financial systems. Financial liberalization is generally defined as the process of reformation of the legal regulations on the banking system and open up the economies to international capital flows in order to attract the international financial activities of developed countries. Examples of these reforms are the liberalization of interest rates, eliminating the reserve requirements that banks have to keep and removing the restrictions on bank lending. With these reforms, high amounts of capital flows poured from developed countries to developing countries. Accordingly, with the free interest rates, private savings in the economy have increased. The increase in financial assets led to a decrease in the liquidity needs which triggers investments and economic growth. However, the emerging credit booms and weaknesses in the macroeconomic and banking system, made banks become overly indebted to international markets and crises have become inevitable.

In addition to the financial liberalization, the causes of the banking crises can also be affected by the macroeconomic, institutional weaknesses or factors such as sudden runs or contagion. In this context, the macroeconomic factors behind the banking crises have been frequently studied in the literature and, macroeconomic instability is shown as a significant cause of banking crises. For instance, Demirgüç-Kunt and Detragiache (1998)

find a significant relationship between low GDP growth and the emergence of banking crises. In low growth environment, the profitability and balance sheets of both firms and banks deteriorate due to the increase in the non-performing loan ratio where the banking sector become vulnerable to the banking crisis. According to Kaminsky and Reinhart (1996), due to the change in international interest rates and the depreciation of the exchange rate, domestic interest rates can increase by affecting the borrowing costs of firms and banks. This causes problems in the payment of debts and may result in a banking crisis. Furthermore, the exchange rate volatility causes a mismatch between the assets and liabilities of banks. Claessens et al. (2010) draw attention to the relationship between the capital inflows and the credit expansion. The authors explain that the large amount capital inflows to domestic financial markets affects the loosening of credit restrictions for corporations and households. As a result, a rapid credit expansion is emerged and real estate and asset prices rise dramatically by increasing the fragility of the banking sector. Reinhart and Rogoff (2009) explain that increasing asset prices, stock and housing markets, low GDP per capita, large current account deficit and increasing government debt are significant and common indicators of the crises. The authors examine that there was usually a large increase in equity and housing prices before the crises occurred.

1.3. THIRD GROUP OF BANKING CRISES THEORIES

Recent banking crisis theories, recognize banking crises as a result of the asset price bubbles associated with the rapid expansion of credit (credit boom). In general terms, asset price bubbles can be defined as the "pronounced increases in asset prices that depart from fundamental values and eventually crash resoundingly" (Mishkin, 2008, p. 66). According to this view, before the crisis begin, an excessive rise in the equity and house prices is observed which usually falls one year after the crisis occurred (Reinhart and Rogoff, 2009). Excessive expansionary monetary and fiscal policies cause excessive borrowing and debt stock, rise in stock and bond prices, and excessive investment in real financial assets which lead to the deterioration of the banks' asset quality by increasing nonperforming loans (Laeven, 2011). The most recent example of this experience is the 2008 global financial crisis. The crisis first started with the collapse of US housing market

by affecting the financial sector and then spread to the real sector through derivative products. In early 2000s, the US Federal Reserve had engaged a significant monetary expansion by lowering the interest rates considerably to solve the liquidity problem and stimulate the economy. The interest reductions caused the use of housing loans to increase rapidly, which triggered an overvaluation of real estate prices. During this processes, lending standards of banks decreased and high amount of subprime mortgage was issued which caused rapid increase in the subprime mortgage industry by taking a significant share in the Us mortgage market (Dell'Ariccia et al. , 2012). This lead overheated asset prices and credit booms. Furthermore, banks also arranged derivative financial instruments based on these loans and released them to the market. Derivative products enable mortgage lenders to transfer the default risk to third parties, such as hedge funds.[2] In 2007, the total size of the housing loans used in the USA and derivative products linked to these loans reached 10 trillion dollars and formed the world's largest loan market (Göçer, 2012). However, credit institutions took much greater risks and the derivatives market grew enormously with these new loans. The value of derivative instruments exceeded the house value that linked to loans depreciated and the depreciation increased exponentially due to leveraged transactions. The size of the loans and structured financial products was so high that the equity of financial institutions was insufficient to meet the depreciation. Furthermore, the rapid decline in real estate prices and increasing interest rates eliminated the chance of borrowers to pay their loans to banks by selling houses, and made it impossible for banks to recover their loans by selling the houses they had foreclosed. Finally, the bubble was created by high real estate prices and the mortgage market burst. The defaults on mortgage loans created a significant impact to the financial system which caused large losses to financial institutions by deteriorating their balance sheets. In addition, since the net worth of banks decreased and their ability to provide financing to the private sector weakened, credit spreads increased sharply which led disruption of economic growth, depressing asset prices and worsened the net worth of banks (Akinci and Queralto, 2016). Moreover, the decreasing lending also affected the major macroeconomic activities as investment, employment and consumption. With the

[2] Hedge fund is an investment tool specially offered by creating a pool of investors' contributions to invest in a wide range of assets such as securities, derivatives, bonds, foreign currencies (Carey et al., 2013). It is established and managed privately and can follow various active investment strategies to generate positive absolute returns.

collapse of US financial markets, shock waves were sent to international banking markets and the crisis also spread to other countries causing destructive outcomes all over the World. Therefore, the 2008 global crisis show the impact of asset bubbles and credit booms on financial system of the countries.

1.4. EXPERIENCES OF BANKING CRISES

With increasing interaction and integration between the financial markets, a broad range of developed and developing countries has experienced banking crises especially after the 1900s. In the most general sense, banking crises can be defined as "occurrence of severely impaired ability of banks to perform their intermediary role" (Davis and Karim, 2008, p. 90). As Lindgren et al. (1996) investigates between 1980 and 1996, more than 130 IMF countries out of 180 were exposed to significant banking sector problems and crises that led destructive consequences with huge amount of costs. Furthermore, Caprio and Klingebiel (1997), determine 112 banking crises in 93 countries and 51 borderline crises in 46 countries between 1970s and 1990s.

Table 1: Selected Banking Crises: Non-Performing Loans, Bank Credit and Fiscal and Quasi Fiscal Cost (%)[3]

Country	Year	Non-performing Loans (% of total loans)	Bank credit (% of GDP)	Fiscal and quasi fiscal cost (% of GDP)
Finland	1991-1993	9	89.9	11
Japan	1992-1998	13	119.5	8
Norway	1988-1992	9	61.2	8
Spain	1977-1985	n.a	68.1	16.8
Sweden	1991	11	50.8	4
US	1984-1991	4	128.5	3.2
Argentina	1980-1982, 1995	9, n.a	29.8, 19.7	55.3, 1.6
Brazil	1994-1996	15	31.7	5-10
Chile	1981-1983	19	58.8	41.2
Colombia	1982-1987	25	14.7	5
Indonesia	1994, 1997	n.a, 65-75	51.9, 60.8	1.8, 50-55
Malaysia	1985-1988	33	64.5	4.7
Mexico	1994-1995	11	31	20
Sri Lanka	1989-1993	35	21.3	5
Thailand	1983-1987, 1997	15, 46	44.5, 118.8	15, 42.3
Turkey	1997, 2001	n.a	14.2, n.a	1.1, n.a

n.a: Not available

[3] Hoggarth et al., 2002.

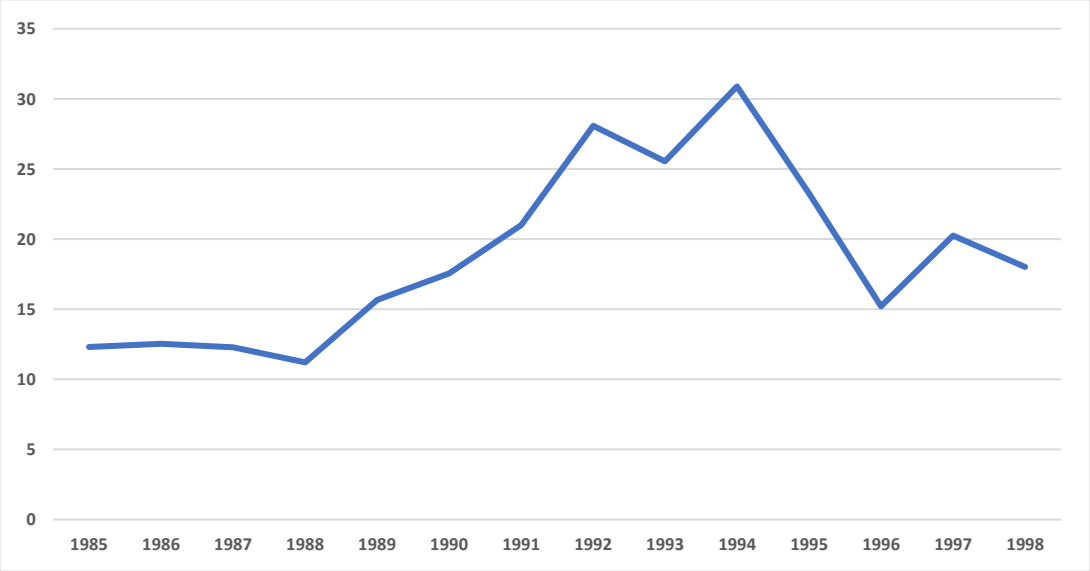
As one can see from Table 1, particularly developing countries are faced with banking crises in the post-1980 period. The average fiscal cost as a percentage of GDP of these banking crises is approximately 16%. However, for Argentina and Chile it was 55.3% and 41.2% respectively. In addition, the average rate of the non-performing loans as a percentage of total loans were 22.4% where the ratio is greater than 20% in Columbia, Indonesia, Malaysia and Thailand (Hoggarth et al., 2002).

The crises in question are mostly associated with international financial shocks, mismanagement of the exchange rate, financial irregularity, financial liberalization and the weakness of the national banking system (Sachs, 1995). For instance, after 1980s most of the banks in the Nordic countries such as Norway, Sweden and Finland, experienced major banking sector problems that are mainly triggered by the deregulation of the financial systems. With the financial deregulation and strongly expansionary macroeconomic momentum in these countries, the domestic financial markets are liberalized by removing the cross-border restrictions. This led large capital inflows to the countries by causing uncontrolled credit expansions and thus, end up with financial fragility, weak balance sheets and deteriorated financial performance with low asset quality and interest margin and, bank loan losses. The bank loan losses were 3.4% for Finland, 2.7% for Norway and 4.8% for Sweden between 1990 and 1993 (Drees and Pazarbasioglu, 1998; Honkapohja, 2011).

Latin American countries such as Mexico, Venezuela, Argentina and Paraguay, faced half more crises between 1970 and 1995 than East Asia or Europe and the Middle East countries. The main causes of those crises emerged from the macroeconomic imbalances, incomplete financial liberalization and inadequate bank supervision (García-Herrero, 1997). In this context, one of the leading crises experienced in Latin American countries was the 1994-1995 Mexican tequila crisis. Mexico entered the process of economic recovery and financial reform in the mid-1980s and experienced significant changes in its banking system. In this regard, the controls on interest rates and maturities on bank instruments and deposits were removed, reserve requirements were eliminated, the required reserves on bank deposits were replaced by a 30 percent liquidity ratio where bank lending to private sector restrictions were removed (Loser and Kalter, 1992, p. 10).

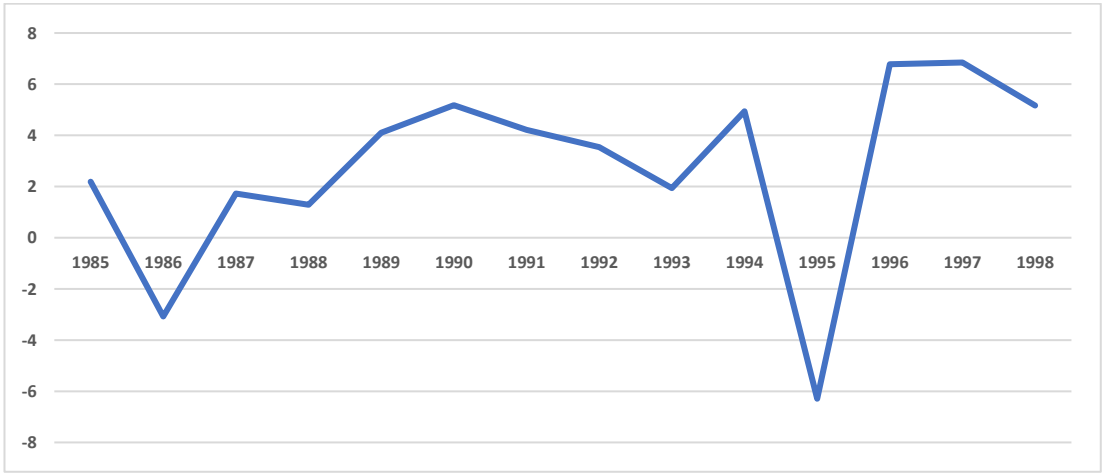
Following this, after the "lost decade" of low growth and high inflation in the 1980s, during the liberalization of the financial system between 1987 and 1994, huge amount of capital inflows poured into the country where the Mexican economy grew by 4 percent and inflation fell considerably. However, these capital inflows represented euphoria and a herd instinct (Singh, 1997, p. 778). In other words, the capital inflows adversely affected the investments and triggered the consumption by decreasing the amount of the private savings. The main problem in Mexico was the credit expansion of the banking system. While the debt of the domestic banks to international banks was $8 billion in 1991, it was doubled in 1994 and reached to $16.5 billion (Graf, 1994). Furthermore, domestic credit to private sector by banks also doubled in 1994 compared to 1987 (see Figure 1). The crisis in Mexico spread to other Latin American countries due to the distrust that prevailed in the region and caused significant drops in the stock markets of the countries in the region such as Venezuela, Argentina and Paraguay (Güloğlu and Altunoğlu, 2011).

Figure 1: Domestic Credit to Private Sector by Banks (% GDP), Mexico, 1985-1998[4]



[4] Depicted by the author using World Development Indicators, World Bank.

Figure 2: GDP Growth (Annual %), Mexico, 1985-1998[5]



Regarding the Asian crisis, Berg (1999) suggests that the main factors behind were macroeconomic weaknesses and, domestic and external financial vulnerabilities. For instance, Thailand was already experiencing macroeconomic imbalances in the pre-crisis period. The country had large current account deficit and high inflation rates. In addition, the tightening monetary and fiscal policies poured large capital inflows into the country causing a credit expansion. The combination of the weaknesses in the macroeconomic environment and financial system made the country more prone to domestic and external vulnerabilities. In the pegged exchange tare system, with the appreciation of the dollar in 1996 the country currency-Baht was also appreciated leading export slow down and increase in current account deficit. The value of the stock market dropped dramatically and asset quality of banks deteriorated. With the increasing interest rates, the percentage of non-performing loans as a percentage of total loans increased considerably. As a policy response, the government devaluated the currency by 20-30% and allowed the exchange rate to float. The crisis that emerged in Thailand, also spread to other Asian countries in a short period of time. For example, although the macroeconomic performance of the Malaysian economy and the financial system were stronger than Thailand, Malaysia Ringgit exposed to a significant pressure due to the devaluation of the Baht. The devaluation in Thailand increased the pressure on Rupiah and led Indonesia more vulnerable to capital outflows as well (Berg, 1999).

[5] Depicted by the author using World Development Indicators, World Bank.

Figure 3: GDP Growth (Annual %)[6]

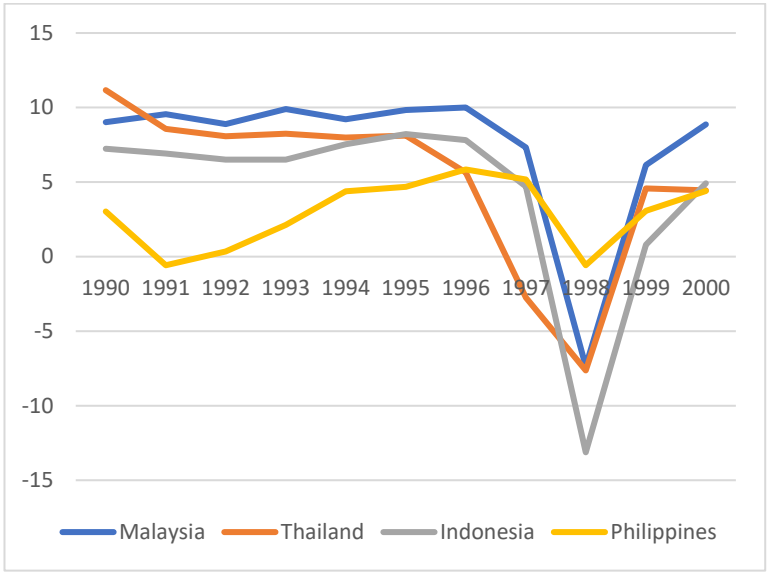


Figure 4: Domestic Credit to Private Sector by Banks[7]

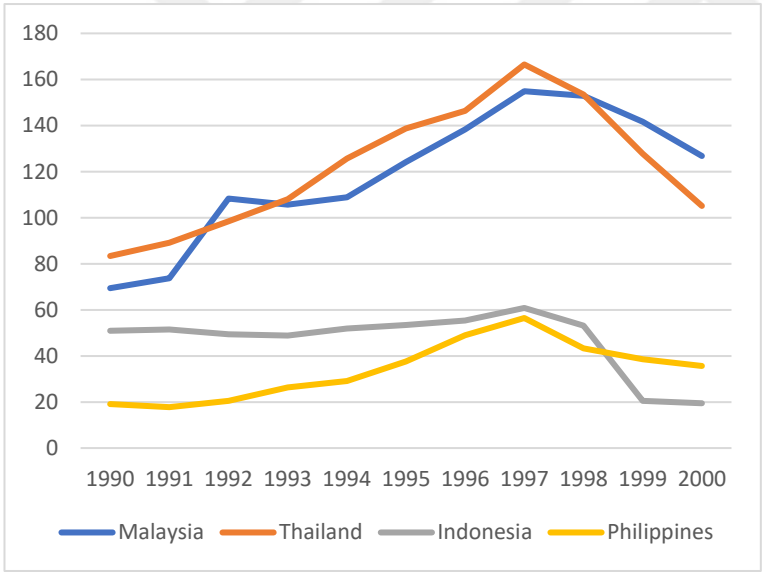
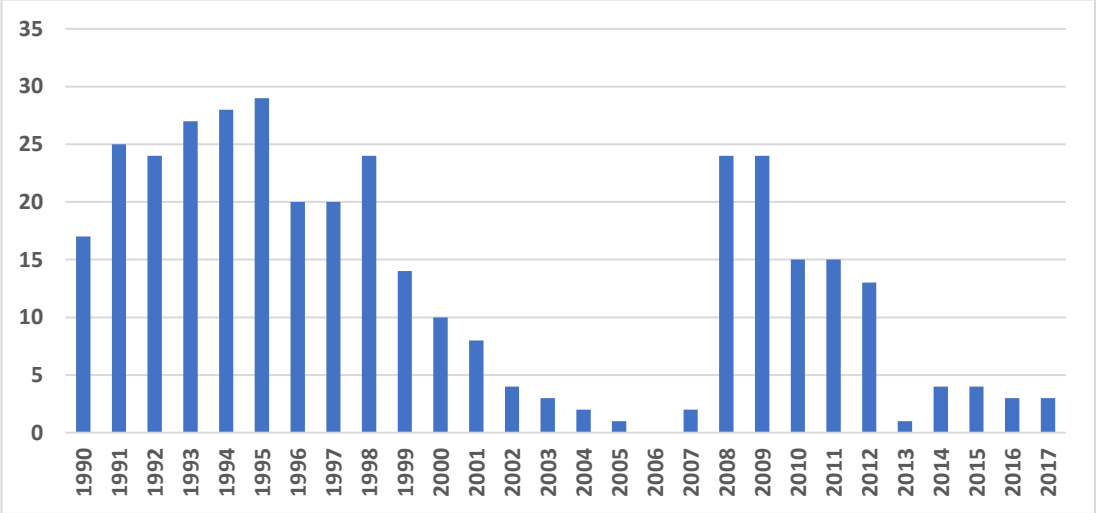


Figure 5 presents the total number of banking crises experienced between 1990 and 2017 in the World. During the investigated period, 364 banking crises was experienced in various countries which caused destructive consequences on their economic, cultural, political and social structure as well as major and expensive overhaul of the banking

6 Depicted by the author using World Development Indicators, World Bank.
7 Depicted by the author using World Development Indicators, World Bank.

systems. For instance, while Hoggarth et al. (2002) points out output losses range between 15 percent and 20 percent of annual GDP during those banking crises while Laeven and Valencia (2010) find that they are approximately 37 percent with a persistent impact on asset prices, unemployment (Reinhart and Rogoff, 2009).

Figure 5: Number of Banking Crises, 1990-2017[8]



According to Laeven and Valencia (2018) net fiscal costs to resolve and restructure the financial sector can be costly. The authors show that while net resolution costs for banking crises for the emerging economies are 10% of GDP, the costs are lower in advanced economies which are 3.8% of GDP. Additionally, Reinhart and Rogoff (2009) explain that the crisis periods are associated with considerable decrease in tax revenues and increasing government debt during the three years period following a banking crisis.

1.5. 2008 GLOBAL FINANCIAL CRISIS AND ISLAMIC FINANCE

The global financial crisis of 2008 is one of the most severe recessions in the history. It is considered as the second most serious breakdown since the Great Depression. The globalization process which is accelerated by technological innovations and economic integrations, causes a crisis in one country to affect other countries in a short period of

[8] Depicted by the author using World Development Indicators, World Bank. It is formed by using banking crisis data for 214 countries available in the database.

time. For this reason, each country integrated with world markets in terms of free movement of goods, services and production factors is faced with positive or negative effects of the developments in foreign markets (Kibritçioğlu, 2010). Accordingly, due to the contagion effect and financial globalization, the 2008 crisis that emerged first in the USA spilled over the World dramatically. That is, this crisis gained a global character by expanding its impact area over time and had a significant negative impact on the world economy by causing a global recession.

Figure 6: GDP Growth (annual %) of World[9]

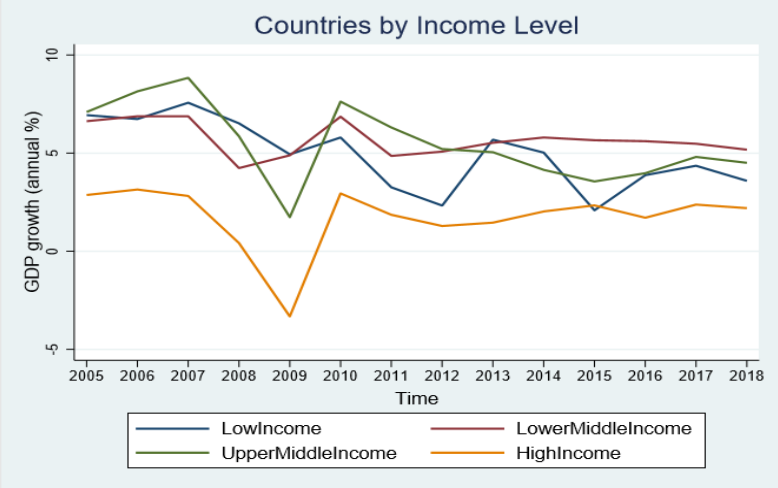
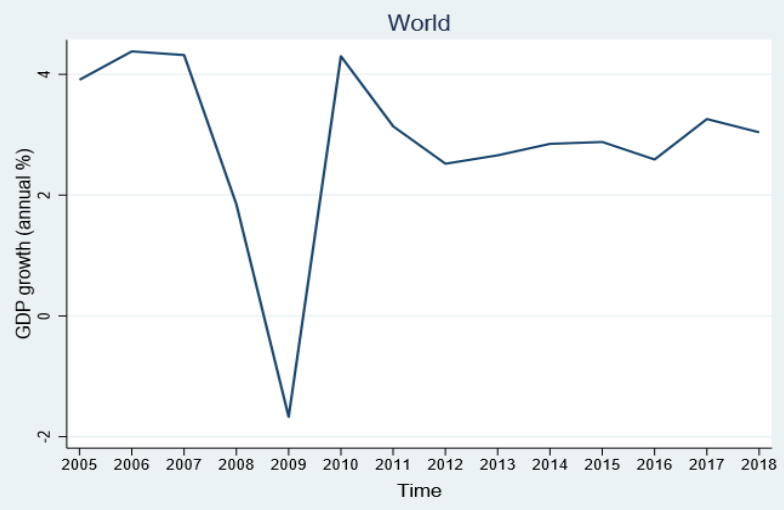


Figure 7: GDP Growth (annual %) by Income[10]



9 Depicted by the author using World Development Indicators, World Bank.
10 Depicted by the author using World Development Indicators, World Bank.

Figure 6 presents the annual GDP growth by Income level. Note that, the global crisis experienced in 2008 caused considerable output losses not only on high- and middle-income countries but also in low income countries. Figure 7 additionally illustrates that the global crisis had destructive results in the world GDP as a whole. While the global GDP per capita grew by 2.2% before the crisis, it fell by 1.8% in 2009 which is the biggest decline that global economy experienced since the World War II (Claessens and Kose, 2013). Chen et al. (2019) explain that even after ten years since the 2008 crisis, the negative outcomes of the crisis for the World economy was still perceptible. Chen et al. show that the ratio of government debt to GDP increased by 36 percent and reached to 51% in ten years after the crisis. Additionally, the central bank balance sheets raised several multiples of their pre-crisis size.

The global breakdown of 2008 triggered the efforts to examine the impact of the crisis on Islamic banks and the relationship between the Islamic banking industry and the financial crises. Within this context, the different views in the literature can be grouped into three approaches regarding the performance of the conventional and Islamic banks during the global crisis. With respect to the first view, there is no significant difference between Islamic banks and conventional banks in terms of the impact of the financial crises on banking soundness and profitability, since Islamic banks mimic the commercial strategies of conventional banks and diverge from the theoretical business models of Islamic banking (Sehrish et al., 2012; Bourkhis and Nabi, 2013).

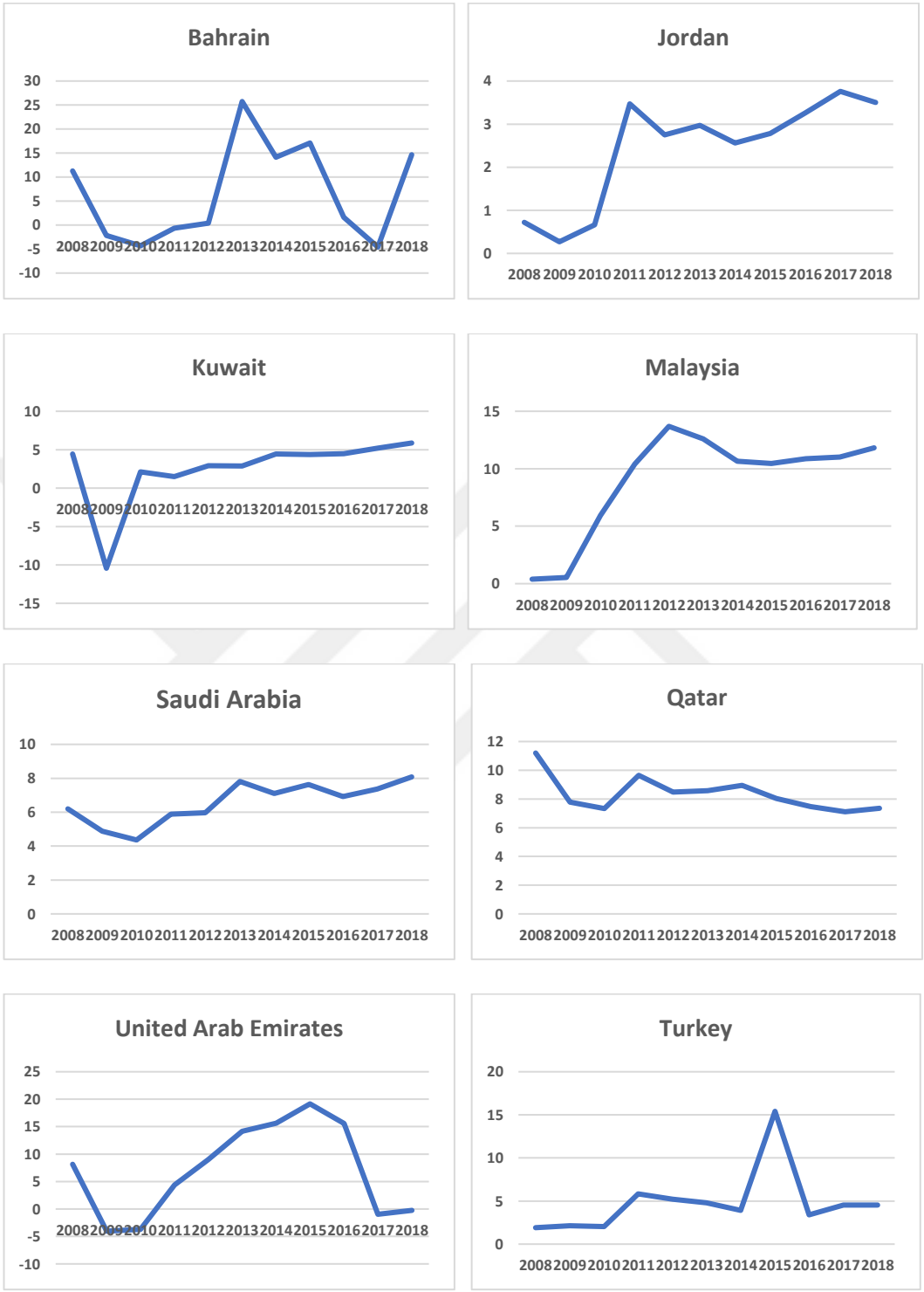
According to the second view, the financial crisis does not affect the Islamic banks and they performance better than conventional banks in terms of stability, efficiency, return and asset quality (Ansari and Rehman, 2011; Zehri et al., 2012). Almanaseer (2014) uncovers that the 2008 global financial crisis does not have a significant impact on the profitability of Islamic banks. The author inspects the increasing bank size, equity capital and, decreasing expenses and liquidity to decrease the impact of the global financial crisis in Islamic banks' performances. According to Chapra (2011), Islamic banks experience lower financial instability since they perform their lending and borrowing functions based on the principle of PLS, prohibition of *gharar* (uncertainity), *riba* (interest) and gambling where they provide credit for purchasing of real goods and services. Moreover, according

to Ibrahim and Rizvi (2018), the financings of Islamic banks grow higher than the lending growth of the conventional banks during the crisis period.

The third view provides evidences on that Islamic banks are affected by the negative effects of the 2008 crisis in the following year 2009, with the spread of the crisis to the developed and developing countries and due to the intense pressure of the crisis on the real economy. Related to this, the weakness of the risk management of Islamic banks is seen as the main reason behind the profitability losses of the Islamic banks where they were affected more negatively than conventional banks (Hasan and Dridi, 2011; Hidayat and Abduh, 2012). According to World Islamic Banking Competitiveness Report of Ernst and Young, it was found that the profitability of Islamic banks was affected more negatively than conventional banks and their compound annual growth rate decreased by 16% between 2010 and 2014 (Ernst & Young, 2015). In 2012, Indonesian Central Bank reported that the market shares of Islamic banks decreased to 9.44% and further experienced a negative trend with a growth rate of 6.07% in 2013. The market shares of Islamic banks experienced a negative growth of 4% in December 2014 for the first time in Indonesian Islamic Bank's development period (Anwar and Ali, 2018).

Figure 8 shows the return on assets ratio (ROA) of Islamic banks in Bahrain, Jordan, Kuwait, Malaysia, Qatar, Saudi Arabi, Turkey and United Arab Emirates between 2008 and 2018. ROA is an essential ratio that represents the profitability of banks by indicating the returns generated from the bank's assets.

Figure 8: Return on Assets (ROA) of Islamic Banks for Selected Countries, 2008-2018[11]



According to Figure 8, based on real data the profitability of Islamic banks was impacted negatively during the 2008 global financial crisis. The ROA ratio of the Islamic banks

11 Depicted by the author using BankScope Database.

seems to decrease in all countries.[12] Consequently, Islamic banks are not completely safe against the negative impacts of financial crises although emerged in other parts of the World. They also experience banking crises, especially considering that they carry the similar risk factors and financial functions as conventional banks.

Banking crises are accepted as a natural element of the economies in the modern global economic environment. For this reason, detecting the economic weaknesses and vulnerabilities and taking early precautions against an upcoming crisis become an inevitable necessity for the Islamic banking system as well. At this point, early warning systems (EWS) are used in order to anticipate whether and when the system and countries may experience a financial crisis (Wang, 2008). The next chapter provides detailed information on the early warning systems (EWS) within the context of Islamic banking crises in particular.

[12] Except for Malaysia.

CHAPTER 2

EARLY WARNING SYSTEMS AND THE BACKGROUND LITERATURE

In recent years, the increasing number of banking crises and its destructive effects, triggered the effort to construct early warning systems (EWS) to identify the early signals of any crisis where the topic has become a subject of research by both academics and policy makers. The primary motivation behind constructing EWS models is to design a system to estimate the probability of a crisis for a country in a specific time period. They are useful in monitoring the crisis risk by providing an opportunity to prevent the crises or take early precautions to minimize the loss in situations where it is not possible to prevent the crisis. These models reveal a predictive power based on the correctly predicted crises and non-crisis episodes. Therefore, the success of an EWS model is directly related to the predictive power of the system. In order to construct an EWS model that reveals substantial predictive power, the main criteria should be chosen appropriately. In this respect, the technical specifications of an EWS model are built on four basic criteria such as: (i) the definition of the crisis, (ii) explanatory variables determining the crisis, (iii) country coverage and the time period of the data, (iv) estimation methodology. Correspondingly, there are vast number of studies in the literature that differ in terms of the crisis definition, time span, country coverage, indicator selection and the estimation methodology. Therefore, in this section, we introduce the empirical studies that investigate the EWS of banking crises that differ in terms of these four basic criteria.

2.1. DEFINITION OF A CRISIS

In order to build a solid EWS model, the first and the most important step is to construct a precise definition of the crisis event. The crisis definition is the dependent variable of the EWS models which separates the crisis and non-crisis episodes. Thus, the identification of significant early warning indicators and measuring the predictive power

rates directly depend on this definition. Since the crisis event is the dependent variable of the EWS model to be constructed, inconsistent crisis definitions reveal inconsistent outcomes even if the other specifications of EWS is convenient (Ishihara, 2005). De Bandt and Hartmann (2000) states that the crisis definition is also related with the regulatory policies. More precisely, the banking crisis definition addresses the source of the problem and for this reason, it also influences the management policies of the banking crises. At this juncture, the challenge is the lack of a consensus on how to define the banking crises in the literature (Caprio and Klingebiel, 1997; Demirgüç-Kunt and Detragiache, 1998; Filippopoulou et al., 2020). However, according to the existing empirical studies, banking crises definitions can be built by two approaches as "event-based banking crisis definitions" and "index-based banking crisis definitions". The event-based approach relies on the certain events as solvency, bank runs, bankruptcy, high level of nonperforming loans (NPL), large-scale nationalizations, deposit freezes, closures, mergers and, the cost of rescue operations in order to identify the banking crisis (Caprio and Klingebiel, 1997; Demirgüç-Kunt and Detragiache, 1998). In index-based approach, on the other hand, the banking crisis is defined by constructing a banking sector fragility index (BSFI) which measures the effect of different combinations of proxies for the considered banking risk factors (Kibritçioğlu, 2003; Kusuma and Duasa, 2016; Singh, 2011). In the index-based approach, if the BSFI exceeds an arbitrarily determined threshold value, the presence of banking crisis is considered in that specific time period. Within this context, although the studies conducted after the financial crisis of 2008 show that Islamic banks are also exposed to the negative effects of the crises, that is, it is not possible for Islamic banks to be exempt from the crises (Amba and Almukharreq, 2013; Hasan and Dridi, 2011; Rashwan, 2012), as far as we know there are limited number of studies that attempt to construct an EWS model for Islamic banks. Therefore, in this section, we also include the empirical studies on banking crisis of conventional banks since the construction of EWS does not show any difference between conventional banks and Islamic banks.

2.1.1. The Event-Based Approach

In event-based approaches the occurrence of a banking crisis depends on an explicit "event". To identify the banking crises, the event-based approach is widely used in the empirical studies of EWS. For instance, Caprio and Klingebiel (1996) examine the causes and effects of the banking crises and government responses during the time period of 1970 and 1995. They separate the banking crises into two as systemic crises and border line crises. The systemic crisis is defined as "when much or all of bank capital is being exhausted" (Caprio and Klingebiel, 1996, p.2). The borderline crisis, on the other hand, is defined as the existence of situations that shows strong banking problems such as the government takeovers, forced merges or bank runs. Caprio and Klingebiel (1996) reveal that, after 1945, banking crises occur every twenty-five years. In addition to this, the incidence of the banking crises increases after the 1970s where industrialized and developing countries experienced 69 banking crises until 1996. Lindgren et al. (1996) define banking crises as the "cases where there were runs or other substantial portfolio shifts, collapses of financial firms, or massive government intervention" (Lindgren et al., 1996, p. 20).

In order to examine the relationship between the currency crises and banking crises and, to define the macroeconomic conditions signalizing these events; Kaminsky and Reinhart (1999) defines a banking crisis as an event that (i) bank runs which cause closure, merging or takeover by the public sector of one or more financial institutions, or (ii) in case of no runs, the closure, merging, takeover, or large-scale government assistance of an important financial institution (or group of institutions), that marks the start of a string of similar outcomes for other financial institutions (Kaminsky and Reinhart, 1999, p. 14).

One of the most prominent study in the banking crisis literature is done by Demirgüç-Kunt and Detragiache (1998). They consider the episodes of the banking crises if at least one of the following conditions hold; (i) the ratio of nonperforming assets to total assets in the banking system exceeds 10%; (ii) the cost of the rescue operation (public bailout) is at least 2% of GDP; (iii) banking sector problems result in a large-scale nationalization of banks and (iv) extensive bank runs take place or emergency measures such as deposit

freezes, prolonged bank holidays or generalized deposit guarantees are enacted by the government in response to the crisis (Demirgüç-Kunt and Detragiache, 1998; pp.16) .

In order to identify countries that experience a banking crisis, Borio and Drehmann (2009) suggest two event-based definitions as (i) countries where the government had to inject capital in more than one large bank and/or more than one large bank failed and (ii) countries that undertook at least two of the following policy operations: issue wholesale guarantees; buy assets; inject capital into at least one large bank or announce a large-scale recapitalization program.

Reinhart and Rogoff (2009), on the other hand, consider the episodes of the banking crises if "bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions" or "if there are no runs, the closure, merging, takeover, or large-scale government assistance of an important financial institution (or group of institutions), that marks the start of a string of similar outcomes for other financial institutions" (Reinhart and Rogoff, 2009, p. 81).

To provide a comprehensive database on the systemic banking crisis Laeven and Valencia (2013) define banking crisis as an event that (i) significant signals of financial distress in the banking system such as significant bank runs, losses in the banking system and bank liquidations and (ii) significant banking policy intervention measures regarding the significant losses in the banking system. According to them, in order to a banking crisis becomes systemic, both of these criteria need to be fulfilled. On the other hand, they include that if the losses or liquidations are severe, then the first criterion is enough to specify the systemic banking crisis. On this basis, they indicate that the losses are severe if either (i) a country's banking system exhibits significant losses resulting in a share of nonperforming loans (NPLs) above 20 percent or bank closures of at least 20 percent of banking system assets or (ii) fiscal restructuring costs of the banking sector are sufficiently high, exceeding 5 percent of GDP. Furthermore, the policy interventions are significant if at least 3 conditions from the following are experienced: deposit freezes or bank holidays; significant bank nationalizations; bank restructuring fiscal costs at least 3 percent of GDP; liquidity support at least 5 percent of deposits and liabilities; significant

guarantees put in place; and significant asset purchases of at least 5 percent of GDP (Laeven and Valencia, 2013, pp. 229–230).

2.1.2. The Index-Based Approach

Within the context of the index-based banking crisis definitions, a banking crisis is defined by considering on various banking sector risk factors such as credit risk, liquidity risk and market risk and/or macroeconomic variables. After constructing a BSFI, an arbitrarily determined threshold level, φ, is defined which identifies the crisis and non-crisis episodes.

$$Banking\ Crisis\ (BC)_{i,t} = \begin{cases} 1, & if\ BSFI_{i,t} < \varphi \\ 0, & otherwise \end{cases} \quad (1)$$

According to the equation 1, if the fragility index exceeds a certain threshold value in a specific time period, this is considered as a crisis period. More precisely, the BSFI is transformed into a binary variable and takes the value 1 if BSFI is less than φ. This states that there occurs a banking crisis in county i at time t. On the other hand, an episode is classified as a non-crisis episode if the BSFI exceeds φ.

It is often stated in the literature that determining an index value to define the banking crisis is difficult due to lack of reliable data on the financial activities of the banking sector such as NPL (Hawkins and Klou, 2011; Kibritçioğlu, 2003). Despite that, efforts to identify the banking crises by determining an index value have increased especially in the resent years. Related to this, one of the main studies is done by Kibritçioğlu (2003) pioneering the development of the studies in this field. In this prominent study, a banking crisis is defined by constructing a banking sector fragility (BSF) index. The BSF index is defined as the average standardized values of credit risk proxy, exchange rate risk proxy and liquidity risk proxy. Bank deposits is considered as a proxy for the liquidity risk; Domestic credit to private sector by banks is considered as a proxy for the credit risk and foreign liabilities of banks is considered as a proxy for the market/exchange rate risk. The author defines two fragility episodes of the banking system as medium fragility and high

fragility episodes. According to this, if BSF index is between 0 and -0.5, then the sector experiences a medium fragility episode. Moreover, if the index is equal or lower than -0.5, then the banking system is highly fragile to the systemic crisis. In order to indicate whether the liquidity risk has any impact on the crisis identification, Kibritçioğlu (2003) also constructs two alternative BSF indices. The first alternative index is comprised of the same proxies as in the main BSF index except the bank deposit variable. The second alternative BSF index is constructed subtracting the bank deposit variable from the main index. The results reveal that while BSF index is highly beneficial in the context of monitoring and determining the banking crises, bank runs generally does not play a crucial role in triggering the crisis.

Ahmad and Mazlan (2015) develop an annual BSF index for Malaysian local-based and foreign-based commercial banks to investigate the fragility of these banks. Although, the BSF index is obtained following Kibritçioğlu (2003), the authors prefer to use different proxies in order to measure credit risk and market risk. On this basis, NPL variable is used to measure credit risk and time interest earned ratio (Tier) proxy is chosen for the market risk.

To identify the episodes of Islamic banking crises in Indonesia, Kusuma and Asif (2016) construct an EWS by using an Islamic banking sector fragility index (IBSFI). Following Kibritçioğlu (2003), the authors construct the IBSFI based on liquidity risk and credit risk. While Islamic bank deposits is considered as proxy for the liquidity risk, domestic credit is used as the credit risk proxy. The results show that Islamic banking in Indonesia experienced high fragility episodes between 2005 and 2006. Moreover, their EWS model predicts 80% of the banking crisis periods correctly.

Another study that covers EWS of Islamic banking crisis is done by Wiranatakusuma and Duasa (2017). The scholars construct an EWS in order to identify the signaling indicators of Islamic banking resilience in Indonesia between 2004 and 2016. For this aim, following Kibritçioğlu (2003), the Islamic Banking Resilience Index (IBRI) is obtained regarding the liquidity risk and credit risk proxies. However, different from Kibritçioğlu

(2003), the authors prefer using financing of Islamic banks variable in order to measure the credit risk.

Van Hogen and Ho (2007) define the banking crises by constructing an index of money market pressure (IMP) following the index-based currency crisis definition of Eichengreen et al. (1996). The main motivation for defining the banking crises based on a money market pressure index is due to the link between the banking crisis and the aggregate demand of the banking sector for central bank reserves. In other words, the authors explain that any banking crisis is connected with increasing non-performing assets, deposit withdrawals and decreasing inter-bank lending. Accordingly, they create the IMP by considering the weighted average of the changes in the ratio of total reserves of banking system to total non-bank deposits and short-term interest rate. The scholars accept the presence of the banking crisis if the index exceeds 98% and, if the index increases more than 5% with respect to the previous year.

Davis and Karim (2008) use two separate depended variables following the Demirgüç-Kunt and Detragiache (1998) and Caprio and Klingebiel (1996) banking crisis definitions. Their results reveal that, different banking crisis definitions reveal different results. For instance, according to the dependent variable which is constructed with Demirgüç-Kunt and Detragiache's (1998) banking crisis definition, real interest rate is a significant indicator of banking crisis. However, it becomes insignificant when the dependent variable is constructed based on Caprio and Klingebiel's (1996) banking crisis definition.

Singh (2011) constructs two monthly BSFIs in order to identify the fragility episodes of Indian banks. The first BSFI is constructed considering weighted averages of the annual growth of real time deposits, real non-food credits, real investments, real foreign currency assets and liabilities and, real net reserves. The alternative index, on the other hand, is created by using the same proxies as in the main index, except for the real time deposits variable. Singh distinguishes the fragility episodes as high fragility and medium fragility episodes. Accordingly, the banking sector is in a high fragility episode if BSFI is lower than the negative standard deviation of the index. The sector is medium fragile if the BSF index is between zero and negative standard deviation of the index. The results reveal that

two BSFIs show similar movement patterns, thus the bank runs do not play an important role in the fragility of the Indian banking sector.

Jing et al. (2015) use the money market pressure index of Von Hagen and Ho (2007) however they modify the index by changing the weights of the variables. Moreover, they create alternative indices by using nominal interest rate variable instead of real interest rate in order to detect the stress in money market better.

2.2. EXPLANATORY VARIABLES FOR EWS

One important step to construct an EWS model is to determine the explanatory variables of the banking crisis. Although most of the attempts towards constructing an EWS in the literature is to identify the leading indicators (Demirgüç-Kunt and Detragiache, 1998; Kaminsky, Lizondo and Reinhart, 1998; Pedro et al., 2018), there is lack of consensus on the indicators that are helpful in anticipating the banking crisis. As Davis and Karim (2008) state, there are no standard list of indicators in the literature since the crises occur from different events. For instance, the earlier studies on EWS of banking crises explain the crisis primarily on the worsening macroeconomic conditions. Caprio and Klingebiel (1996) link the banking crisis after 1970s to the decreasing GDP and insufficient supervisions.

Demirgüç-Kunt and Detragiache (1998) categorize their explanatory variables in three main groups as financial, macroeconomic and institutional variables and they use 13 explanatory variables in total. According to their empirical results, low GDP growth, high real interest rate, high inflation, explicit deposit insurance and the degree of financial liberalization increase the probability of banking crisis. They also find that while there is a weak evidence that declining terms of trade has impact on banking crisis, the size of fiscal deficit and depreciation of the exchange rate do not have a significant impact on the probability of banking crisis.

Kaminsky and Reinhart (1999) analyze the movements of 20 macroeconomic indicators that could have an impact on the emergence of these crises by using signal extraction approach. According to their results, the liberalization of the capital account, domestic financial sector and the real sector indicators such as real exchange rate, M2 multiplier, domestic credit/GDP, stock prices, the level of financial liberalization and domestic real interest rates are significant indicators of banking crisis. Moreover, they report that M2 multiplier is a significant indicator of the banking crises, which correctly identifies the banking crises episodes 73 percent of the time with a signal to noise ratio of 0.5.[13] In addition, real interest rate correctly predicts 100 percent of the crisis, real exchange rate correctly predicts 58 percent of the crisis, stock prices predict 81 percent, domestic credit/GDP predicts 50 percent with a signal to noise ratio of 0.45, 0.28, 0.28 and 0.59 respectively.

Wong et al. (2010; 2011) investigates the probability and the leading indicators of banking distress in the emerging Asia–Pacific (EMAP) countries . The scholars use the same banking crisis definition with Demirgüç-Kunt and Detragiache (1998). Their study shows that decreasing GDP growth, increasing inflation and the ratio of money supply to foreign exchange reserves, as well as credit risk of banks and non-bank financial institutions, asset price gaps, credit growth and contagion are significant indicators of banking distress. Furthermore, their EWS model correctly predict the banking distress events by 74%.

In order to investigate the significant indicators and predict the banking crises in six Asian countries[14] Musdholifah et al. (2013) consider 15 explanatory variables by categorizing them in four group of variables as macroeconomic, internal bank, institutional and global factors. The authors use the banking crisis definition of Demirgüç-Kunt and Detragiache (1998) as a dependent variable. According to their results, decreasing real GDP growth, high inflation rate, asset quality of banks, liquidity level, the level of financial

[13] Kaminsky et al. (1997) defines the ratio of the false signals to the good signals as “signal to noise ratio”. See Section 2.4 for detailed explanations.

[14] India, Japan, Indonesia, Malaysia, Thailand and Philippines.

liberalization, independence of central bank, world oil prices, economic growth in US and US inflation rate are the significant variables of a banking crisis.

Pedro et al. (2018) use the banking crisis definition of Laeven and Valencia (2013) but, different from Laeven and Valencia (2013), they do not analyze systemic and non-systemic banking crises individually. They use binary response models and reveal that size, level of debt, GDP growth, high inflation rate and contagion are significant variables to determine the banking crises.

Constructing an EWS for Islamic banks, Kusuma and Asif (2016) find that real effective exchange rate, inflation rate, credit growth and M2/reserve growth are significant indicators of Islamic banking crises in Indonesia. Wiranatakusuma and Duasa (2017), on the other hand, investigate that M2/reserves, credit growth, real effective exchange rate, and inflation rate are significant indicators for Islamic banking resilience in Indonesia.

Van Hogen and Ho (2007) consider 16 explanatory variables for macroeconomic, financial and institutional factors. According to their results, real GDP growth, short-term real interest rate, real exchange rate and fiscal deficits are significant indicators of a banking crisis. Furthermore, while their EWS model correctly predicts the crisis episodes by 58-71%, the predictive power ranges between 89-91% for predicting the non-crisis episodes.

According to Singh (2011), increasing ratio of foreign currency assets to liabilities, imports, M3 multiplier, call money rate, real interest rate, increasing stock price index and inflation increase the probability of high fragility episodes of the banking sector. In the context of the predictive power rate, the overall predictive power of the model is found as 94%. More specifically, while the non-fragility episodes are forecasted correctly by 97%, the medium and high fragile periods are correctly called by 89% and 90%, respectively.

Jing et al. (2015) find that using nominal interest rate rather than real interest rate in the IMP increases the number of correctly predicted crisis episodes. Moreover, they show that their modified index gives better predictive power results with fewer false alarms than Von Hagen and Ho (2007).

Therefore, for constructing an EWS, there is no optimal number of independent variables. For this reason, determining the optimum number and list of explanatory variables is an important and challenging criterion in the construction of an EWS model.

2.3. COUNTRY COVERAGE AND TIME PERIOD

Determining the country set and the time period are another criterion for constructing an EWS. The EWS models can be applied to single country, group of countries or it is also possible to construct a global EWS. In the EWS literature, for instance, while Davis and Karim (2008) construct a global EWS and investigate 105 different countries as a group between 1979 and 2003, Demirgüç-Kunt and Detragiache (1998) construct their data set with 65 developing and developed countries covering the period 1980 to 1994. Ahmad and Mazlan develop an EWS only for Malaysia for the time period between 1996 and 2011. Despite there are no restrictions in terms of country coverage, the explanatory variables and the estimation methodology should be determined considering the country set in order to achieve substantial EWS results.

2.4. ESTIMATION METHODOLOGY

In order to develop an EWS model that provides substantial information on the leading indicators of the banking crisis and reveals high predictive power results, a relevant estimation technique should be employed. In the literature, various forecasting methods are used to anticipate the banking crises and these methods can be categorized as parametric approaches and non-parametric approaches.

The non-parametric approach, namely the Signal Extraction Approach, is developed by Kaminsky et al. (1997). The logic behind the Signal Extraction Approach depends on the different behavior of the indicators in the crisis and tranquil episodes. Therefore, the Signal Extraction Approach is based on monitoring the behavior of a large set of indicators in crisis and tranquil periods in order to predict a possible future crisis. More precisely, in the first part of this approach, the explanatory variables, which are expected to have significant impact on the occurrence of a crisis, are selected. Correspondingly, an arbitrarily determined threshold value is determined for each variable and the values of these indicators are compared in crisis and tranquil episodes. Within this context, each indicator is analyzed separately and if an indicator deviates from its normal level and exceeds the threshold value, it is interpreted as an early warning signal of a possible crisis that will occur in the following 24 months.

The primary issue in the signal approach is to determine the optimal threshold value since the signals given by the model depend on these threshold values. If a low threshold value is determined, the system gives more crisis signals which increases the number of wrong signals (Type 2 error). Higher threshold value, on the other hand, sends less crisis signals that leads to missing actual crisis episodes (Type 1 error).

Table 2: Signal Matrix

	$Y_{i,t}=1$ Crisis within 24 months	**$Y_{i,t}=0$ No crisis within 24 months**
Signal	A Good signal of crisis event	B Type 2 Error False Signal
No signal	C Type 1 Error Missing Signal	D Good signal of non-crisis event

According to the table, A denotes the number of months that the indicator sends good signals. In other words, good signals mean that the indicator sends crisis signals and crisis occurs in the following 24 months. B is the number of months that the indicator issues a bad signal. This means that the indicator sends crisis signal but no crisis observed in the next 24 months which is also referred as type 2 error. C denotes for number of months that the indicator does not issue any signal but a crisis occurred which is the type 1 error.

D is the number of months that there the indicator does not send any signal and no crisis event experienced. Kaminsky et al. (1997) defines the ratio of false signals to good signals as noise to signal ratio. Accordingly, the authors adjusted the optimal threshold value for each indicator that minimize the noise to signal ratio, which can be formulized as:

$$\text{Noise to signal ratio} = \left[\frac{B}{B+D}\right] / \left[\frac{A}{A+C}\right] \quad (2)$$

The non-parametric EWS, the signal extraction approach, is widely accepted by the academics and the policy makers since it gives an opportunity to analyze wide range of explanatory variables by revealing the leading indicators of a forthcoming crisis by giving the prediction powers of each indicator. For instance, Borio and Drehmann (2009) conduct their analysis with signal extraction approach and find reasonable evidence about the impact of credit and asset prices on the probability of banking distress. In addition, their model correctly predicts the crisis by 77% with a noise to signal ratio varying between 6% and 14%. Furthermore, the signal extraction approach also implies to EWS of Islamic banking crises by Kusuma and Asif (2016) and Wiranatakusuma and Duasa (2017).

However, this method is frequently criticized due to some of its drawbacks. For instance, as Frankel and Rose (1996) state, the signal extraction approach reveals the individual contribution of the indicators rather than the marginal contributions thus the relation between the explanatory variables is neglected. Furthermore, determining the optimal threshold value is another crucial point since the prediction power and the leading indicators are directly related with this value. If a low threshold value is chosen, the system gives more crisis signals which increases the number of false alarms (Type 2 error). Higher threshold value, on the other hand, sends less crisis signals that leads to missing actual crisis episodes (Type 1 error). For this reason, the threshold value is set regarding to minimize the Type 1 and Type 2 errors which appears as a crucial and challenging aspect of the model. Furthermore, this approach does not give an opportunity to evaluate the amount of the deviations of the indicators from the threshold value and to test the statistical significance levels of the indicators.

In this respect, some of the drawbacks in the signal extraction approach have been solved within the framework of the parametric approach, namely with limited dependent variable approach. It is a regression-based approach in which binary models with logit or probit functions are used and the probability of the crises is estimated as a function of various explanatory variables. While the signal method transforms each variable into a binary variable by restricting to observe the relationship between the indicators, the logit and probit methods analyze all variables simultaneously and reveal the marginal contribution of each variable. Additionally, they give an opportunity to test the statistical significance of the indicators by providing the magnitude of each variable. As in signal extraction methodology, the parametric approach has also some drawbacks. For instance, while it provides an opportunity to find if a variable is a significant indicator of a banking crisis or not, it is not possible to determine how successfully the individual variable predicts the crisis episodes.

The first attempt to employ logistic methodology in an early warning model of banking failures is made by Martin (1977). The author considers 5700 Federal Reserve member banks in US between the period of 1990 and 1976. According to the results of the study, the logit model reveals substantial results by correctly classifying the failed and non-failed banks by 87% and 88.6% respectively. After Martin (1977), the logit model has become a widely used methodology in predicting banking crises in the related literature (Demirgüç-Kunt, 1989). For instance, Lestano and Kuper (2002) construct and EWS model by conducting logistic methodology to examine the significant indicators of currency, banking and debt crisis on a panel of six Asian countries[15] over 1970-2001 period. The authors find that GDP per capita and the ratio of M2 to international reserves are crucial determinants of the banking crisis. Furthermore, there are vast number of studies in the literature that attempt to compare the parametric and nonparametric EWS. For instance, Berg and Patillo (1999) compare the signal extraction approach to probit approach and find that probit approach gives superior prediction results compared to the signal approach. By comparing parametric and non-parametric EWS, Beckmann et al. (2007) show parametric EWS is more successful than non-parametric EWS in terms of identifying the correct crisis episodes. Moreover, Davis and Karim (2008) construct an

[15] Malaysia, Indonesia, Philippines, Singapore, South Korea, and Thailand.

EWS model for banking crisis and compare the results of the logit model EWS and signal extraction model EWS. The authors conclude that while the logit model shows a better performance in predicting global EWS, the signal extraction model is more appropriate to anticipate the country specific banking crises. Additionally, Comelli (2014) compares the logit and probit EWS. The author states that while both models reveal similar outcomes, logit EWS gives slightly better prediction results compared to those from probit EWS.

In sum, there is a wide range of studies that construct early warning systems to anticipate the banking crises for different countries relying on various explanatory variables, estimation methods and time periods. Moreover, most of these studies consider only the conventional banking system. To the best of our knowledge this study is the first attempt to investigate (i) the impact of banking crisis definition variations on significant indicators of the banking crises of Islamic banks (ii) the choice of the proxies that are used to construct BSFIs on the predictive power of EWS of Islamic banks, (iii) the impact of banking risk factors that are used to construct BSFIs on the predictive power of the EWS of Islamic banks, (iv) the impact of the profitability risk factor on the predictive power of EWS models and, (v) a BSFI definition specific to Islamic banks. In addition, this study extends the related literature by establishing an EWS model for Islamic banking system that covers all the leading countries in terms of Islamic banking assets rather than focusing on a country as well as examining a wide range of banking-specific and macroeconomic factors.

CHAPTER 3

ISLAMIC FINANCIAL SYSTEM

Islamic finance is a system that is shaped in line with the basic principles of *Shari'ah* (Islamic law) and consists of financial transactions and services in accordance with these rules and principles. In other words, it is a system where the objective and all kinds of transactions are compiled within the framework of Islamic rules. The main objective of Sharia is protecting and preserving the Muslim religion, life, progeny, property, intellect and honour (Ayub, 2007). To achieve these objectives, the primary sources of *Shari'ah* are the Holly Qur'an and Sunnah. Qur'an, holy book and main text of Islam, is considered to be the most sacred and important source of Islamic Law. The second main source of Islamic Law is the Sunnah, which represents the Prophet Muhammad's actions and sayings[16] that are formulated in the form of narratives and known as the Prophetic Hadiths (Hallaq, 2009).

In case the legal issues are not covered in the Quran or Hadith, the secondary sources of *Shari'ah* constitutes the basis of *Shari'ah* which are *Ijma* (consensus), *Qiyas* (analogy) and *Ijtihad* and *Urf*. *Ijma*, is a consensus among religious scholars on certain issues. Qiyas is the analogical deduction to provide an opinion about a situation not mentioned in the Quran or Sunna compared to another situation referred to in the *Qur'an* and *Sunnah*. *Ijtihad* is the independent comments and instructions of the competent jurists and scholars for the issues that are not mentioned in the *Quran* and Sunnah. In addition, *Urf* (prevalent practice) are also crucial for Islamic jurists. It is compulsory for the jurists, *Shari'ah* scholars, *Shari'ah* boards of Islamic banks and other institutions dealing with *Shari'ah* matters, purpose the solutions and issue edicts with respect to these sources of *Shari'ah* (Ayub, 2012). The basic framework of the Islamic financial system consists of a set of rules and laws that are fully associated with the religion of Islam that govern the

[16] Also includes the actions and sayings approved by the Prophet.

economic, social, political and cultural aspects of Islamic societies (Van Greuning and Iqbal, 2007).

The Islamic financial system is a phenomenon that emerged in the mid-1980s, and previous references to commercial activities in accordance with Islamic principles have been made under the name of either "interest-free" or "Islamic" banking. In this context, despite the prohibition of interest as the main principle; it is supported by other principles of Islamic teaching that support social justice, risk-sharing, the rights, duties and responsibilities of individuals and society, property rights, and the sanctity of contracts (van Greuning and Iqbal, 2007).

3.1. PROHIBITIONS OF THE ISLAMIC FINANCE

In Islamic finance, commercial activities and financial transactions are carried out within certain principles and prohibitions. As explained in detail in the above section, Islamic law defines transactions involving illegitimate elements. Therefore, Islamic law clearly states the factors or elements that must be avoided in transactions to be carried out in commercial and business life. The fundamental principles and practices that Islamic law specifically prohibits in financial transactions can be listed as follows (Khaki and Sangmi, 2012, p.3):

- Prohibition of *Riba* (Interest)
- Prohibition of *Gharar* (Uncertainty)
- Prohibition of *Maysir* (Gambling)
- Avoiding *Haram*
- Principle of Profit and Risk Sharing
- Money as a Medium of Exchange
- Sanctity of Contracts and the Preservation of Property Rights

3.1.1. Prohibition of *Riba* (Interest)

Riba is the fundamental prohibition of Islamic banking. While it literally means increase, addition, growth; in technical terms it refers to interest. The concept of riba has a broader scope than the concept of interest since it involves not only in loans and debts transactions but also in sale and exchange transactions. The most important issue at this point is, most of the Muslim jurist accept all forms of interest is prohibited by Islam (Ayub, 2012). The reason of this full consensus relies on the verses in the principle text of Islam, Qur'an, and hadiths, Prophet Mohammed's sayings.[17] With respect to Qur'an and Hadiths, it is clearly stated that all forms of interest is condemned and prohibited. Although there is a consensus in the literature that *riba* is strictly prohibited in Islam, yet there are different opinions about the definition and scope of *riba*.

In the literature, various definitions have been made to indicate the meaning and scope of *riba. Riba* is defined as the premium that the borrower must pay to the lender together with the principle amount for the loan or in the case of an extension for the loans maturity (Chapra, 1990). Within this context, *riba* is considered as interest since interest is the excess over the principle lent (Khan, 1987). Furthermore, Alam et al. (2017) define *riba* as "unjustified earning where a person could receive a monetary advantage in a business transactions without giving a just counter-value" (Alam, Gupta and Shanmugam, 2017, p. 36).

Islamic terminology defines interest as an increase in the principle amount or wealth gained without putting any effort. *Riba* is an unearned income that the owner of the money gains. In other words, it is an unrequited excess determined in favour of one of the parties in exchange contracts which arises from Loans/Debts and Sale/Exchange Transactions. Therefore, the concept of *riba* is divided into two categories as *riba* on loans (*Riba al-nasiah*) and *Riba al-fadl* (*Riba* on sales). These can be explained as follows:

[17] Surah al-Rum, verse 39, Surah al-Nisa', verse 161, Surah Al-e-Imran, verse 130, Surah al-Baqarah, verses 275–281.

Riba al-nasiah:

The word *nasiah* is coming from the root *nasa'a* which means delay or postpone something for a while. *Riba al - nasiah* deals with "*riba* in money to money exchanges, where the exchange is delayed or deferred and gives rise to an additional charge" (Z. Iqbal and Mirakhor, 2011, p. 58). This *riba* is also called *Riba al-Jahiliyyah. Riba al-Jahiliyyah* contains an exorbitant increase by doubling and redoubling the initial amount for the extension of the period of debt. This implies that the loan is offered without *riba* but it is collected only when the borrower do not pay the debt at the end of the maturity date. In other words, the additional amount and overpayment received by the creditor from the debtor to correspond to the maturity difference is called interest. *Riba al nasiah* is also known as *riba al- Qur'an* (Quranic interest) since it is considered in the Qur'an as the most harmful and unethical of all forms of *riba*.

Riba al-fadl:

The literal meaning of fazl is excess. *Riba al fadl* is the "excess which is taken in exchange of specific homogenous commodities and encountered in their hand to hand purchase and sale" (Arif, Hussain and Azeem, 2012, p. 145). *Riba al fadl* is prohibited by a hadith which describes six commodities.[18] They include that there is some disagreement among jurists as to whether the injunctive relief applies only to the six items listed or whether there are some general principles covering other aspects. However, it is seen that the prohibition of *Riba al-Fadl* has the aim of ensuring justice and eliminating all kinds of abuse through unfair exchange. *Riba al-Fadl* is involved in a transaction through the combination of an exchange of goods and money in cash and an exchange between two goods or money of the same kind etc. (Özsoy, 1995, p. 85).

[18] As Arif et al. (2012) mentioned (pp. 145): The Prophet (PBUH) said "sell gold in exchange of equivalent gold, sell silver in exchange of equivalent silver, sell dates in exchange of equivalent dates, sell wheat in exchange of equivalent wheat, sell salt in exchange of equivalent salt, sell barley in exchange of equivalent barley, but if a person transacts in excess, it will be usury (*riba*). However, sell gold for silver any way you please on the condition it is hand to hand (spot) and sell barley for date anyway you please on the condition it is hand to hand (spot)".

One of the most important features that distinguishes Islamic finance from conventional finance is the interest. In conventional banking, interest is the major source of funds where individuals give their savings to conventional financial institutions in return for interest, and these institutions offer their savings to the market for consumption and investment purposes in return for a certain interest rate. Since interest is at the center of the modern economy, it is especially included in most of the transactions of conventional financial institutions. This has led some scholars to interpret interest in different perspectives.

The majority of Islamic scholars emphasized that both the meanings and scope of interest and *riba* are the same (Khan, 1987). They argue that any loan that includes a predetermined or prefixed return is *riba* and strictly prohibited. With respect to them, regardless of the amount of interest, it is a form of *riba* as it is added to the borrowed capital, and therefore does not conform to the Qur'an.

Moreover, they oppose the idea that interest rates in conventional banks are not exorbitant and do not fall under the prohibited *riba* since they are not for exploitation purposes. For instance, Ali (2006) states that there is no difference between interest and usury, or returns on consumer loans or production loans even if they are for production purposes. Therefore, any addition to the amount of debt, regardless of the interest rate, is prohibited (Ayub, 2012). Therefore, despite a number of different opinions, there are near consensus among the Muslim jurist that bank interest is considered as *riba* (Schacht, 1964; Haque, 1995; Iqbal and M. Siddiqi, 2004).

3.1.2. Prohibition of *Gharar* (Uncertainity)

The second fundamental principle of Islamic finance is the prohibition of *gharar*. While *gharar* literally means fraud (al-khida), it assigns different meanings in different transactions such as risk and uncertainty. It encompasses a broad range of area in the Islamic law. Al-Saati (2003) states that there is no consensus among Muslim jurists in the issue of accepting the degree of uncertainty in transactions as *gharar*. In the related literature, the definition of *gharar* can be perceived in three dimensions. With respect to some Muslim jurists such as Ibn Abidin, *gharar* links to the doubt over the existence of

the subject matter of a sale contract (Kamali, 2000). In the Zahiri school of thought, *gharar* is involved in the cases when the buyer or seller does not know what he/she is buying or selling (Ayub, 2012).[19] According to the third view, which is accepted by the majority of the Muslim jurists, the scope of the *gharar* is widened and it includes both unknown and the doubtful cases. Within this context, *gharar* is defined as the "uncertainty indeterminacy involved in transactions where the quality and the quantity of the commodity on sale is not predetermined and known" (Marhaini and Ahmad, 1972, p. 65). In other words, in Islamic finance, the products or services subject to partnership between the parties should be clear and certain. Therefore, *gharar* comes in the evidence if the rights or obligations of the parties in a product or service exchange are not known as certain (Walkey, 1973). Similarly, Iqbal and Mirakhor (2011) link *gharar* with excessive/unnecessary risk and danger in consequence of "too little information or asymmetric information about price, quality and quantity of the counter-value, the date of delivery, the ability of either the buyer or the seller to fulfil their commitment, or ambiguity in the terms of the deal and thereby, exposing either of the two parties to unnecessary risks" (Z. Iqbal and Mirakhor, 2011, p. 10).

According to The Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI), the types of *gharar* can be divided into three as excessive *gharar*, medium *gharar* and minor *gharar*. *Gharar* is excessive if the presence of *gharar* effect the contract and nullifies the transaction. Furthermore, the following four conditions must be fulfilled for the presence of the excessive *gharar* (AAOIFI, 2017, p. 773) (i) if it is involved in an exchange-based contract or any contract of that nature (ii) if it is excessive in degree (iii) if it relates to the primary subject matter of the contract (iv) if it is not justified by a *Shari'ah* -recognizable necessity.

Accordingly, while *gharar* is involved in financial transactions such as sales and lease, it does not affect donation agreements such as gifts and will agreements. Based on Islamic law, for risk or uncertainty to be prohibited, they must be excessive or substantial and these should affect the basic elements of the sales contract. Excessive *gharar* is involved

[19] Ibn Hazn, 1988, 8, p. 343, 389, 439.

if there is excessive risk and uncertainty that may affect a contract. In other words, *gharar* is excessive when there is a dominant and distinctive aspect of the contract and, this can lead to conflict such as selling the fish in the sea or fruits before the production process or signing a lease contract for an unspecified period (AAOIFI, 2017, p. 773) . On the other hand, since uncertainty in commercial transactions cannot be completely eliminated, reasonable or minor uncertainties and risks are tolerated. These unavoidable uncertainties and risks are identified as minor *gharar*. The situations under minor *gharar* are negligible and do not sufficient enough to cause conflict to affect the validity of the contract. Medium *gharar* is the midpoint of the excessive and minor *gharar* and does have any impact on the contract. In addition, the contract becomes invalid if *gharar* is concerned with the primary subject of the transaction.

In Islamic finance, *gharar* means the speculative transactions, in other words, the sale of goods and services where the characteristics are uncertain and ambiguous in terms of contract are prohibited. With the *gharar* prohibition, it is aimed to prevent the inclusion of an uncertainty that may cause financial loss for one of the parties of a transaction and protect them from the negative consequences of unforeseen situations due to lack of information. Consequently, unknown or uncertain cases are harmful to society. They promote immorality, cause volatile markets, financial risk and instability, deception where ruthless greed is directly linked to *gharar* and prohibited in Islam (Metwally, 1997; Paldi, 2014).

3.1.3. Prohibition of *Maysir* (Gambling)

Maysir, which comes from an Arabic word *al-yasar* (easy), literally means easily obtained wealth, gamble or game of chance. *Maysir* can be defined as making wealth by chance or obtaining revenues easily and receive benefits without any hassle. Gambling, excessive ambiguity and all types of game of chance activities and any income from them are prohibited in Islam since they cause unfair earnings, waste of property and time, weakness of will and social disintegration.

A number of conventional financial transactions that are similar to the concept of lottery, such as conventional insurance, bonus/prize bonds, present futures and options contracts involve *riba, gharar, jahl* and gambling and they are prohibited in Islamic finance (Ayub, 2012)). Moreover, *maysir* is also attributed to two interrelated terms in the literature; as speculation and price manipulation. According to the literature, *maysir* is also defined as speculation (and linked with gambling that exists in various forms in modern practice (Mohamed Ibrahim, 2007; Uddin, 2015). Speculation can be defined as the purchase/sale of goods for resale/repurchase at a future date with the expectation of the changes in the relevant prices (Kaldor, 1939, p. 111) . In other words, the main objective is winning the income margin by various financial transactions rather than the purpose of using or obtaining the commodity by the contracting parties (Kalimullina and Orlov, 2020).

As explained in detail in Section 3.3.2, the Islamic capital market refers to markets where the transactions take place in accordance with Islamic principles. Most of products, services and functions are similar between Islamic capital market and conventional capital markets except that the transactions and operations in the Islamic capital markets must be permissible by Islamic law. Although speculators and investors have significant influence on price discovery and stabilization with respect to conventional finance; cross-cutting issue is the excessive and large-scale speculation which can cause instability in the system. Speculation is an important discussion topic in the Islamic law. With respect to some early Muslim scholars, the financial speculations in the stock market is linked with gambling and thus against Islamic principles (Z. Iqbal and Mirakhor, 2011). They argue that, speculation serves the purpose of gaining profit through price fluctuations. Accordingly, in a speculative environment, transactions are made under market uncertainties by taking extreme risks thus, they are evaluated within the framework of *gharar* and *maysir* which are not permissible in Islamic capital market. For instance, Tag el-din and Hassan (2007) express that the aim of the transactions in the stock market is based on making profit and the reason of the price changes can be natural or artificial. For this reason, speculators are believed to behave with unconventional market patterns in random walks of stock price movements by adopting different gambling positions.

According to other perspectives, since the transactions in the capital market is carried on by analyzing economic data and the level of uncertainty, it is permissible to invest in stocks based on profit and loss sharing in order to make profit. They argue that Islamic law allows trade for the purpose of profit-making even if transactions in the capital market are considered speculative but it sets certain limits to avoid the detrimental effects of excessive speculation (Kalimullina and Orlov, 2020).

Furthermore, some Muslim scholars differentiate the concepts of speculation and risk taking and, make some suggestions as placing essential restrictions to dealers in order to prevent rapid price changes as well as introducing a new tax structure for the investment holding period to avoid the unwanted speculation and the gambling (Z. Iqbal and Mirakhor, 2011). For instance, Kamali (2011) distinguishes between gambling and speculation on the basis of the nature of risk and its potential contribution to social benefit. According to him, gambling creates a previously non-existent risk, which is not beneficial for the social welfare. However, investment speculation is the commitment of capital to a business in order to generate profits. Here it is assumed that the profit earned in the future is based on the performance of the company. Investment speculation consists of committing capital to a business in anticipation of making a profit. In this context, it is assumed that the profit is earned in the future through the performances and efforts of the company. Therefore, while the speculation about the investment in the stock is based on the real value of the company gambling is not based on anything.

As it can be seen, gambling is strictly prohibited by Islamic law since it has destructive impacts both at individual and social level by damaging the social welfare and economic growth. Particularly, the main reason for the prohibition of *maysir* is that the risk of profit and loss is not distributed equally. With the excessive risk taken in gambling, while one party wins, the other party suffers from significant losses and may even face bankruptcy. The main purpose of banning the *maysir* is to protect the society socially and economically. Therefore, with the *maysir* prohibition, it is aimed to maintain the social and economic welfare from negative outcomes of gambling.

3.2. FUNDAMENTAL PRINCIPLES OF ISLAMIC FINANCE

3.2.1. Avoiding *Haram*

Haram refers to forbidden and unlawful in terms of Islamic religion and it also makes contracts vicious. In the Islamic financial system, only *Shari'ah* compliant activities are allowed for production, trade and investment and thus, transactions that do not conform to Islamic moral values or are known to be harmful to society are *haram*. For instance, trading alcoholic beverages, companies offering conventional financial services, consumption of selling of pork products and adult entertainment are examples of *Haram* activities according to *Shari'ah* (Kettell, 2012; Lewis and Algaoud, 2013).

3.2.2. Compliance with the Business Ethics and Norms

In addition to the basic prohibitions of *riba, gharar, maysir* and avoiding *haram*; compliance with the business ethics and norms are also essential for a valid contract. The principle of justice, which means fair dealing and keeping the balance, is one of the most essential principle that regulates commercial transactions according to Islamic law. Within this context, according to Islamic law, honesty, truthfulness and care for others are also crucial principles in respect of business transactions. Furthermore, *Najash*, which means increasing the price without the intention of receiving the goods, is forbidden since it is unethical and cause unbalances in the market. Additionally, *Khalabah*, misleading and misinforming the customer by showing a product different than it actually is, is prohibited because it is against the moral rules. Another important feature is the disclosure, transparency and facilitating inspection principle. In this context, the seller should give the customer enough opportunity to see, examine and control the product. Otherwise, the parties have the right to terminate the contract. In addition, the parties must fulfil their responsibilities arising from commercial and financial agreements, act in accordance with the Free Marketing and Fair Pricing rules, and both parties of the contract must refrain from committing harmful acts to each other (Ayub, 2012).

3.2.3. Principles of Profit and Loss Sharing

One of the main principles of Islamic finance is the profit- loss sharing (PLS) principle. In the Islamic financial system, receiving and giving any pre-determined or guaranteed income is forbidden. Additionally, every transaction with an expectation of profit needs to carry a symmetrical risk return distribution for each of the parties (van Greuning and Iqbal, 2007). This is referred as *al-ghounm bi al-ghourm* in Islamic finance which constitutes the basis of the principle of Profits and Losses Sharing (PLS). In other words, if a person wants to gain profit from an investment, the risk of the loss must also be taken.

Since interest is prohibited in Islamic banking, fund suppliers are the investors or entrepreneurs rather than lenders or creditors as in conventional banking. Furthermore, the risk is shared fairly between the parties. This implies that, both parties of a financial transaction, investor and the financial capital provider are involved in the risk. Furthermore, PLS is crucial for Islamic banking since it effects both the assets and liabilities sides of the balance sheet (Chong and Liu, 2009).

3.2.4. Money as a medium of exchange

In Islamic finance, the status, value, role and functions of money are different from those in conventional finance (Benhayoun and Fogal, 2016). While conventional system money is used as a commodity, in Islamic finance money is a medium of exchange or a measure of value. In other words, conventional finance deal in money but Islamic banks deal in goods and documents (Ayub, 2012).

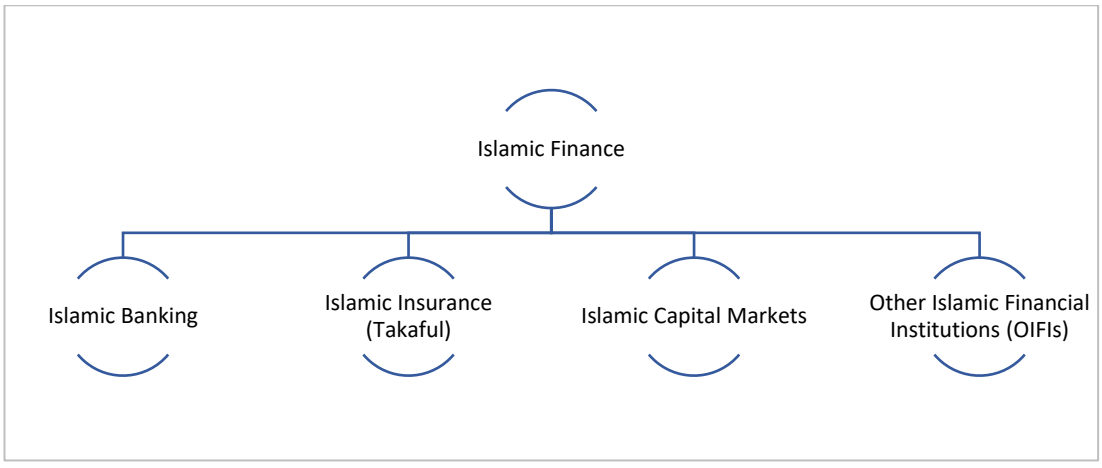
In conventional banking system, bank gets money as loans by paying interest, thus it can be sold, bought or rented in order to gain profit. However, in Islamic finance, money does not have an intrinsic value. Money is used as a medium of exchange to buy goods for the purpose of renting or selling goods in order to generate profit or income. Moreover, the use of money to third parties without trade or partnership is only possible through *karz-ı hasen*. In this case, no excess (*riba*) can be claimed (Özsoy, 1995).

Additionally, there is a consensus that the forward price of a good or service may vary according to its cash price, which is equivalent to accepting the time value of money in pricing the goods. In this context, the parties must have agreed on the price from the beginning. Moreover, it is not possible to reprice the goods sold within the framework of Islamic finance. In case of a delay, no additional fee can be requested since this excess is *riba*.

3.3. THE COMPONENTS OF THE ISLAMIC FINANCE

As explained in detail above, the commercial and financial transactions within the framework of Islamic finance must comply with Islamic law. As illustrated in Figure 9, Islamic financial system is comprised of four subsectors as Islamic banking, Islamic insurance, Islamic capital markets and other Islamic financial institutions (OIFIs). In 2018, Islamic banking is the largest component of the Islamic finance industry which is accounted for 71% of the total global Islamic finance assets. Accordingly, Sukuk is the second largest market with a share of 17% and, Islamic funds market amounted to 4% of the total industry assets. Other Islamic financial institutions and takaful on the other hand, accounted for 6% and 4% of the total global assets respectively (ICD - Thomson Reuters Islamic Finance Development Report 2014, 2014).

Figure 9: Components of Islamic Finance



3.3.1. Islamic Banking

Islamic banking is the main subsector of the Islamic financial system. In the most general sense, it refers to a banking system that is built in line with the values and belief system of the religion of Islam. In other words, Islamic banking is governed based on *Shari'ah* principles where the entire operations and objectives are regulated in accordance with these rules.

According to Organization of the Islamic Conference (OIC), Islamic banking is defined as "a financial institution whose statutes, rules and procedures expressly state its commitment to the principles of Islamic *Shari'ah* and to the banning of the receipt and payment of interest on any of its operations" (Kabir Hassan, 1999, p. 60). Moreover, according to Participation Banks Association of Turkey (TKBB) (2015) Islamic banking is a banking type that accepts the principle of interest-free as the most basic and important principle, collects funds on the basis of profit and loss sharing (PLS) and provides funds with methods such as trade, partnership and leasing. Islamic banking is also expressed as participation banking since it is based on the principle of participation in profit and loss.

Although Islamic banks are governed based on traditional management and risk management rules, they are distinguished from the conventional banking sector in terms of its governing laws and operation dynamics (Al-Zumai and Al-Wasmi, 2016). The fundamental differences between Islamic banks and conventional banks are presented in Table 3 (Hassan et al., 2005, p. 3-4).

Table 3: The Fundamental Differences Between Islamic Banks and Conventional Banks

	Islamic Banking	**Conventional Banking**
1	An advance step toward achievement of Islamic economics	Part of the capitalistic interest-based financial system
2	Try to ensure social justice/ welfare or the objectives of *Shari'ah*	Not concerned
3	Flow of financial resources are in favour of the poor and disadvantaged sections of society	Not concerned
4	Prepare and implement investment plans to reduce the income-inequality and wealth-disparity between the rich and poor	Increase the gap
5	Make arrangements for investment funds for asset-less, poor but physically fit people	All plans are taken for the rich people
6	Observe the legitimate and illegitimate criteria fixed by the *Shari'ah* in case of production and investment	No such rules and regulations
7	Implement investment plans on *Mudarabah* and *Musharakah* to stimulate the income of the people under the poverty line	No such program
8	Interest and usury are avoided at all levels of financial transactions	The basis of all financial transactions are interest and high-level usury
9	Depositors bear the risk, no need for deposit insurance	Depositors do not bear any risk, moreover bank is inclined to pay back principal with guaranteed interest amount
10	The relationship between depositors and entrepreneurs are friendly and cooperative	Creditor-Debtor relationship
11	Socially needed investment projects are considered	Projects below the fixed interest level are not considered
12	Elimination of the exploitation of interest and hegemony of that	Helps to increase capital of the capitalists
13	Islamic bank become partner in the business of the client after sanctioning the credit and bears loss	Do not bear any loss of client
14	Islamic bank can absorb any endogenous or exogenous shock	Cannot absorb any shock because of the ex-ante commitment
15	Islamic banking is committed to implement welfare-oriented principles of financing	No such commitment, extend oppression and exploitation
16	Inter-bank transactions are based on profit and loss share (PLS) basis	On interest basis and create unusual bubble in the market i.e. exorbitant increase in the call money rate
17	Islamic banks work under the surveillance of the *Shari'ah* Supervisory Boards	No such surveillance
18	Lower rate of moral hazard problem because of the brotherhood relationship between the bank and customers	High moral hazard problem because relation is based only on monetary transactions
19	Avoids speculation related financial activities	Main functions are speculation related
20	Bank pays zakat on income and inspires clients to pay zakat which ensures redistribution of income in favor of the poor	No zakat system for the benefit of the poor
21	The basis of business policy is socio-economic upliftment of the disadvantaged groups of the society	Profit is the main target of business or the prime duty is to maximize the shareholders' value
22	Dual target: implementation of the objectives of *Shari'ah* and profit	Only profit making is the sole objective
23	Islamic banks sell and purchase foreign currency on spot basis, not on forward booking or future basis	Spot and forward both are used

3.3.2. Islamic Capital Markets

The development of *Shari'ah* compliant financial products dates back to the early 1970s with the emergence of the first Islamic banks and has been growing dramatically especially in the last decades. Although the components of the Islamic capital market and the conventional capital market are similar, the properties of the products that constitute each component are different (Alam et al., 2017). The Islamic capital market can be defined as the securities markets where all kinds of transactions are carried out in accordance with Islamic principles. The main purpose of the Islamic capital market is the same as conventional capital markets. However, the main difference is the transactions that must be made in accordance with the Islamic rulings such as prohibition of interest, uncertainty and gambling. In this context, in Islamic equity market, it is not possible to invest in the stocks of companies that involve; interest-based activities, activities related to the entertainment sector such as gambling and nightclubs, organizations dealing with the production and sale of *haram* products such as alcoholic beverages, activities based on uncertainty, and stocks of companies that involve activities related to the weapon and defense industry.

Islamic capital markets consist of Islamic equity markets, Islamic bond market (Sukuk) and Islamic derivatives market. The equity market, also known as stock market, can be defined as the market where the shares of joint stock companies are traded. Within the framework of Islamic equity market, the crucial point is the activities of the issuer companies. Namely, in Islamic equity market, it is important to examine whether the company's activities are carried out according to *Shari'ah* principles or not. Alam et al. (2017) defines the Islamic equity market and related products based on Islamic funds and Islamic equity funds as follows:

Public listed companies: A platform for deficit units to raise money through equity financing and for investors to invest in companies' stocks.

Unit Trusts and Mutual Funds: An investment plan in which a fund manager collects money from investors with similar investment objectives to invest in a portfolio of assets such as stocks and bonds.

Islamic Private Equity Funds: The equity of companies that are not listed on a public stock exchange. The principle difference that separates Islamic and traditional private equity funds is the suitability of the investee companies with respect to the *Shari'ah* board.

Islamic Specialized Funds: Funds that invest neither in listed nor non-listed companies.

Although the Islamic investment funds, which are the funds managed in accordance with Islamic criteria, emerged in the early 1990s, they have grown rapidly among Islamic financial products. Moreover, they can be restricted to a particular class of assets such as real estate, leasing and commodities and also hybrid of equities and commodities.

Derivatives, on the other hand, can be defined as the financial contracts that are arranged between two parties to buy and sell from today, depending on the future value of assets whose qualifications are predetermined. Derivative markets are the markets in which derivatives are traded. In other words, derivative markets are the markets where any goods or financial instruments are purchased and sold today for delivery or cash settlement at a later date (Ersoy, 2011). As in conventional finance, risk management is critical and crucial in Islamic finance. Within this context, as Iqbal and Mirakhor (2007) explain, derivative markets carries out three main functions as risk reduction and redistribution, price discovery, stabilization and completeness of markets. Accordingly, the main purpose of the derivative markets is facilitating the risk transfer among the economic agents. In Islamic finance, the derivatives market is comprised of Islamic forward forex, Islamic options, Islamic forwards and futures and swap contracts. However, while Islamic banks must first examine the derivatives that they use risks, such as foreign exchange, market, credit, and liquidity risks, they must first examine the compliance of these instruments with Islamic principles. Furthermore, the existence of forward and future markets increases the information flow while leading price discovery

function to the sector. In addition, derivatives market customizes and monetizes payoffs with considerable transaction costs (Iqbal and Mirakhor, 2007).

Sukuk is the second largest component of the Islamic finance sector after Islamic banking. According to The Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) sukuk is defined as the "certificates of equal value representing undivided shares in ownership of tangible assets, usufruct and services or (in the ownership of) the assets of particular projects or special investment activity" (AAOIFI, 2017, p. 468). Sukuk is also referred as Islamic bonds and it is an interest-free investment instrument that provides ownership right on a real asset and enables to earn income from the relevant asset.

The most commonly used sukuk certificates can be given as follows:

- *Sukuk al-Ijarah*: A leasing contract. The usufruct of the asset subject to the certificate passes from the asset owner to the contract renter.
- *Sukuk al-Mudharaba*: A partnership contract realized on the basis of profit-loss partnership where one party provides capital (money) and the other party provides labor, knowledge, experience or management.
- *Sukuk al-Murabahah*: A sale and purchase contract with predetermined cost and profit
- *Sukuk al-Musharakah*: A type of partnership where two or more parties come together to trade and make profit on the basis of profit and loss sharing principle.
- *Sukuk al-Salam*: Forward based certificates issued to raise funds for the purchase of the *Salam* based goods subject to transaction.
- *Sukuk al-Istisna'*: A type of sukuk that has been developed to fund manufacturers or contractors, mostly in real estate development, large equipment and equipment construction, and financing of large infrastructure projects that are produced in the future.

Sukuk is different from bonds and stocks in many aspects. These differences are given in Table 4 (ISRA, 2017, p. 31-31):

Table 4: Comparison Between Bonds, Sukuk and Shares

	Bonds	**Sukuk**	**Shares**
Nature	Represent an IOU or interest-bearing debt obligation of the issuer.	Represent proportionate ownership in *Shari'ah* compliant assets, usufructs, services, intangible assets, commodities or profit-sharing venture or financial asset or any combination thereof through a mixed portfolio of various assets.	Represent proportionate ownership in the corporation as a whole.
Issuer	Issuer of conventional is not limited in the business activities.	Any issuer who is engaged in business activities which are permissible under *Shari'ah.*	Any issuer.
Investors	Only non-Islamic investors	Islamic and non-Islamic investors.	Islamic and non-Islamic investors.
Relationship Established between Issuer and Investor	Lending relationship giving investors the status of creditors.	Relationship is based on *Shari'ah* contracts used for structuring the sukuk.	The investor is conferred ownership rights in the corporation issuing the shares.
Underlying Assets	No assets required for unsecured bonds i.e. there is no need for collateral backing the bond issue. For secure bonds, underlying assets backing bonds may include non-*Shari'ah* compliant assets.	Underlying assets must comply with *Shari'ah* requirements. Underlying assets can represent both debt and non-debt assets.	Not required
Asset-Relates Expenses	Bond holders are not affected by asset-related expenses.	Sukuk holders may be affected by asset-related expenses.	None
Status	Generally, represent unsecured creditors, except if bonds are backed by specific assets.	Sukuk holders in asset backed sukuk have recourse to the assets in the event of default or if the issuer faces difficulty to pay. They are ranked senior to unsecured creditors. Sukuk holders in asset based sukuk are generally ranked pari passu with other unsecured creditors and have no recourse to the assets.	Shareholders represent the most junior in rank to other classes of securities with full or preferred voting rights. Equity shares can also be in the form of preference shares which have near-senior claims to dividends and capital.
Return on Investors	Coupon payment in the form of interest representing a percentage of the capital. They correspond to fixed interest, connoted to *riba*.	Periodic payments represent a percentage of actual profits and rentals.	Shareholders receive dividend payments. These are not guaranteed by the corporation.

	Bonds	Sukuk	Shares
Principal Repayment by Issuer	Return of principal at maturity is an irrevocable obligation, irrespective of whether the project funded was profitable.	In principle, there i s no ex-ante fixed obligation of capital repayment for partnership based sukuk structures However, in sale based and lease-based structures, the return of principal is guaranteed.	None, as the shares represent perpetual instruments.
Utilization of Proceeds	No specific requirements. Bonds can be issued for meeting any financing needs that are legal in the jurisdiction of the issuer.	Proceeds must be used to finance *Shari'ah* compliant activities.	Equity can be issued for meeting any financing needs of the corporation.
Tradability in Secondary Market	Selling bonds represents sle of debt.	Selling sukuk is basically the sale of a share of an asset or in a project. *Shari'ah* standards at the global level only allow the sale of tangible assets, some intangible assets and interest in ventures.	Represent a sale of shares in the company.
Pricing	Bond pricing is based on credit rating of the issuer and terms and conditions, usually a spread over a reference interest rate.	Sukuk pricing depends on the structure of the sukuk. For non-recourse asset-backed sukuk, pricing is based on the asset backing the sukuk. For sukuk structured based on fixed income and debt-creating contracts, their pricing is typically similar to bond pricing, but may be affected by factors including market depth, liquidity, complexity etc.	Pricing is tied to performance of the corporation.

3.3.3. Islamic Insurance (Takaful)

Insurance has become a necessity for both businesses and individuals to compensate for any future damage they may encounter in any way and to mitigate their effects, risks and losses. Due to the fact that conventional insurance includes *riba*, *gharar* and *maysir*, an alternative insurance requirement in accordance with *Shari'ah* principles has emerged and a takaful system has been developed to fill this gap.

Takaful, which literally means trust or solidarity, refers to Islamic insurance. In the standard No. 26 specified by AAOIFI, Islamic Insurance is an agreement process between a group of people in order to deal with injuries caused by certain risks that may cause vulnerability. In takaful, the contribution payments are made as donations, thus, an insurance fund is created with legal entity status and has independent financial liability. Participants protect their groups by paying the contributions that make up the resources of the insurance fund. The management of the fund is assigned to a committee of policyholders or a joint stock company licensed for the insurance business (AAOIFI, 2018). The parts of these collected funds for investment should be directed to investment instruments in accordance with Islamic procedures.

The foundation of the takaful system is based on partnership and the volunteering of the participants is essential. For this reason, total contributions are considered as donations, not premiums. Under this agreement, the participants gather a certain amount of money and when any of the participants suffer a loss, they are compensated by this fund. The premiums collected are invested in interest-free financing instruments and the risk is distributed among the partners.

Since takaful a cooperative risk sharing mechanism which is based on *Shari'ah* requirements, different takaful models have been established in order to avoid the prohibitions such as *gharar* and *maysir* which are involved in conventional insurance (Htay et al., 2013). The types of takaful can also be divided into two as family takaful and general takaful (life policies). Family takaful is concerned with providing financial assistance to participants and their families in cases of death or injury of participants. The general takaful is an insurance that provides mutual compensation in case of a certain loss such as car insurance, property insurance, accident insurance.

The takaful system is based on shared responsibility, common benefit and mutual solidarity. In takaful system, each policyholder pays their subscription and agree to help each other out of their contributions when any of them are faced with disaster or damage. Thus, takaful system is based on mutual aid rather than gaining profit as in conventional banking.

3.3.4. Other Islamic Financial Institutions (OIFIs)

OIFIs can be defined as the institutions that carry out the functions as lending, resource mobilization, asset management and financial advice. These institutions do not have a full banking license thus they do not accept deposit accounts. They are comprised of private equity and venture capital firms, specialized sector finance companies, leasing and factoring companies, insurance companies, credit unions, microfinance institutions and development focused lending institutions. The OIFIs within the framework of Islamic finance, engaged in four classes as asset and fund management such as mutual, commodity, and leasing funds; specialized sector finance companies as mortgage, leasing, and *Mudarabah* companies; development institutions as multilateral and microfinance institutions and takaful (Iqbal and Mirakhor, 2011; pp.208).

3.4. DEVELOPMENT AND GROWTH OF ISLAMIC FINANCIAL SYSTEM

Islamic banking is based on Islamic principles (principles of *Shari'ah*) and all forms of interest (*riba*) is strictly prohibited in Islam. These financial institutions also known as Islamic banks and participation banks. They are distinguished from conventional financial institutions by their interest-free transactions comply with *Shari'ah*. The prohibition of all the transactions based on interest, which forms the basis of conventional financial institutions, led to the establishment of a separate financial system in Muslim countries. Therefore, the probation of interest in Islam is the main reason of the emergence of Islamic financial system. In other words, at national level, Islamic banking has emerged in order to encourage the inclusion of the unused funds, which has arisen due to the religious beliefs of investors, in the banking system to ensure their economic appraisal. On the international level, Islamic banking has arisen due to the need of realizing the capital movements between Islamic countries in an interest-free system.

From a historical perspective, although the first Islamic banking practices dates back to ancient times, the intellectual foundations of Islamic finance are laid and the first applications are seen between 1940 and 1960. In addition, the birth, development and

institutionalization years of Islamic banking in the modern sense can be regarded as the years between 1970 and 1980. In 1990s, Islamic banking experiences a rapid growth and trigger international conventional banks to establish their own *Shari'ah* compliant businesses. After the 2000s, with the impact of globalization and technological developments in the banking sector Islamic banking has spread to various countries.

The historical roots of Islamic banking practices date back to ancient times. The first practice of participation banking is in the Hammurabi Laws enacted by Hammurabi, who ruled in Babylon between 2123 and 2081 BC. Although implications of various types of interest-free financing practices date back a long time in history, the Islamic banking as a system is first introduced in the 1940s. Accordingly, the first attempt to establish interest-free financial institutions in Islamic geography is considered as the Patni Cooperative Credit Society and the Muslim Fund Tanda Bavli established in Surat and Rampur cities of India in the 1940s. A distinct transaction model in opposition to transactions that are based on interest is established by the Muslims of Pakistan and India in 1946. According to this transaction model, in addition to fulfilling his/her current debt obligation, a Muslim who give a loan is asked to pay zakat of his/her income from the transaction to another bank (Mutlu, 2003).

Muhammed Uzeyr who lived in Pakistan in 1955, on the other hand, first introduces the idea of interest-free banking in the modern sense. The pioneering attempt to establish an Islamic bank takes place in the Egyptian town of Mit Ghamr in 1963 with the establishment of Mit Ghamr Savings Bank. These banks operate as saving banks based on profit sharing with no charged or paid interest (Walkey, 1973). Fundamentally, they are operated as saving investment institutions rather than commercial banks (Ariff, 1988). With this bank, sub financing methods such as commercial partnership, barter and financial leasing are implemented for the first time in Islamic banking area. However, it is taken over by the Egyptian National Bank in 1971 and shuts down its banking activities. Following that another modern Islamic bank emerges in 1971 in Egypt with the establishment of the Nasser Social Bank.

Due to the reasons as increasing economic independence movements in the Islamic geography, capital accumulation in the oil-rich Islamic countries with the rising oil prices in consequence of the 1973 oil crisis, high growth rates in Islamic countries and the requests of Muslim investors who want to make use of these revenues in accordance with Islam, efforts to create investment opportunities suitable for Islam have increased. These economic and political developments trigger the growth of the Islamic financial institutions. In 1975, Dubai Islamic Bank, one of the first private initiatives and the first major Islamic commercial bank, was founded in the United Arab Emirates.[20] In line with these developments, the Islamic Development Bank (IsDB), which is regarded as a milestone in the history of Islamic banking, was established in the same year. As an international financial institution, the main purpose of IsDB is to support the economic and social development of member countries or non-member Muslim communities in accordance with the *Shari'ah*. After the establishment of IsDB, the developments in Islamic modes of financing have increased gradually and spread dramatically to different countries.

In the late 1970's and 1980's, the industry of Islamic finance expands and grows dramatically on a global scale. In 1977, Kuwait Finance House of Kuwait and Faisal Islamic Bank of Sudan were established. In 1978, Faisal Islamic Bank of Egypt and Islamic Finance House in Luxembourg, which is the first country that license Islamic finance in Europe, was established. These were followed by the establishments of Jordan Islamic Bank for Finance and Investment in 1979, Bahrain Islamic Bank in 1979, Dar Al-mal Al-Islami Group in Switzerland in 1981, Al Baraka International Bank in UK in 1982, which is the first Islamic banking practice in Europe, Tadamon Islamic Bank in Sudan, Malaysia Berhad in 1983 and, Al-Baraka Banking Group in 1985. Apparently, the high potential of Islamic finance is recognized by many local and international conventional banks, which trigger them to operate in this field (Iqbal and Mirakhor, 2011). Especially in the period between 1975 and 1990, Islamic banking spread to various countries such as US, UK and Switzerland and displayed a significant development.

[20] It was established on private initiative by providing 20% public capital support from the UAE and 10% from Kuwait governments (Iqbal and Molyneux, 2005).

In the development process of Islamic banking, three different structuring types emerges depending on the cultural, political and financial needs of the countries. In the first model, which is more common in Western countries, a bank or financial institution offers both conventional banking and Islamic banking services under the same roof. For instance, some leading conventional financial institutions such as Citibank, BNP-Paribas, Union Bank of Switzerland, Hong Kong Shanghai Banking Corporation (HSBC), Kleinwort Benson, ANZ Grindlays, Goldman Sachs, United Bank of Kuwait and Arab Banking Corporation establish Islamic windows (*Shari'ah* compatible services) and include interest-free banking into their banking systems. In the second model, conventional banking and Islamic banking operate as two separate institutions independent from each other. For instance, in Pakistan, Islamic banks are included in the sector along with traditional banks. In the third model, countries such as Iran and Sudan, adopt only Islamic banking system and prohibit conventional banking which is based on interest. For instance, after the 1979 revolution, all banks in Iran were nationalized and Iran transformed its entire banking system into an Islamic interest free banking. Moreover, considering the success of the Islamic banking system after the establishment of Faisal Islamic Bank, the Sudanese government converted the entire financial system into an interest free banking system in 1990s. Following this, all commercial and foreign banks adopt Islamic modes of finance and operate on the basis of interest free banking (Mohsin, 2005).

In the 1990's the Islamic finance industry gains a considerable momentum and Islamic Equity Funds are established. Due to the increasing volume and fast-growing industry and the development of new products and services of the Islamic banking, the need for regulatory and supervisory institutions to set standards in Islamic finance has increased. For this purpose, the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) was established in 1990 with the aim of preparing accounting, auditing, governance, ethical, and *Shari'ah* standards for Islamic financial institutions and the Islamic finance industry. Furthermore, Dow Jones (DJ) and Financial Times, the World's leading stock index providers, launched Islamic indices. Thereby, Islamic finance has started to be applied in capital markets, which is considered as one of the most important elements of the financial system (Kettell, 2010).

In addition to Islamic banks, a number of conventional banks, such as American Express Bank Ltd., ANZ Grindlays, BNP-Paribas, Deutsche Bank UBS, and Kleinwort Benson, started to offer Islamic windows. In 2000's, Sukuks (Islamic bonds) are launched and it can be said that the globalization period of Islamic financial services started as the system was expanding to Europe, Asia and North America. Moreover, some crucial steps were taken to address the need for regulatory authorities and, Islamic Financial Services Board (IFSB), International Islamic Financial Market (IIFM), Islamic International Rating Agency (IIRA), General Counsel for Islamic Banks And Financial Institutions (CIBAFI) and The International Islamic Centre for Reconciliation and Arbitration (IICRA) were established.

Table 5: The Development of the Modern Islamic Banking[21]

1963	-Establishment of the Mit Ghamr Savings Bank in Egypt
1971	-Establishment of Nasser Social Bank in Egypt
1975	-Establishment of the first international Islamic bank (IsDB) in Saudi Arabia with the aim of to support the economic and social development of the member countries and Muslim communities in accordance with the principles of Islamic law. -Establishment of the Dubai Islamic Bank in United Arab Emirates
1977	-Establishment of Kuwait Finance House in Kuwait Establishment of the International Association of Islamic Banks with the aim of strengthen cooperation and increase coordination among Islamic banks. -Establishment of The Faisal Islamic Bank of Egypt, Establishment of The Faisal Islamic Bank of Sudan.
1978	-Establishment of Islamic Finance House in Luxembourg
1979	-Establishment of Bahrain Islamic Bank in Bahrain
1981	-Establishment of Islamic Research and Training Institute (IRTI) with the aim of conducting research and educational activities in the fields of Islamic economics, finance and banking. -Establishment of Dar Al-mal Al-Islami Group in Switzerland -Establishment of Tadamon Islamic Bank in Sudan
1982	-Establishment of Qatar Islamic Bank in Qatar - Establishment of Al Baraka Banking Group in Bahrain
1983	-Establishment of Bank Islam Malaysia Berhad in Malaysia -Establishment of the Supreme Supervisory Commission on Fatwa and *Shari'ah* with the aim of examine all the fatawas released by the supervisory boards and fatawa committees of the Islamic financial institutions that were members of the International Union of Islamic Banks and to give opinions regarding their adherence to *Shari'ah* principles and o monitor the activities of the members of the International Union of Islamic banks to ensure their compliance with the provisions of Islamic *Shari'ah* and alert stakeholders to any deviation from *Shari'ah* principles.
1984	-Establishment of Albaraka Turk Finance House in Turkey -All banks in Iran switched to interest free banking system
1990	-Establishment of Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) with the aim of prepare accounting, auditing, governance, ethical, and *Shari'ah* standards for Islamic financial institutions and the Islamic finance industry.

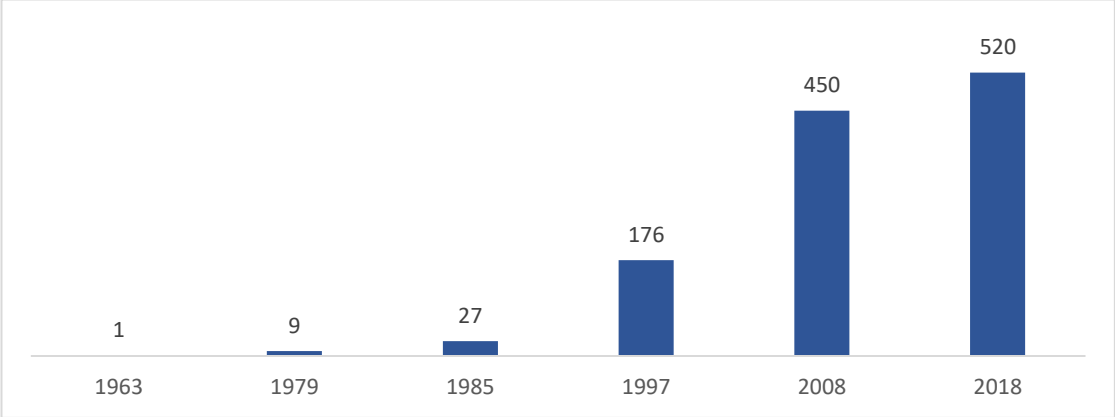
[21] Alharbi, A. (2015). Development of the Islamic Banking System. Journal of Islamic Banking and Finance. Vol. 3, No. 1, pp. 12-25.

1992	-All banks in Sudan switched to interest free banking system
1993	-Establishment of Islamic bank of Brunei Darussalam
1996	-Citibank opened its first Islamic bank subsidiary in Bahrain
1998	-Establishment of HSBC Amanah in Malaysia
1999	- Establishment of Islamic Corporation for the Development of the Private Sector (ICD) with the aim of contribute to the economic development of member countries by financing private sector projects, supporting competition and entrepreneurship, providing consultancy services to governments and private companies, and supporting cross-border investments.
2001	-The International Association of Islamic Banks was reorganized and renamed as the General Council for Islamic Banks and Financial Institutions (CIBAFI)
2002	-Establishment of The Islamic Financial Services Board (IFSB) in Malaysia with the aim of guiding principles and standards for the Islamic financial industry to maintain soundness and stability. -Establishment of International Islamic Financial Market (IIFM) in Bahrain with the aim of providing guiding recommendations for the development of Islamic capital markets and money markets on a global scale and ensuring the standardization and development of the structures, contracts, product development and infrastructure processes of Islamic financial products. -Establishment of The Islamic Bank of Thailand
2004	-Establishment of the Islamic International Foundation for Economics and Finance (IFEF) with the aim of support for the coordination and integration among scientific research institutions in the field of Islamic economics; found a scientific body dedicated to developing Islamic economic theory; explore the future applications of Islamic economic theory; develop the Islamic economic model; discover tools, models, and products that will assess the application of Islamic economic theory and contribute to finding alternative solutions to the problems of the traditional economic system. -Establishment of Al Rayan Bank in UK
2005	-Establishment of the International Islamic Centre for Reconciliation and Arbitration (IICRA) in Bahrain which is an independent international non-profit organization that specializes in arbitrating and conciliating settlement disputes regarding Islamic *Shari'ah* provisions. -Establishment of Islamic International Rating Agency (IIRA) with the aim to provide independent evaluation of Islamic financial products and exporting institutions of these products.
2006	- Establishment of the European Islamic Investment Bank (EIIB) in London
2007	- Establishment of International Islamic Trade Finance Corporation (ITFC) with the aim of developing trade between Muslim countries to improve the economic situation of the Islamic world. -Establishment of DBS Bank in Singapore
2010	-International Islamic Liquidity Management Corporation (IILM) in Malaysia with aim of arranging and exporting short-term Islamic financial instruments in order to supply the liquidity needs of countries and Islamic financial institutions in accordance with Islamic rules. -Establishment of Al Hilal Bank in Kazakhstan
2012	- Establishment of Jaiz Bank in Nigeria
2013	- Establishment of Nizwa Bank in Umman
2015	- Establishment KT Bank AG in Germany

Table 6 lists the developments in modern Islamic banking historically. According to Alharbi (2015), modern Islamic banking have experienced three different phases of development. He refers the first stage as "Interest-Free Banking as an Idea". The stage between 1963 and 1976 is called as "the emergence and establishment of Islamic banks". In this phase, Islamic banking reveals considerable intellectual and implementation

progress especially with the sudden increase in oil revenues and the prevalence of large liquidity. The phase between 1977 to present is called as "The Spread of Islamic Banks". During that period, many international banks have been established and the borders of interest-free banks have been spread over many countries of the World.

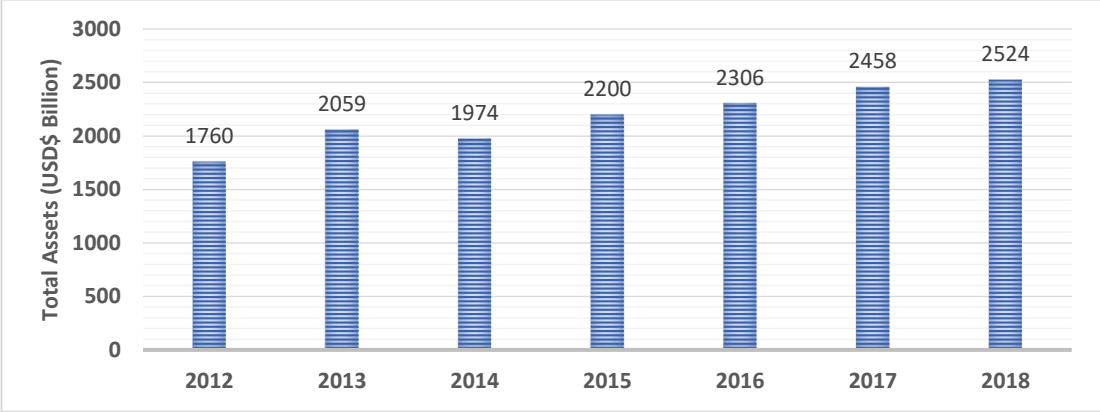
Figure 10: The Total Number of Islamic Banks in the World, 1963-2018[22]



Islamic banks are the institutions that operate on the basis of interest free banking. Following the success of Islamic banking, the number of banks operating based on interest free Islamic banking system has increased dramatically since 1963. Figure 10 lists the total number of Islamic banks operating in the world between 1963 and 2018. As explained in detail in section 3.4, the first Islamic bank in the history was established in 1963. Following that the number of Islamic banks increased rapidly. While there were 27 Islamic banks operated in the world in 1985, the number increased to 176 in 1997. Moreover, over the past decade the number of Islamic banks increased by 16% and there are 520 full-fledged Islamic banks in 2018.[23] Islamic banks operate as commercial, investment, wholesale and specialized banks. In this context, most of the Islamic banks are commercial. In 2018, there are 418 commercial Islamic banks operating globally. Furthermore, the number of investment banks are 58, the wholesale banks are 25 and specialized banks are 19.

[22] The Global Islamic Bankers' Survey (Gibs) Report, General Counsel for Islamic Banks and Financial Institutions (CIBAFI), 2018.
[23] Including Islamic banking windows.

Figure 11: Global Islamic Finance Assets, US$ Billion, 2012-2018[24]



Following the rapid growth of Islamic finance industry, Islamic financial products are offered by the various banks across the world. Figure 11 shows the global total Islamic finance assets between 2012 and 2018. According to the figure, in 2013 the total Islamic finance assets grew by 17% and reached to US$ 2 trillion. Although the industry grows slower with parallel to the global economy after 2016, the size of the industry reached to US$ 2.5 trillion in 2018. In other words, the total Islamic finance assets grow by a compound annual growth rate (CAGR) of 6% by 2012.

Figure 12: Top Countries in Islamic Finance Assets 2018[25]

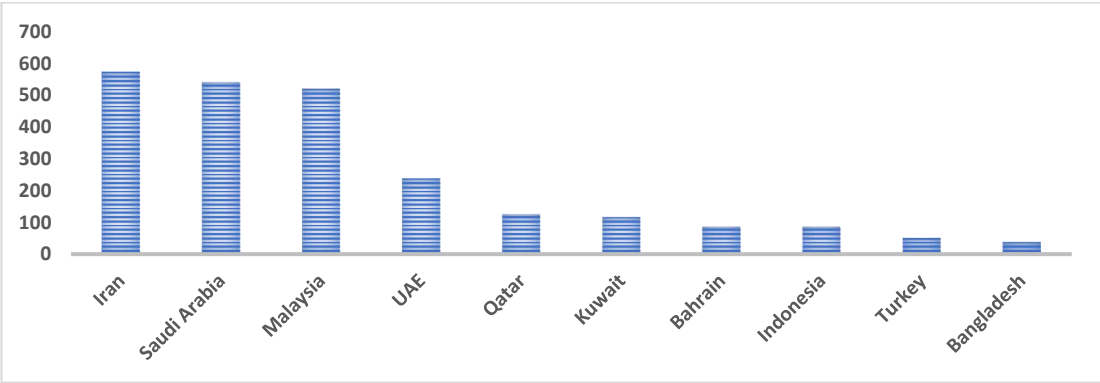


Figure 12 shows the top countries in terms of Islamic finance assets in 2018. According to the table, Iran is the largest market by holding 23% of the global Islamic finance assets. Additionally, the share of global Islamic finance assets of Iran, Saudi Arabia and

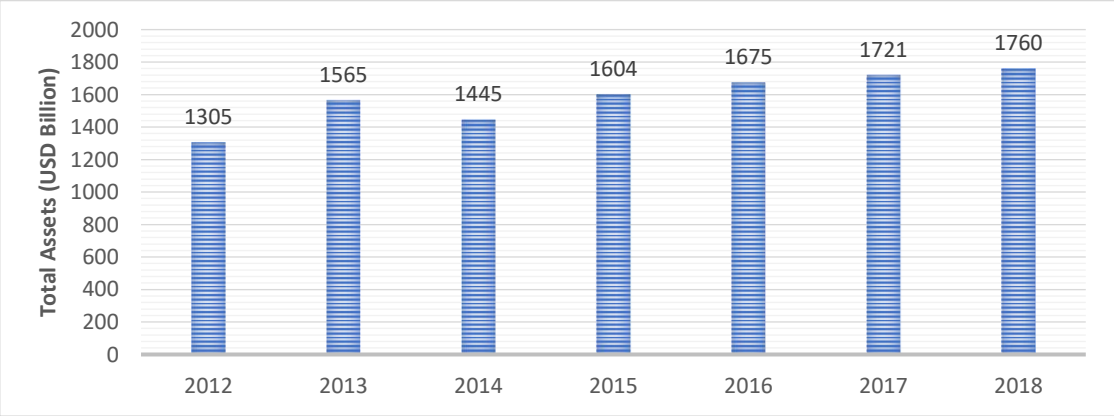
[24] Reuters, 2018.
[25] Reuters, 2018.

Malaysia is accounted by 65% of the industry. While UAE held 9% of the global Islamic finance assets, the share of Qatar and Kuwait is 5%. This is followed by Bahrain (3%), Indonesia (3%), Turkey (2%) and Bangladesh (2%).

Furthermore, the Islamic finance sector can be divided into three sub-groups as Islamic banking, Islamic capital market and Islamic non-banking financial institutions. Within this context, when the sectoral composition of Islamic finance sector is examined in detail, it is seen that Islamic banking constitutes 70% of the Islamic financial system in 2018. Additionally, among Islamic capital markets, while Sukuk (Islamic bond) has a share of 19%, Islamic funds comprise 4% of the assets. Other Islamic financial institutions (OIFI) such as investment companies and microfinance institutions and, Takaful (Islamic insurance) have a share of 5% and, 2% respectively. Therefore, it is important to examine these main areas of the global Islamic financial sector in detail in order to observe the global development of the industry comprehensively.

As for the Islamic banking sector which is the leading sector of the Islamic finance industry with regard to asset size, it is accounted for 70% of the global Islamic finance industry assets in 2018. Figure 13 shows the global Islamic banking assets growth between 2012 and 2018.

Figure 13: Global Islamic Banking Assets Growth, 2012-2018[26]



[26] Reuters, 2018.

Moreover, although the conventional banks offer interest free financial products to their customers as windows besides their specific banking products, which makes difficult for Islamic banks to compete with conventional banks, Islamic banking still grows rapidly. The Islamic banking assets amounted to US$ 1.760 billion in 2018 with a 5% CAGR between the years 2012 and 2018. The share of Islamic banking assets accounted for 6% of the total global banking assets in 2018. While there were 67 countries with Islamic banks and windows in 2017, the number of countries involved in the sector increased to 72 in 2018.

Figure 14: Top Countries in Islamic Banking Assets, 2018 (US$ Billion)[27]

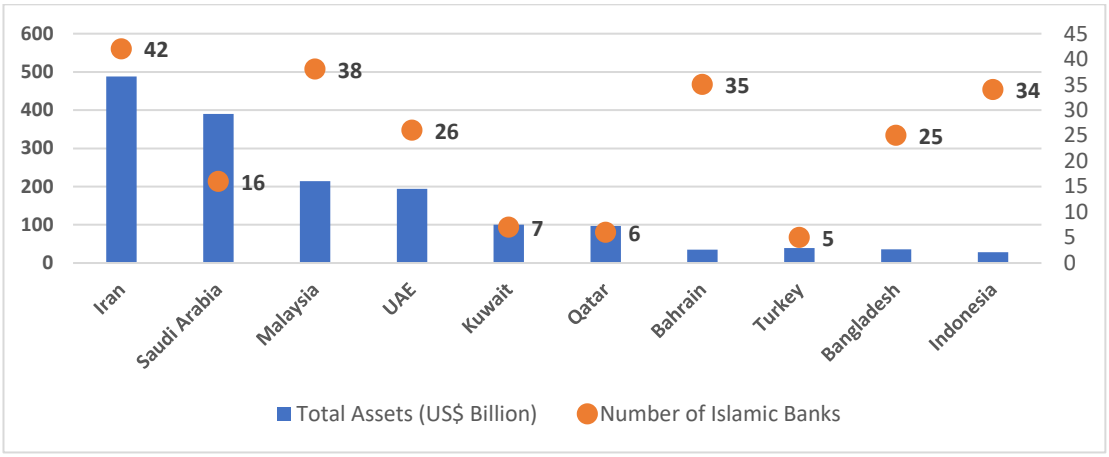


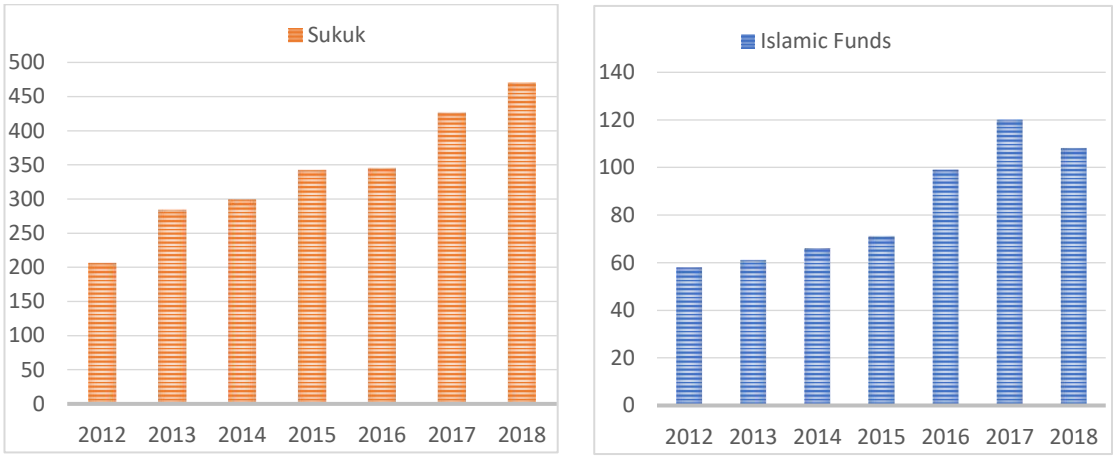
Figure 14 shows the top countries in terms of Islamic banking assets in 2018. According to the table, it can be seen that the total Islamic banking assets are particularly concentrated in two countries. Iran and Saudi Arabia held the largest share of Islamic banking assets by constituting half of global Islamic banking assets in 2018 by 28% and 22% respectively. The share of Islamic banking assets in total banking assets in Malaysia is 12% in the same year. This is followed by UAE (11%), Kuwait (6%), Qatar (6%), Bahrain (2%), Turkey (2%), Bangladesh (2%) and Indonesia (2%) respectively.

Sukuk and Islamic funds are the major assets of the Islamic capital markets. Sukuk, is the largest investment instrument with a share of 19% in 2018. Figure 15 indicates the global value of Sukuk and Islamic Funds between 2012 and 2018. According to the table, Sukuk

[27] Reuters, 2018.

and Islamic funds show a rapid growth with a CAGR of 5% and 11% respectively between the years 2012 and 2018. While the value of Sukuk was US$ 206 Billion in 2021, it reached to US$ 470 Billion in 2018. On the other hand, in 2018 the value of Islamic funds is US$ 108 Billion with an increase by 86% compared to 2012.

Figure 15: Sukuk Value Outstanding Growth and Islamic Funds Assets Growth, US$ Billion, 2012-2018[28]

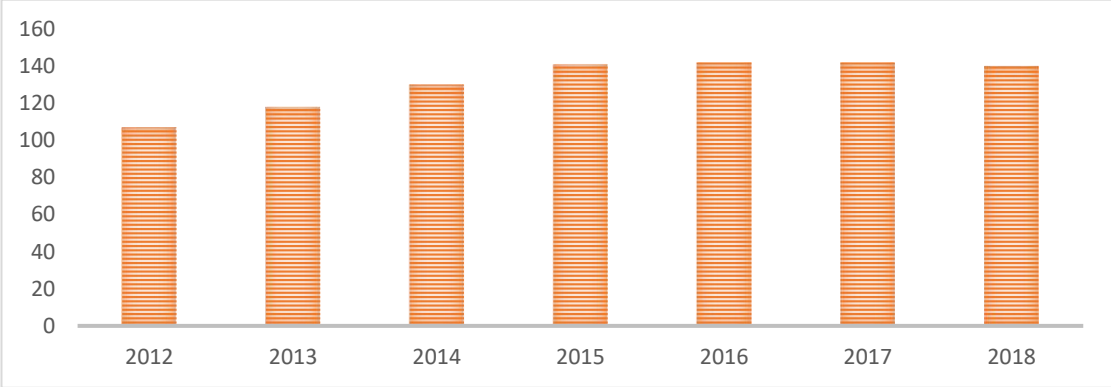


The size of the Sukuk sector accounted for US$ 470 Billion in 2018 while the number of countries involved in reached to 27. Furthermore, Malaysia, Saudi Arabia and Indonesia are the top three countries which constitute 78% of the global Sukuk value in 2018. Furthermore, Oman, Malaysia and Saudi Arabia are the top three markets and accounted for the 77% of the global Islamic funds in 2018.

OIFI, which constitutes 5% of the global Islamic finance assets, consist of financial institutions comprised of financial institutions as financing, mortgage, leasing and factoring companies (van Greuning and Iqbal, 2007). Figure 16 shows the OIFI assets growth between 2012 and 2018. According to the table it is seen that the total OIFI assets in 2018 reached to US$140 Billion.

[28] Reuters, 2018.

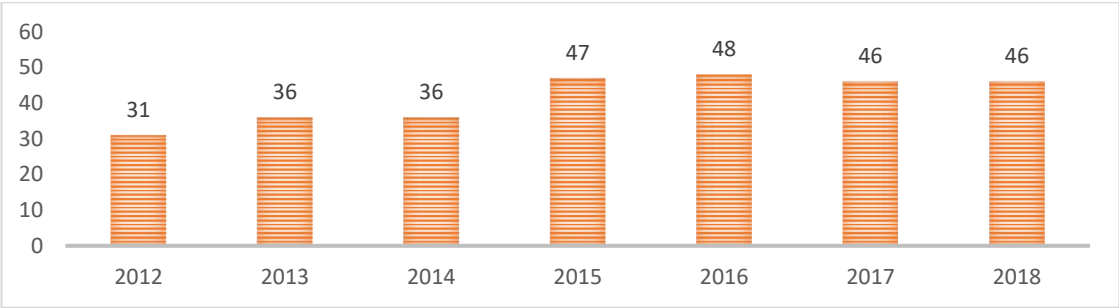
Figure 16: OIFI Asset Growth, US $ Billion, 2012-2018[29]



The assets held by the global OIFI sector grow with a CAGR of 5% between 2012 and 2018. Moreover, Malaysia, Iran and Saudi Arabia are the top three markets regarding the OIFI assets in 2018 and they represent 72% of the global OIFI assets.

In terms of takaful, in 2018, it constituted 2% of the global Islamic finance assets. According to the Figure 17, it is seen that in the same year, total takaful assets are US$ Billion 46 with a CAGR of 7% between 2012 and 2018.

Figure 17: Takaful Assets, 2012-2018[30]



Furthermore, the largest markets regarding takaful assets are Saudi Arabia, Iran and Malaysia and their share of global takaful assets is 80% in 2018.

[29] Reuters, 2018.
[30] Reuters, 2018.

3.5. ISLAMIC MODES OF FINANCE

Although, the Islamic finance is built on the principles of *Shari'ah,* they share the same basic functions with conventional banks. However, different from the conventional banking system, all types of financings are carried out based on the principle of PLS and prohibition of interest in terms of both raising and utilizing the funds. According to the *Shari'ah* principles, debt is not used as a source of funding in Islamic banks. Alternatively, equity financing is preferred over debt financing in lending transactions. In this respect, the main sources of funding of Islamic banks are owner's equity, deposits (current accounts and PLS accounts), investment accounts (*Mudarabah*) and special investment accounts (*Mudarabah* and *Musharakah*).

Islamic banks utilize these funds through Islamic financing methods. The Islamic financing methods can be categorized into two groups based on the type of financing they provide. Firstly, the Islamic banks provide direct finance to the customers through capital funds. This type of funding is based on partnership structure and profit-loss sharing principle that consist of *Mudarabah* and *Musharakah*. Secondly, they provide indirect financing through trade-based as leasing (*Ijarah*) and sale contracts such as *Murabahah*, *Salam*, and *Istisna'* (Ahmad, 2010). Furthermore, other common financing methods used by Islamic banks are takaful, sukuk and *karz-ı hasen*. The common points in these financing methods are that the bank has the information about where the customer will use this fund and in some of the financing methods, the bank is directly involved in the commercial activity subject to the contract.

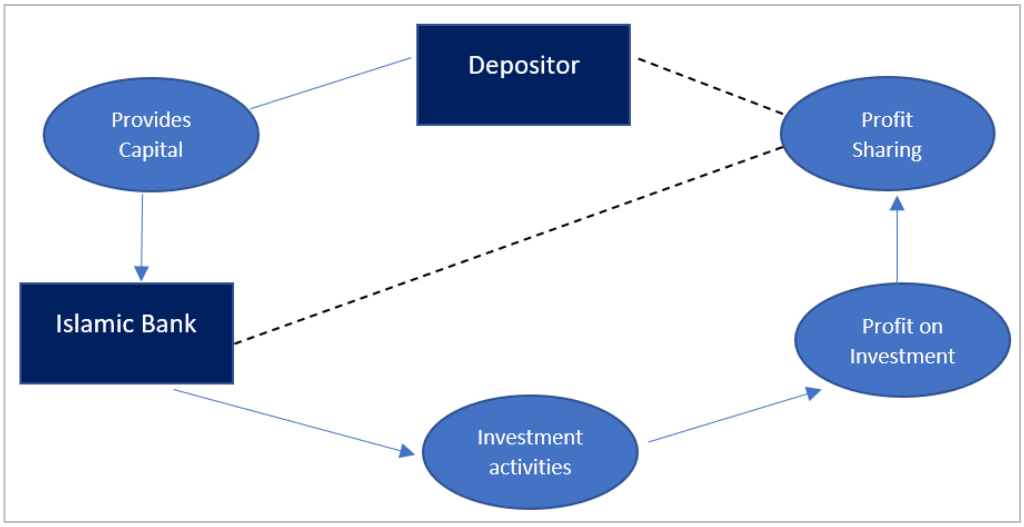
3.5.1. Mudarabah

Mudarabah is a trust-based contract between two parties with the Islamic banks as fund suppliers and fund seeking entrepreneurs. It can be defined as a labor-capital partnership between two parties in profit where "one party provides capital (*Rab al-Mal*) and the other party provides labor (*Mudarib*)" (AAOIFI, 2017, p. 670) In other words, the financial institution provides all the capital required for the project, while the client is responsible for the management of the project. *Mudarabah* contract is based on the PLS principle.

All details about this partnership are determined before the partnership starts. The profit is shared among the stakeholders according to the pre-determined rate that is stipulated in the contract. In case of loss, while the investor is responsible for covering all the losses, the entrepreneurs cannot receive anything in return for their labor, knowledge and experience.

In Islamic banking, the *Mudarabah* is applied as a two-tier model since it appears on both sides of the bank balance sheet. In the first tier, the contract is made between the depositors and the Islamic bank. Individuals who want to utilize their fund apply to the bank. The bank offers special investment accounts for the investors by making a *Mudarabah* agreement. The funds are distributed to the pool of investments by the bank. By putting their money into the investment account, the depositors become the fund providers where the Islamic bank manages the funds (Sangmi and Khaki, 2012). The profit is distributed in accordance with the pre-determined rate. In case of the loss, the bank bears the loss, unless it is caused by the negligence of the investor. In this case, the deposits that are put on the *Mudarabah* basis appear in the liabilities side in the balance sheet of Islamic banks.

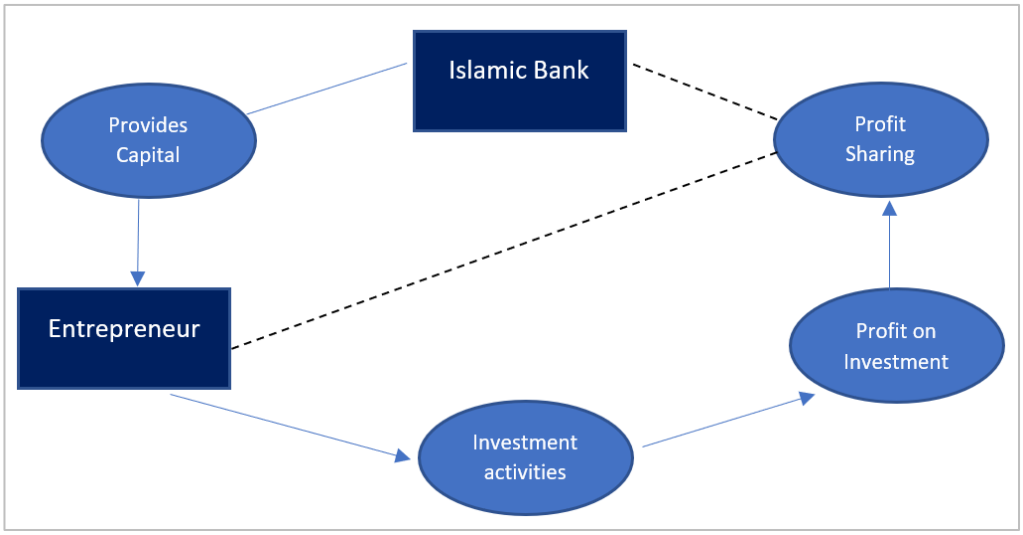
Figure 18: 1st Tier of the Mudarabah Contract[31]



[31] Sangmi and Khaki (2012).

According to the second tier, on the other hand, entrepreneurs, who seek funding, obtain financing from the bank on the condition of PLS principle. In this contract, while one party provides labor, knowledge and experience, the other party provides the capital. The profit is shared between the bank and the customer at pre-determined rates. If there is no profit or loss from the investment, the bank withdraws its capital and the customer does not earn a return. In case of the loss, the Islamic bank cover all the losses.

Figure 19: 2nd Tier of the Mudarabah Contract[32]



In *Mudarabah* contract, both parties agree in advance on how much the profit will be shared. Both parties have equal conditions regarding loss since when the investing party loses its capital, the entrepreneur will also lose his/her effort, time and labor. Moreover, the parties are treated equally in case of the violation of the agreement. For instance, if the manager violates the rules, causes damage as a result of mismanagement or negligence, she/he undertakes the safe return of the total amount in question. If the capital provider violates the rules, it is obliged to pay the executive a sum that could be earned in a similar job (Sangmi and Khaki, 2012).

[32] Sangmi and Khaki (2012).

3.5.2. Musharakah

Musharakah is “an agreement between two or more parties to combine their assets, labor or liabilities for the purpose of making profits” (AAOIFI, 2017, p. 326). It is a capital partnership where all parties contribute to the partnership with their capital and labor and share the loss and profit.

In *Musharakah*, the financing of the project is not only the bank's responsibility and each party has the same rights and liabilities. Different from the *Mudarabah*, all parties are involved in the management and financing of the project. Furthermore, while the profit is distributed in accordance to the partnership agreement, the loss is borne in proportion to the capital contribution. In *Musharakah*, the parties have the right to participate in the management of the project, but it is not compulsory. For this reason, the profit is not shared according to the amount of capital invested, but at the +-determined rate (Hassan and Lewis, 2007).

3.5.3. Murabahah

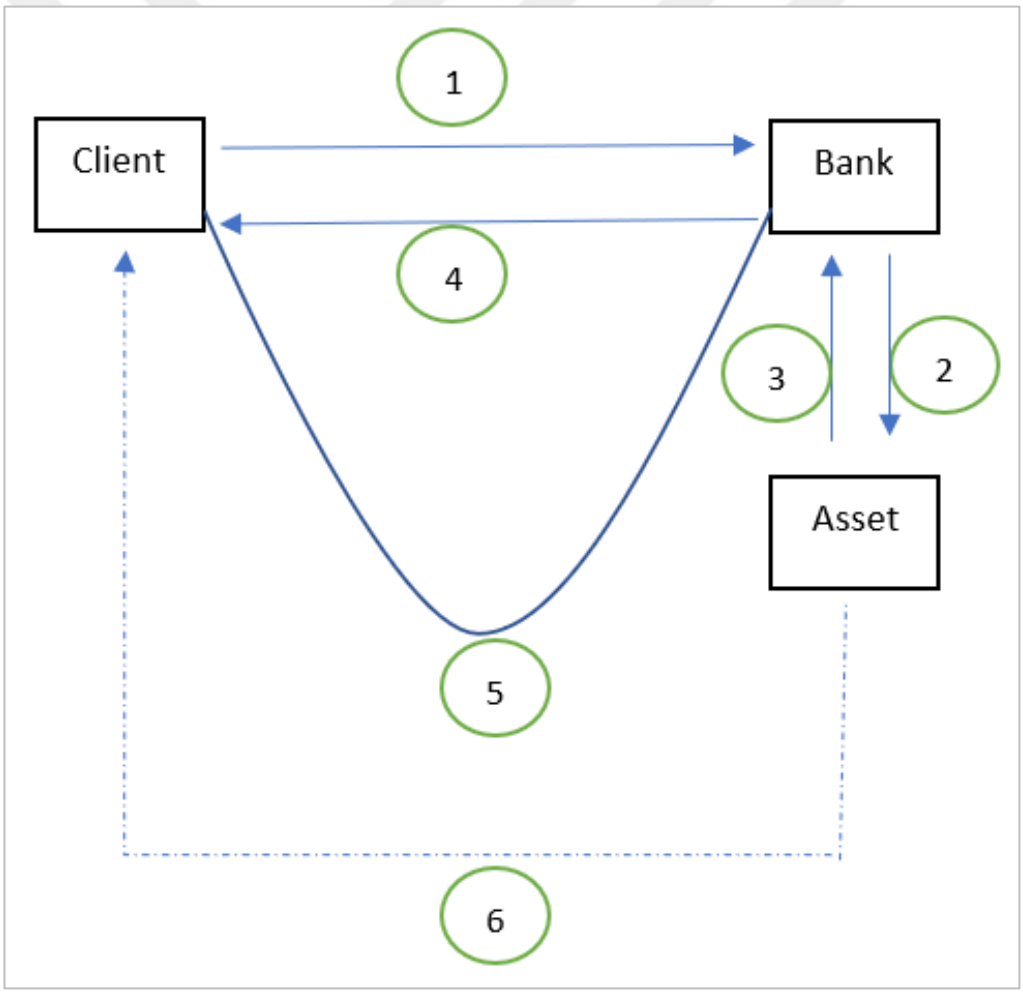
Murabahah is the purchase of a certain good from its owner upon the request of the customer at an agreed mark-up price. The payments is settled in instalment selling or lump sum (Z. Iqbal and Mirakhor, 2011). In *Murabahah*, the price of the relevant good is determined by adding a profit margin that is agreed between the bank and the customer. After the sale is made, no price change is possible until the repayment instalments are over. While the bank makes the payment directly to the seller, the goods are delivered to the customer. In the *Murabahah* transaction, only goods or services that are not prohibited by Islamic law can be financed.

3.5.4. Ijarah

Ijarah means leasing an asset to take advantage of its usufruct. This term also includes hiring labor for wages. In this context, hiring of a person is called a wage, whereas leasing

of commodities or assets becomes rent. *Ijarah* contract is a leasing contract for a known and proposed usufruct of a specific commodity or asset for a specific time period in order to generate a certain lawful return (Ayub, 2012). *Ijarah* includes the purchase of an asset or equipment requested by the customer by the bank and leasing it to the customer. In other words, in this financing method, the bank becomes the lessor and the customer is the lessee. The right to use the purchased asset is sold to the lessee at a pre-determined rental price. In the contract period, ownership of the property belongs to the lessor and is the responsibility for covering all expenses such as maintenance and repair arising from ownership belong to the lessor.

Figure 20: Ijarah Framework[33]



[33] Bakar and Rosbi (2017).

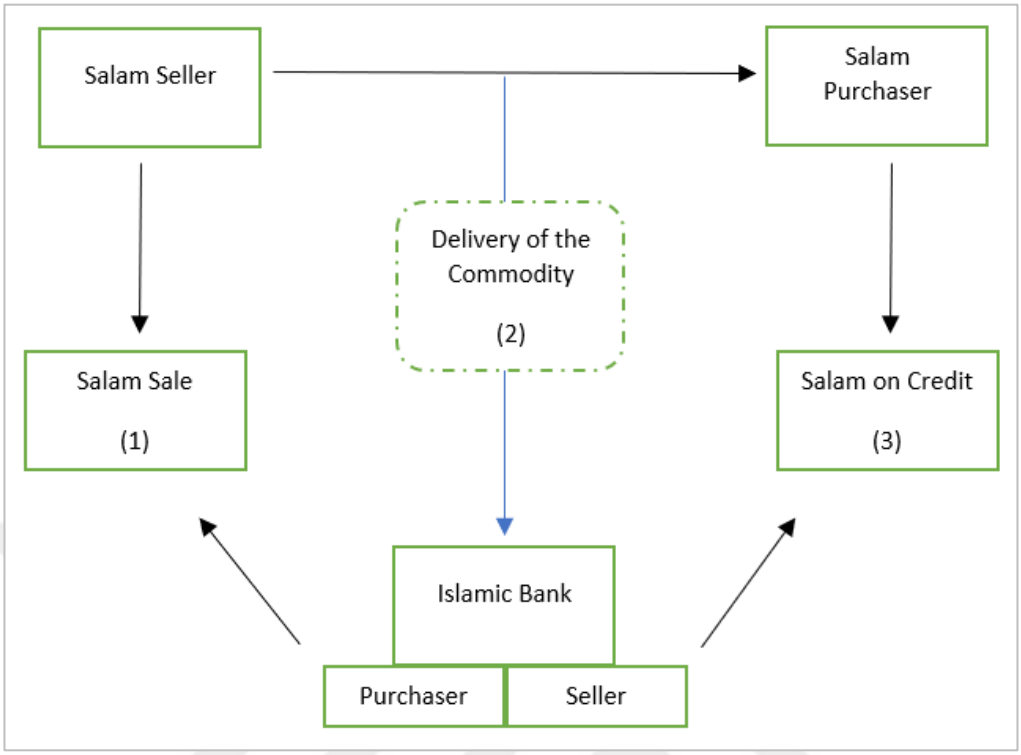
The bank agrees on the lease term and the lease amount for the property that the client wants to rent. The bank buys the commodity from the relevant seller on behalf of the bank. During contract period, the client pays the rental fee and benefit its usufruct. When the term of the lease expires, the asset may remain as a property of the bank or the client can purchase the previously rented goods from the bank at an agreed price.

3.5.5. Istisna' and Salam

As it is detailed in Section 3.1, the sale of non-existent assets is prohibited by the Islamic law. However, the *Salam* and *Istisna'* can be shown as exceptions. *Istisna'* can be defined as a "contract of sale of specified items to be manufactured or constructed, with an obligation on the part of the manufacturer or builder constructed, to deliver them to the customer upon completion" (AAOISI, 2018, pp. 319). In other words, it is a sales contract for the future production of a good whose qualities are well-defined but that do not yet exist. This contract only applies to objects that can be produced or constructed. In *Istisna'* contracts, the fee can be paid before the job, at a specified time or at the delivery of the job.

Salam is a contract in which the payment is made in advance at the time of the contract but the delivery of the specified goods is made later. In the *Salam* contract, the quantity, characteristics, delivery place and delivery date of the goods must be determined during the contract. In the sales contract of *Salam*, the seller promises to supply the goods to the buyer on the condition of advance payment. The flow of *Salam* transactions can be presented as in Figure 21:

Figure 21: The Flow of Salam Transactions by Bank[34]



3.6. THE MAIN RISK FACTORS OF ISLAMIC BANKING

3.6.1. Liquidity Risk

Liquidity can be defined as the ability of a bank to meet the redemption of the deposits and other liabilities and, also to fund the demands in the loan and investment portfolio and it is essential to offset the expected and unexpected balance sheet fluctuations and provide funds for growth (Iqbal and Mirakhour, 2007). As Oldfield and Santamero (1997) explain, unexpected demand of borrowers causes cash or liquid assets inadequacies which effect the bank's ability to provide funds promptly at a reasonable price.

After 1980's the Islamic banking has grown rapidly and spread to countries other than Islamic countries. Accordingly, studies show that there is a positive relationship between

[34] Ayub, 2012, p. 256

the bank size and liquidity risk and therefore, liquidity risks of Islamic banks have increased with the growth of Islamic banking (Ahmed and Usman, 2011; A. Iqbal, 2012).

For Islamic banks, the liquidity risk arises due to lack of liquidity in the market and lack of access to funding (Z. Iqbal and Mirakhor, 2011). The lack of liquidity in the market can be defined as the insufficient level of liquidity in the market or the loss arising from the inability to convert liquid assets into cash promptly and with reasonable price due to the adversities in the financial markets. Lack of access to funding, on the other hand, is the risk of failing to fulfil obligations at a reasonable cost due to irregularities in cash inflows and outflows.

Although Islamic banks comply with the principles of *Shari'ah*, they operate within the framework of conventional banking procedures, principles and practices. Accordingly, although the measurement and evaluation of the liquidity risk in both types of banks show some similarities, the instruments used in liquidity management differ significantly between Islamic banking and conventional banking since Islamic banks are operated based on *Shari'ah* principles. In this context, the main factor that causes liquidity risk in Islamic banking is the interest rate ban on accessing liquidity. Accordingly, the main cause of liquidity risk in Islamic banks are shown as the limited number of liquid *Shari'ah* compliant instruments. More precisely, while conventional banks use the financial instruments in the money market, inter-bank market, the secondary market or discount windows from central bank for liquidity management; Islamic banks cannot use these instruments since they involve interest (Mohammad, 2013). They meet their liquidity requirements through long-term assets or partnership contracts as *Ijarah*, *Mudarabah* and *Musharakah*. Therefore, there exist limited funding options for Islamic banks to manage liquidity risk. Liquidity risk is related to both sides of the balance sheet of Islamic banks. The reason for being on the assets side of the balance sheet arises from the banks' inability to return their assets to cash when needed without incurring any loss. On the other hand, it exists in the liabilities side in cases of unexpected withdrawals of deposit. For this reason, asset and liability management is very important in terms of ensuring a sustainable risk management in Islamic banking.

3.6.2. Credit Risk

One of the most crucial risks that banks take due to their banking activities is the credit risk. Credit risk can be defined as the potential loss that arises when a counterparty fails to fulfil its financial obligations according to the agreed-terms. The credit risk in Islamic banking is directly related to the financial products as *Murabahah*, *Ijarah*, *Salam*, *Istina*, *Musharakah* and *Mudarabah*.

As already explained in the Section 3.5.4, *Ijarah* is a leasing contract where a property is leased to the customer in return for a rental payment for a certain period. *Murabahah* is a transaction where the trader buys a property to sell it to a buyer by placing a certain profit rate (where Islamic banks are the traders). In the context of *Murabahah* and *Ijarah* contracts, there is a risk that the customer might not make his/her payments on time (Akkizidis and Khandelwal, 2008). On the other hand, *Salam* means the prepaid sale of a well-defined product to be delivered in the future. Therefore, for Islamic banks the credit risk occurs, if the customer does not make the agreed payments, where the seller might not deliver the product on time or at agreed quality as well. In *Istina* contract, a producer creates a good of property based on a specific standard and price. It is an advance sale of a specific commodity that is not manufactured or constructed yet. Islamic banks are exposed to credit risk through *Istisna'* contracts if the buyer is disable to buy the agreed product or if the buyer provides the installed payments after receiving the product. *Mudarabah* is a contract of partnership where one party provides capital and the other party provides labor and management. *Musharakah* is a mutual contract to establish a joint venture. One can see that in *Mudarabah* and *Musharakah* contracts, the relationship between the Islamic bank and the counterparts is partnership based. Therefore, credit risk occurs if the financial project does not bear the expected revenue (Akkizidis and Kumar, 2008).

3.6.3. Market risk

As IFSB(2005) explains, market risks can be defined as the losses in on and off balance sheet positions which is caused by the market prices such as fluctuations in values in

tradable, marketable or leasable assets and individual portfolios (Islamic Financial Services Board, 2005, p. 16) . Furthermore, the market is also related to the volatility of the foreign exchange rates.

Islamic banks are exposed to higher market risk than conventional banks due to the asset-backed financial instruments. Additionally, most of the Islamic finance contracts have high market risk. Market risk arising from Islamic finance contracts can be explained with respect to *Murabahah*, *Salam* and *Ijarah* agreements.

The *Murabahah* is associated with the market risk because of the mark-up rate. In *Murabahah*, mark-up rate is fixed during the contract but the benchmark rate may vary. If the prevailing mark-up rate exceeds the rate that is agreed in the contract, then the bank cannot benefit from this price change (van Greuning and Iqbal, 2007). Within the scope of the *Salam*, the market risk arises due to the price fluctuations in the commodity prices. In other words, market risk arises due to price differences in the period between the delivery and sale of the goods. If the bank cannot supply the product to be offered for sale, it may have to buy the same product at a higher bit price from the market. In operating Ijārah, the lessor is exposed to market risk in two ways. Firstly, market risk arises due to the residual value of the leased asset at the term of the lease. Secondly, if the tenant terminates the lease earlier than the specified period at the time of the lease, then the lessor is exposed to market risk (IFSB, 2005).

3.6.4. Profit/ Rate of Return Risk

The Islamic banks are exposed to rate of return risk due to the mismatches between the bank assets and balances of the depositors (IFSB, 2005). There is an uncertainty in the asset side of the Islamic banks' balance sheet in terms of the rate of return since there is no a fixed income from the financings as *Mudarabah* and *Musharakah*. This uncertainty causes the investment account holders' expectations to diverge with respect to the price changes. In other words, if benchmark prices increase, the investment account holders expect higher rate of return. Moreover, if the divergence increases, the rate of return risk also increases.

In Islamic banks, the uncertainty is higher compared to the conventional banks. Conventional banks operate based on interest, thus, on the asset side of their balance sheet, they have fixed income securities and also the return on deposits are predetermined. However, in Islamic banks, the investments are based on mark-up and equity implying that there is no fixed rate of return and, since there is no pre-agreed return on deposits where the uncertainty of the rate of return on investments is higher (van Greuning and Iqbal, 2007).

CHAPTER 4

DATA AND METHODOLOGY

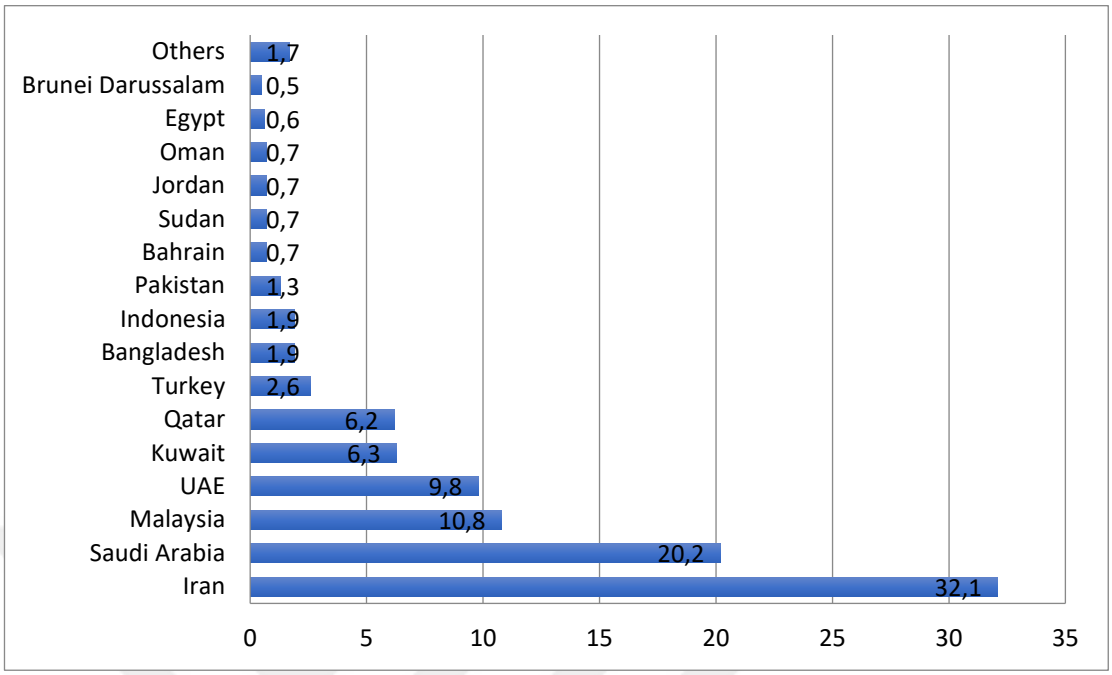
In this section, we first introduce the dataset that we employ to analyze the impact of banking crisis definition variations and the choice of the proxies for the banking sector fragility index (BSFI) on the predictive power of EWS models for Islamic banking. Although constructing EWS models differ across studies, the technical specifications of these models are built on the common criteria such as a precise definition of a crisis, a certain country coverage and time period, an explanatory variable set and, an estimation method that is used to analyze the probability of the occurrence of a crisis. Therefore, in the first part of this section, the country set, time period, explanatory variables and dependent variables of our EWS model are explained. In the second half of the section, we present the methodology we use to construct the EWS model.

4.1. DATA

4.1.1. Time Period, Country Sample and Islamic Banks

In this study, the country set is selected based on the criteria of having the highest 'share of global Islamic banking assets ratio' among the countries that provide Islamic banking services. Accordingly, the main factor for a country to be included in the dataset is to have a minimum 10% share of Islamic banking assets in its total domestic banking sector assets. To gather the share of global Islamic banking assets ratio, Islamic Financial Services Industry Stability Report (2019) of Islamic Financial Services Board was utilized. The countries according to their Islamic banking assets is given in the Figure 22.

Figure 22: Share of Global Islamic Banking Assets, 2018[35]



Due to data availability problem, we exclude some countries even if they match with our criteria (i.e. Egypt, Iran, Oman and Sudan). Therefore, the final country set consists of 12 developing countries from Asia.[36] Furthermore, all of the countries that are included in the analysis are hosting a dual banking system.[37] The final country set is given in Table 6:

Table 6: Country Set

Region	Countries
Western Asia	Bahrain, Kuwait, Qatar, Saudi Arabia, United Arab Emirates, Turkey, Jordan
South-Eastern Asia	Brunei Darussalam, Indonesia, Malaysia
Southern Asia	Pakistan, Bangladesh

[35] The share of the assets is apportioned in US Dollar terms in 2018.
[36] The country regions and economic status are categorized according to United Nations UNCTAD (United Nations Conference on Trade and Development) development status and geographical groups.
[37] It is the banking system where conventional banking and Islamic banking operates side by side.

The banking data is extracted from Datastream, Bankscope and Fitchconnect databases and covers annual observations from 81 Islamic banks from 12 countries over the period 2008- 2018. Table 7 provides the list of Islamic banks that are included in the study. The banks are selected considering data availability. Furthermore, in order to have a complete dataset, the banks that stopped their activities before 2018 are excluded from the dataset.[38]

Table 7: List of Islamic Banks

Country	Bank Name
Bahrain	ABC Islamic Bank
	Albaraka Islamic Bank
	Al-Salam Bank Bahrain
	Arcapita Bank
	Bahrain Islamic Bank
	Bank Alkhair
	Citi Islamic Investment Bank
	First Energy Bank
	GFH Financial House
	International Investment Bank
	Khaleeji Commercial Bank
	Kuwait Finance House
	Liquidity Management Center
	Seera Investment Company
	Venture Capital Bank BSC
Bangladesh	Al-Arafah Islami Bank
	Export Import Bank Of Bangladesh Limited (Exim Bank)
	First Security Islami Bank Limited
	Icb Islamic Bank Limited
	Islami Bank Bangladesh Limited
	Shahjalal Islami Bank Ltd
	Social Islami Bank Ltd
Brunei Darussalam	Bank Islam Brunei Darussalam
Indonesia	Bank BRI Syariah
	Bank Maybank Indonesia
	Bank Syariah Mandiri
	Bank Muamalat Indonesia
	Bank Syariah Bukopin
	Bank Mega Syariah
	Pt Bank Victoria Syariah
Jordan	Islamic Finance House Company
	Islamic International Arab Bank
	Jordan Islamic Bank
	Safwa Islamic Bank
Kuwait	Ahli United Bank
	Boubyan Bank
	Kuwait Finance House
	International Bank Of Kuwait
	Warba Bank
Malaysia	Affin Islamic Bank Berhad

[38] For the analyses, the bank data are aggregated at country level.

	Al Rajhi Banking & Investment Corporation (Malaysia) Berhad
	Alkhair International Islamic Bank Berhad
	Alliance Islamic Bank Berhad
	Ambank Islamic Berhad
	Bank Islam Malaysia Berhad
	Bank Kerjasama Rakyat Malaysia Berhad
	Bank Muamalat Malaysia Berhad
	Cimb Islamic Bank Berhad
	Hong Leong Islamic Bank Berhad
	Hsbc Amanah Malaysia Berhad
	Mbsb Bank Berhad
	Ocbc Al-Amin Bank Berhad
	Public Islamic Bank Berhad
	Rhb Islamic Bank Berhad
	Standard Chartered Saadiq Berhad
Pakistan	Al Baraka Bank Pakistan
	Bankislami Pakistan
	Dubai Islamic Bank Pakistan Limited
	Meezan Bank Limited
	Popular Islamic Modaraba
Qatar	Barwa Bank
	Masraf Al Rayan (Q.S.C.)
	Qatar First Bank Llc
	Qatar International Islamic Bank
	Qatar Islamic Bank
Saudi Arabia	Al-Rajhi Bank
	Alinma Bank
	Bank Albilad
	Bank Aljazira
Turkey	Albaraka Türk Participation Bank
	Kuveyt Türk Katilim Bankasi A.S.
	Türkiye Finans Katilim Bankasi A.S.
UAE	Abu Dhabi Islamic Bank - Public Joint Stock Co.
	Ajman Bank
	Al Hilal Bank Pjsc
	Amlak Finance Pjsc
	Dubai Islamic Bank Pjsc
	Emirates Islamic Bank Pjsc
	Noor Bank
	Sharjah Islamic Bank

4.1.2. Explanatory Variables for EWS

In this thesis, following the related EWS literature which is explained in detail in Chapter 2, various banking sector and macroeconomic variables are used in order to build an EWS model of banking crises. On this basis, considering only macroeconomic variables as explanatory variables does not provide adequate information to explain Islamic banking crisis. As Hardy and Pazarbaşıoğlu (1998) investigate, bank specific variables are also

crucial and gives the best warning signs in terms of the banking crisis events. For this reason, we use both macroeconomic variables and bank-specific variables as explanatory variables. The data for bank specific variables is derived from Datastream, Bankscope and Fitchconnect databases and, the macroeconomic variables are extracted from the World Development Indicators of World Bank and International Financial Statistics of IMF.

4.1.2.1. Bank Specific Variables

In this thesis, the bank specific variables are grouped as capital adequacy, asset quality, management adequacy, earnings ability, liquidity level and sensitivity to market risk. The bank specific variables that are considered in the construction of EWS models are given in Table 8:

Table 8: Bank Specific Variables

Bank Specific Variables

Capital Adequacy	Capital Adequacy Ratio (CAR)
Asset Quality	The ratio of Total Loans to Total Assets (TLtoTA)
Management Quality	The Ratio of Total Operating Revenues to Total Operating Expenses (TORtoTOE)
Earnings Ability	Return on Assets (ROA)
Liquidity Level	Total Loans/Total Deposits (TLtoTD) The Ratio of Total Liquid Assets to Total Assets (TLAtoTA)
Sensitivity to Market Risk	The ratio of Sensitive Liabilities (Securities) to Total Assets (SLtoTA)

The banking specific variables are classified and selected by considering the variables used within the framework of CAMELS method. CAMELS is a rating system which was adopted by the Federal Financial Institutions Examination Council[39] in 1979. It is comprised of six bank safety, soundness and performance components as:

[39] Federal Financial Institutions Examination Council is a formal U.S government interagency body.

- Capital Adequacy: Used to evaluate the capital of the bank in terms of quantity and quality. Capital adequacy measures the financial strength and stability of banks against unexpected and adverse situations.
- Asset Quality: Used to measure the level of risk of the assets owned by banks.
- Management quality: Used to measure the bank's management in terms of quality and capacity.
- Earning Ability: Measures whether banks' assets and equity resources are used efficiently. In other words, it measures the profitability of banks.
- Liquidity Level: Used to measure the responsiveness of the bank in case of sudden cash demands and ability of banks to convert to cash.
- Sensitivity to Market Risk: Measures the preparedness of the bank against market risks such as changes in interest rates and exchange rates.

One of the most important indicators for a safe and stable banking system is maintaining the adequate level of capital. Sufficient amount of capital protects depositors from unforeseen situations and promotes the stability and safety of financial systems. In order to measure the capital adequacy of Islamic banks, we use capital adequacy ratio (CAR). While the level of CAR should be at least 8% according to the international standards, the empirical studies show that this ratio is rather higher in Islamic banks (Abusharba et al., 2013; Bayunya and Haronb, 2017; Errico and Farahbaksh, 1998). The reason of high CAR of Islamic banks is due to the different nature of assets and the high-risk environment of Islamic banks. In other words, high CAR can be mainly attributed to the principle of PLS of Islamic banking. More specifically, *Mudarabah* contracts, for instance, enable the bank to accrue some of the profits while risking the funds of depositors which implies loss bearing by investors. Furthermore, Islamic banks have higher ratio of risk assets to total assets compared to conventional banks. These situations pose an important obstacle for Islamic banks to have adequate capital (Errico and Farahbaksh, 1998; Jobst and Sole, 2020). For this reason, the capital adequacy ratio is crucial in examining the fragilities of the Islamic banks. The CAR has a negative relationship with the fragility of the banking system. Therefore, high CAR is expected to decrease the probability of banking crisis.

According to Grier (2007), most of the banking failures is caused by the poor asset quality. Following Martin (1977), we consider the ratio of total loans to total assets to measure the asset quality. The author suggests the asset risk should be proxied by loans since they are riskier than securities or cash assets. Accordingly, high total loans to total assets ratio means asset quality is low and the structure of assets are more sensitive to loan losses (Atikoğullari, 2009). This implies that high total loans to total assets ratio increases the probability of the occurrence of banking crisis.

We consider the ratio of total operating revenues to total expenses as a proxy for the management quality of the Islamic banks. As higher ratio reflects a strong management quality, higher total operating revenues to total expenses ratio decreases the probability of fragility of banks.

Earning level is also one of the most crucial components of the banking sector. As Khan and Ahmed (2001) highlight, the most critical risk faced by Islamic banks is the rate of return since, for example, the *Murabahah* contracts cannot be repriced and Islamic banks cannot use swaps to hedge the risk. In this study, the earning level is measured by using return on assets variable. The profitability of the bank reflects its strength, thus, higher return on assets decreases the probability of banking crisis.[40]

Banks must keep a certain portion of their resources in liquid form. Accordingly, it is crucial for banks to keep proper level of liquidity in order to response unexpected situations such as bank runs. For liquidity ratios, we prefer to use two different ratios as total liquid assets to total assets ratio[41] and total loans to total deposits ratio. The ratio of total liquid assets to total assets shows the banks' ability to pay its liabilities. The ratio of total loans to total deposits shows the level of bank loans that is funded with deposits. Higher level of these ratios indicates the bank's ability to prevent itself from unexpected bank runs.

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[40] Total Income is comprised of Islamic financings as *Murabahah, Istisna', Ijarah, Salam, Musharakah* and *Mudarabah*.

[41] Martin (1977).

Sensitivity to market risk measures the preparedness of the bank against market risks such as changes in interest rates, exchange rates, commodity prices. Banks are institutions that are affected by market risks such as excessive price changes. Banks become vulnerable to crises with the deterioration in macroeconomic structure and excessive volatility in financial markets. Moreover, following Mayes and Stremmel (2012) and, Khokher and Alhabshi (2019), the sensitivity to market risk is measured by using the ratio of sensitive liabilities to total assets. If this ratio is low, the sensitivity to market risk increases causing the probability of banking crisis increases.

4.1.2.2. Macroeconomic Variables

In the related literature, early warning systems have been developed by considering various macroeconomic variables to investigate the leading indicators of banking crises. For constructing an EWS model, there is no optimal number of independent variables. For instance, while Frankel and Sarvelos (2012) and Rose and Spiegel (2011) use more than 50 explanatory variables, Kusuma and Asif (2016) construct their EWS by using only 4 macroeconomic variables. Furthermore, there is also no standard list of explanatory variables for EWS models since the reasons for the emergence of crises are different (Davis and Karim, 2008). However, some of the macroeconomic variables are frequently used in the literature and observed as significant indicators of banking crises. Therefore, for the analyses of this study, the macroeconomic variables are selected considering the prominent predictors of the banking crisis literature following the previous studies (see among others, Davis and Karim, 2008; Demirgüç-Kunt and Detragiache, 1998; G. L. Kaminsky and Reinhart, 1999). Within this context, Table 9 shows the statistically significant indicators of banking crisis with respect to the prominent studies of the literature.

Table 9: Significant Indicators of Banking Crisis in the Literature[42]

	Demirgüç-Kunt and Detragiache (1998)	Glick and Hutchison (1999)	Kaminsky and Reinhart (1999)	Hardy and Pazarbaşıoğlu (1998)	Davis and Karim (2008)	Jing (2013)	Caggiano et al. (2013)	Qin and Luo (2014)	Hmili and Bouraoui (2015)	Kusuma and Asif (2016)	Wang et al. (2021)
GDP Growth	x	x	x	x	x	x	x	x	x		x
change in terms of trade	x		x		x						x
real exchange rate	x		x	x		x	x	x	x	x	x
real interest rate	x	x	x	x	x			x	x		x
inflation	x	x			x	x	x	x	x	x	x
the ratio of central government budget surplus to GDP	x	x			x				x		
ratio of M2 to foreign exchange reserves	x		x		x	x	x	x	x	x	x
ratio of domestic credit to private sector to GDP	x	x	x	x	x	x	x		x		
ratio of bank liquid reserves to bank assets	x				x						
real domestic credit growth	x				x					x	x
explicit deposit insurance	x	x	x		x						
the quality of law enforcement	x										
financial liberalization		x									
International reserves			x								
M1			x								
M2			x								
consumption				x							
Investment				x							
the ratio of deposit liabilities to GDP				x							
the ratio of foreign liabilities to GDP											
GDP per capita					x						x
the ratio of external debt to GDP						x					
the ratio of short-term debt to reserves						x					
Current Account Balance (% GDP)								x	x		

[42] The table is produced by the author.

As one can see from Table 9, GDP growth, real interest rate, inflation rate, exchange rate, current account balance and money supply are frequently associated with the occurrence of the banking crisis and included as prospective macroeconomic explanatory variables in this study. Furthermore, we also include additional variables which we believe has the ability to explain Islamic banking crises. The macroeconomic variables that are considered as independent variables in the construction of EWS models are given in Table 10.

Table 10: Macroeconomic Variables

Macroeconomic Variables	
Capital Account	Foreign Direct Investment (% of GDP) (FDI)
Debt Profile	Total Reserves (% of Total External Debt) (TotRes)
Current Account	Real Effective Exchange Rate (reer), Current Account Balance (% of GDP) (CAB)
Other Financial	The Ratio of M2 to International Reserves (M2toRes, M2 (%of GDP) (M2toGDP)
Real Sector	Inflation Rate (inflation), GDP Growth (GDPGrwth), Real Interest Rate (rir)

The macroeconomic variables are categorized according to Kaminsky et al.'s (1998) classification. As it is examined in various studies in the literature, real GDP growth is a leading indicator of a banking crisis. The economic growth is associated with a solid and safe financial system by increasing the asset prices and credit quality (Drehmann et al., 2011; Kindleberger and Aliber, 2005). On the other hand, as Allen and Gale (2007) emphasize, declining growth in the real economy can cause financial sector difficulties where it can lead to declines in asset prices and cause the borrowers repayment difficulties of the loans. Therefore, the recession episodes experienced in the economy is shown as one of the most important indicators of banking crises.

As explained in detail in Chapter 3, although Islamic banks operate on the prohibition of interest principal, they are more sensitive to the interest rate risks. The interest rates are the main indicator of the interest rate risks. On this basis**,** increasing interest rates increases the credit rationing and leads to moral hazard and adverse selection bias which increase the probability of banking crisis by causing credit crunch and low economic

growth (Berardi, 2011; Obstfeld, 1996; Velasco, 1987). Furthermore, low ability of the banks to protect themselves from interest rate risk causes a more fragile banking system (Davis and Karim, 2008). Therefore, high interest rates is a leading indicator of banking crises.

The appreciation of exchange rate affects output growth adversely by decreasing the competitiveness of the economy and the revenues of the banks. High inflation rate, on the other hand, cause economic instability by increasing the interest rates which leads adverse effects on real and financial sector. Furthermore, high level of inflation erodes the value of banks assets, thus, causes distortion of credit distribution in the long run by increasing NPL. Current account balance reflects the external balance of the economy. Increasing rate of current account balance to GDP increases the external financing needs of the economy and creates pressure on the exchange rate. Moreover, budget deficits reduce the national savings and lead to high inflation and interest rates. Therefore, it is expected to be positively related with the banking crises incidence. Furthermore, the ratio of foreign direct investments to GDP is found as a statistically significant explanatory variable and increasing value of this ratio decreases the fragility of the banking sector by recovering the debt profile of the economy.

The ratio of M2 to international reserves measures the ability of the banking system against foreign exchange pressure. Significant reductions in international reserves are indicative of abnormal capital outflows. Furthermore, the decreasing ratio weakens the strength of national currency. Therefore, the variable is a significant indicator of the likelihood of banking crises. The ratio of M2 to GDP, on the other hand, reflects the financial depth of the economy and it is expected to negatively related with the crisis occurrence.

Table 11 below provides the summative information about the definitions and the data sources of each explanatory variable used in our EWS models.

Table 11: Data Definitions and Sources of Explanatory Variables

		Variable	Definition	Data Source
Macroeconomic Variables				
	Capital Account	Foreign direct investment (% of GDP)	Foreign direct investment is net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments.	World Bank, WDI
	Debt Profile	Total Reserves (% of Total External Debt)	International reserves to total external debt stocks.	World Bank, WDI
	Current Account	Real Effective Exchange Rate	Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs.	World Bank, WDI; National Central Bank Sources
		Current Account Balance (% of GDP)	Current account balance is the sum of net exports of goods and services, net primary income, and net secondary income.	World Bank, WDI
	Other Financial Variables	The Ratio of M2 to International Reserves; M2 (%of GDP)	Broad money is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.	World Bank, WDI; National Central Bank Sources
	Real Sector Variables	Inflation Rate	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.	World Bank, WDI
		GDP growth (annual %)	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.	World Bank, WDI
		Real Interest Rate	Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator.	World Bank, WDI

Bank Specific Variables				
	Capital Adequacy	Capital Adequacy Ratio	The ratio of the total regulatory capital to risk weighted assets. The total regulatory capital includes all capital as defined by the regulator. This is the sum of Tier 1 and Tier 2 capital.	Bankscope
	Asset Quality	The ratio of Total Loans to Total Assets	Total loans include net loans+ reserves against possible losses on impaired or non-performing loans. Total assets include total earning assets+ cash and due from banks+foreclosed real estate+fixed+assets+goodwill+other intangibles+current tax assets+defereed tax+discontinued operations+other assets	Bankscope
	Management Quality	The Ratio of Total Operating Revenues to Total Operating Expenses	Operating revenues includes income gained from operating activities such as rental income, income from investments and trading and derivatives. Total operating expenses include wages, salaries, social security costs, pension costs and other staff costs, expensing of staff stock options, depreciation, amortization, administrative expenses, occupancy costs, software costs, operating rentals, audit and professional fees and other operating expenses of an administrative nature.	Bankscope
	Earnings Ability	Return on Assets	The ratio shows compares the efficiency and operational performance of banks as it looks at the returns generated from bank's assets.	Fitchconnect
	Liquidity Level	The Ratio of Total Liquid Assets to Total Assets	Liquid assets include cash and due from banks, central banks, other banks and other credit institutions+deposits+ treasury bills+ other bills+ government securities+ trading securities. Total assets include total earning assets+ cash and due from banks+foreclosed real estate+fixed assets+goodwill+other intangibles+current tax assets+defereed tax+discontinued operations+other assets	Bankscope
	Sensitivity to Market Risk	The ratio of Securities to Total Assets	Securities include debt securities, equity securities and other securities. Total assets include total earning assets+ cash and due from banks+foreclosed real estate+fixed assets+goodwill+other intangibles+current tax assets+defereed tax+discontinued operations+other assets	Fitchconnect

4.1.3. The Dependent Variables for EWS

EWS models are designed to estimate the probability of a banking crisis for a country in a specific time period. They are useful in monitoring the crisis risk by providing an opportunity to prevent the crisis or take early precautions to minimize the loss in situations where it is not possible to prevent the crisis. These models reveal a predictive power based on the correctly predicted crisis and non-crisis episodes. Within this framework, the first and the most crucial step to construct an EWS is to make an explicit and precise definition of the crisis event. The crisis definition is the dependent variable of the model and the predictive power of EWS and the significant indicators of the crisis depend on the crisis occurrence. At this juncture, the main challenge is the lack of consensus on the definition of the banking crises in the related literature. According to the existing empirical studies, banking crises definitions can be classified into two approaches as the event-based and index-based. The event-based approach accepts the events of solvency, bank runs, bankruptcy, high level of nonperforming loans (NPL), bank holidays, large-scale nationalizations, deposit freezes, closures, mergers and, the cost of rescue operations as the banking crisis (Caprio and Klingebiel, 1997; Demirgüç-Kunt and Detragiache, 1998). In index-based approach, on the other hand, the banking crisis is defined by constructing a banking system fragility index (BSFI) which measures the effect of different combinations of proxies for the considered banking risk factors (Kibritçioğlu, 2006; Singh, 2011; Wiranatakusuma and Duasa, 2016).

The event-based approach is widely used in the empirical studies of EWS. The main reasons behind this choice are based on the data concerns and the complication of designing a BSFI. For instance, the data required to define a banking crisis based on a certain event as bank runs, government interventions or change in banking regulations are relatively accessible. Despite such advantages, however, the event-based approach has critical drawbacks. Within this context, Von Hagen and Ho (2007) explain these drawbacks fourfold. Firstly, they emphasize the timing problem of the approach. In the literature, the identification of the banking crises within event-based approach mostly relies on the government interventions, closures and mergers (Lindgren et al., 1996;

Kaminsky,1998; Demirgüç-Kunt and Detragiache, 1998). However, the problems in the banking sector begin to arise before these events take place. For instance, although the governments support the banks in the first phases of the banking crisis, these early interventions are not perceived since the governments tends to conceal their supports due to the policy concerns (Von Hagen and Ho, 2007). Furthermore, the other events for the identification of the banking crisis such as the bank holidays[43] and the nationalization of banks usually takes place after the banking crisis occurs and becomes severe. For these reasons, the event-based approach may lead to detect the banking crisis too late (Von Hagen and Ho, 2007). The second and the third drawbacks are related to the severity of the government intervention and the exact timing of the crisis episodes. More precisely, since the objective standards about the policy intervention is limited, it is difficult to determine if the policy intervention by the government is large enough. In this context, as Boyd et al. (2009) explain, in event-based approach, the identification of the banking crises is based primarily on the information about the government measures against the banking crises which is obtained from banks regulators and/or central banks of the countries. In other words, the information that is required to identify the banking crisis is directly under the control of the governments. For this reason, although this approach effectively measures the response of the governments towards a banking crisis, it does not enable to determine the actual beginning date and the duration of an adverse shock to the banking system (Boyd et al., 2009).

The fourth drawback of the event-based approach is the selection bias problem. According to Von Hagen and Ho (2007), this method identifies the banking crises only if they have severe impacts that trigger the market. In other words, the banking crises that are successfully controlled by applying prompt corrective policies are ignored which leads to a selection bias problem.

It is often stated in the literature that creating an index value for defining the banking crisis is difficult due to lack of reliable sectoral data on the banking sector such as NPL

[43] Bank holiday refers to closing all the banks temporarily. For instance, in US a bank holiday is declared by the President on the entire banking system from March 6 1933 to March 13 1933 in order to prevent the bank failures that was caused by massive bank runs (Chandler and Kennedy, 1974).

(Hawkins and Klau, 2011; Klingebiel, 2003). Moreover, determining the proxies for the specific risk factors is also challenging in the construction of a BSFI. In the literature, although indices are developed considering the same banking risk factors, the proxies that are used to measure the risk factors differ. Therefore, it is crucial to determine the relevant proxies since the identification of the crisis episodes is directly related with the proxies. However, despite these difficulties, the attempts towards defining the banking crisis with developing a BSFI has increased in the literature both for conventional banking and Islamic banking.

In this thesis, our main objective is to provide a solid banking crisis definition for Islamic banks. To this aim, considering the drawbacks of the event-based approach that detailed above, we focus on the index-based approach to construct an EWS model that reveals substantial predictive power results for Islamic banking. For this, we construct a BSFI which is comprised of the main risk factors of the Islamic banking system as the credit risk (CR), liquidity risk (LR) and market risk (MR). Furthermore, apart from the existing literature, we incorporate a profitability risk (PR) measure, in order to explore whether the profitability risk factor has a significant impact on the predictive power of EWS for Islamic banks. The BSFIs are defined as the average standardized value of the credit risk proxy, market risk proxy, liquidity risk proxy and profitability risk proxy. Following Kibritçioğlu (2002) and Ahmad and Mazlan (2015), the BSFI in period t is defined as follows:

$$BSFI_{i,t} = \frac{\left(\frac{CR\ Proxy_t - \mu_{CR\ Proxy}}{\sigma_{CR\ Proxy}}\right) + \left(\frac{MR\ Proxy_t - \mu_{MR\ Proxy}}{\sigma_{MR\ Proxy}}\right) + \left(\frac{LR\ Proxy_t - \mu_{LR\ Proxy}}{\sigma_{LR\ Proxy}}\right) + \left(\frac{PR\ Proxy_t - \mu_{PR\ Proxy}}{\sigma_{PR\ Proxy}}\right)}{N} \quad (3)$$

where,

$$CR\ Proxy_t = \frac{(CR\ Proxy_t - CR\ Proxy_{t-1})}{CR\ Proxy_{t-1}} \quad (4)$$

$$MR\ Proxy_t = \frac{(MR\ Proxy_t - MR\ Proxy_{t-1})}{MR\ Proxy_{t-1}} \quad (5)$$

$$LR\ Proxy_t = \frac{(LR\ Proxy_t - LR\ Proxy_{t-1})}{LR\ Proxy_{t-1}} \quad (6)$$

$$PR\ Proxy_t = \frac{(PR\ Proxy_t - PR\ Proxy_{t-1})}{PR\ Proxy_{t-1}} \quad (7)$$

μ and σ are the mean and standard deviation of the proxies, respectively. N is the number of proxies used.

We consider episodes as banking crisis if the index value is less than 0. That is:

$$Fragility\ Episode(FE)_{i,t} = \begin{cases} 1, & if\ BSFI_{i,t} < 0 \\ 0, & otherwise \end{cases} \quad (8)$$

More precisely, the BSFI is transformed into a binary variable *FE*, defining the fragility episode and takes the value 1 if BSFI is less than 0. This states that Islamic banks in county *i* at time *t* are fragile to banking crises. On the other hand, an episode is classified as tranquil period if the BSFI exceeds 0 and the FE variable takes the value 0.

In the related literature, there is no consensus for the definition of the banking crises as well as the proxies of the banking sector risk factors. Therefore, the predictive power rates, which is an important indicator of upcoming crisis probabilities, differ from model to model causing a significant diversity across studies. For this reason, in order to investigate the impact of banking crisis definition variations and the impact of the choice of the proxies for the banking fragility index on the predictive power of EWS models for Islamic banking, we develop twenty-five different banking crisis definitions. All of the indices are developed considering three banking risk factors as CR, LR, MR and PR whereas the proxies that are used to measure the risk factors differ in each of the indices. In constructing our BSFIs, we focus on the main risk factors of the Islamic banking that explained in Section 3.6 in detail. In this framework, the ratio of domestic credit to private sector (BC) and non-performing financing (NPF) are considered as proxies for credit risk; bank deposits (DEP) is considered as a liquidity risk proxy and; banks' real foreign liabilities (FL) and time interest earned ratio (TIER) are considered as proxies for market risk. To measure the profitability risk factor, we use return on equity (ROE).[44]

[44] Due to data availability problem, to measure profitability we use ROE proxy among others which has a complete and reliable data.

4.1.3.1. Proxies for the BSFI

In line with the existing literature, we consider the non-performing financing (NPF) and the ratio of domestic credit to private sector proxies in order to measure the credit risk. In the literature, non-performing loans (NPL) and non performing financing are widely used and accepted as prominent determinants for credit risk both for conventional and Islamic banks (Berger and DeYoung, 1997; Firmansyah, 2015; Salim et al., 2017; Khan et al., 2020). The non-performing loans (NPL) in *Shari'ah* banking, in fact are calculated as non-performing financing (NPF) since Islamic banking is different from conventional banking in terms of financing. One should also note that NPF is directly related with Islamic Bank specific contracts such as *Murabahah, Ijarah, Salam, Istisna', Musharakah* and *Mudarabah*. Therefore, including NPF as a credit risk proxy to measure fragility, our choice reflects the tenets of Islamic financing that are different from conventional banking.[45] A rising value of NPF adversely affects the health of the banking system thus increases the fragility of banks. Besides, the ratio of domestic credit to private sector is a commonly used proxy in the related literature to measure the financial debt reflecting the developments in the credit market (Baum et al., 2020; Beck et al., 2013; Levine and Zervos, 1998).

[45] Note that, credit risk can be defined as the possibility that the counterpart might not be able to pay his/her obligations. Accordingly, credit risk in Islamic banking is directly related to the financial products as *Murabahah, Ijarah, Salam, Istisna, Musharakah* and M*udarabah.* As already explained in the Section 3.5, Ijarah is a leasing contract where a property is leased to the customer in return for a rental payment for a certain period. *Murabahah* is a transaction where the trader buys a property to sell it to a buyer by placing a certain profit rate (where Islamic banks are the traders). In the context of *Murabahah* and *Ijarah* contracts, there is a risk that the customer might not make his/her payments on time (Akkizidis and Kumar, 2008). On the other hand, *Salam* means the prepaid sale of a well-defined product to be delivered in the future. Therefore, for Islamic banks the credit risk occurs due to *Salam* contracts, if the customer does not make the agreed payments and where the seller might not deliver the product on time or at agreed quality as well. In *Istina* contract, a producer creates a good of property based on a specific standard and price. It is an advance sale of a specific commodity that is not manufactured or constructed yet. Islamic banks are exposed to credit risk through *Istisna'* contracts if the buyer is disable to buy the agreed product or if the buyer provides the installed payments after receiving the product. *Mudarabah* is a contract of partnership where one party provides capital and the other party provides labor and management. *Musharakah* is a mutual contract to establish a joint venture. One can see that in *Mudarabah* and *Musharakah* contracts, the relationship between the Islamic bank and the counterparts is partnership based. Therefore, credit risk occurs if the financial project does not bear the expected revenue (Akkizidis and Kumar, 2008).

For the liquidity risk, bank deposits variable is considered. In Islamic banking, the bank deposits are comprised of demand deposits (*Wadia*), saving deposits (*Wadia* and *Mudarabah*), and Time Deposits (*Mudarabah* 1, 3,6,12,>12 months). Bank deposits is a standard measure for liquidity risk and frequently used in Islamic banking literature (Kibritçioğlu 2003, Ahmad and Mazlan, 2015; Kusuma and Asif, 2016; Wiranatakusuma and Duasa, 2017).

In order to measure the market risk, banks' real foreign liabilities and time interest earned ratio (TIER) are considered. As Kibritçioğlu (2003) explains, under the expectation that currency is not devaluated in the near future, the banking sector tends to obtain funds from international financial markets by taking excessive risk. In this respect, if banks hold a considerable amount of unhedged foreign currency debt, an unexpected devaluation increase the fragility of the domestic banking sector by decreasing the net worth of banks. For this reason, foreign liabilities is a crucial proxy for measuring the market risk. On the other hand, following Dincer (2011) and Carey and Stulz (2007), we also measure the market risk through the size of the bank in terms of the assets. The authors suggest that bank size is negatively related to the sensitivity of market risk and decreases the fragility of the banks since larger banks have more diversified portfolios than the small banks.

In this thesis, one of our attempts is to investigate whether the profitability risk has any impact on the predictive power results of EWS for Islamic banks. To this aim, we use ROE since it is accepted as the most important indicator of a bank's profitability and, also widely-used for Islamic banking (Moin, 2013; Srouji et al., 2015; Bilal et al., 2016; Ekinci and Poyraz, 2019). ROE can be defined as the ratio of net income to stockholders' equity. More explicitly ROE is the profit after tax over equity capital and, it is the net earnings per dollar of the Islamic bank's equity capital. In order to calculate the net income for Islamic banks, expenses are subtracted from the gross income where expenses include salaries and other operating expenses, depreciation and provisions (Krueger, 2017). Table 12 presents the proxies for each of the banking risk factors that are used in constructing banking fragility indices to define banking crises.

Table 12: The Proxies and Risk Factors Used in the Construction of BSFIs

	Credit Risk	*Liquidity Risk*	*Market Risk*	*Profitability Risk*
Model 1[46]	NPF	DEP	TIER	-
Model 2	NPF	-	TIER	-
Model 3	BC	-	TIER	-
Model 4	NPF	DEP	FL	-
Model 5	BC	DEP	TIER	-
Model 6	NPF	-	FL	-
Model 7	NPF	DEP	TIER	ROE
Model 8	NPF	-	TIER	ROE
Model 9	BC	DEP	TIER	ROE
Model 10	BC	-	TIER	ROE
Model 11	NPF	DEP	FL	ROE
Model 12	NPF	-	FL	ROE
Model 13	BC	-	FL	ROE
Model 14	BC	DEP	FL	ROE
Model 15[47]	BC	DEP	FL	-
Model 16	BC	-	FL	-
Model 17	BC	DEP	-	-
Model 18	BC	DEP	-	ROE
Model 19	NPF	DEP	-	ROE
Model 20	NPF	-	-	ROE
Model 21	BC	-	-	ROE
Model 22	-	DEP	TIER	ROE
Model 23	NPF	DEP	-	-
Model 24	-	DEP	-	ROE
Model 25	-	-	TIER	ROE

Notes: BC defines the ratio of domestic credit to private sector; NPF defines non-performing financing; DEP defines bank deposits; FL defines real foreign liabilities; TIER defines time interest earned ratio; ROE defines return on equity.

As it can be seen from the above table, we construct 25 different banking crisis definitions using the same risk factor proxies set. That is, the ratio of domestic credit to private sector (BC) and non-performing financing (NPF) are used as credit risk proxies. The liquidity risk is proxied by bank deposits. TIER and real foreign liabilities are used as a proxy for market risk of Islamic banking. Furthermore, the profitability risk is proxied by return on equity (ROE). To achieve a substantial banking crisis definition for Islamic banks which will improve the predictive power of the EWS, we construct alternative crisis definitions by using different combinations of the significant risk factors. Furthermore, in order to make robust analyses of whether the credit risk, market risk, liquidity risk and

[46] Same as the BSFI of Ahmad and Mazlan (2015).
[47] Same as the BSFI of Kibritçioğlu (2003).

profitability risk factors play significant effects on the predictive power of our EWS models, we alternately include and exclude these risk factors in alternating banking crisis definitions. Namely, while we construct BSFI in some definitions we omit one of the risk factors in question to investigate its impact on the prediction power of the EWS.[48] Based on these definitions, we develop twenty-five EWS models in total. The analyses are conducted with the same methodology, explanatory variable set, bank coverage and time period for all the models. Therefore, the models differ only in banking crisis definitions that enable us to observe the impacts of banking crisis definitions on the predictive power of the EWS. The BSFIs for each model are presented in Table 13:

[48] For instance, while we define the banking crisis in Model 1 based on credit risk, liquidity risk and market risk; we exclude liquidity risk factor in the BSFI in Model 2 to examine whether it plays an important role in the prediction power of the EWS.

Table 13: BSFI by Model

Model 1

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right)}{3}$$

Model 2

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right)}{2}$$

Model 3

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right)}{2}$$

Model 4

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right)}{3}$$

Model 5

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right)}{3}$$

Model 6

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right)}{2}$$

Model 7

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right) + \left(\frac{[(ROE_t -/}{}\right.}{4}$$

Model 8

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right) + \left(\frac{[(ROE_t -/ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{4}$$

Model 9:

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/BC_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right) + \left(\frac{[(ROE_t - /ROE_{t-}}{\sigma_{ROE}}\right.}{4}$$

Model 10

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{3}$$

Model 11

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right) + \left(\frac{[(ROE_t - /ROE_t}{\sigma_{ROE}}\right.}{4}$$

Model 12

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{3}$$

Model 13

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{3}$$

Model 14

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] -}{\sigma_{ROE}}\right.}{4}$$

Model 15

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right)}{3}$$

Model 16

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right)}{2}$$

Model 17

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right)}{2}$$

Model 18

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{3}$$

Model 19

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{3}$$

Model 20

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{2}$$

Model 21

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{2}$$

Model 22

$$BSFI_{i,t} = \frac{\left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{3}$$

Model 23

$$BSFI_{i,t} = \frac{\left(\frac{[(NPF_t - NPF_{t-1})/NPF_{t-1}] - \mu_{NPF}}{\sigma_{NPF}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right)}{2}$$

Model 24

$$BSFI_{i,t} = \frac{\left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{2}$$

Model 25

$$BSFI_{i,t} = \frac{\left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{2}$$

4.2. METHODOLOGY

In this section, we explain the estimation methodology employed to investigate the significant variables and prediction powers of each of the EWS models. Determining an appropriate estimation methodology is crucial since it plays an important role in observing the leading indicators and the prediction power of the EWS.

In the related literature, various forecasting methods are used to anticipate the banking crises and, these methods can be categorized as parametric approaches and non-parametric approaches.[49] We prefer to use a parametric model, namely binary logistic regression model, as an estimation methodology to construct the EWS models for identifying the banking crises of Islamic banks following Davis and Karim (2008), Musdholifah et al. (2013) and, Caggiano et al. (2016). The main reasons behind preferring a parametric model to non-parametric models, namely preferring the logit model to signal extraction is as follows. As explained in Section 2.4, the signal extraction approach gives the individual contribution of each variable by omitting the relationship between the explanatory variables. However, the logistic model reveals the marginal contributions and the magnitudes of each explanatory variable on the probability of the crisis occurrence. Furthermore, while signal extraction approach reveals the predictive power of each individual indicator, logit model gives the predictive power of the model as a whole. In this thesis our main objective to investigate a relevant BSFI for Islamic banking that reveals substantial predictive performance results for the EWS model, rather than obtaining the most proper signaling indicators that are successful in explaining the crisis event. Accordingly, logistic model allows us to obtain the predictive power rates of the EWS models rather than the predictive performances of the explanatory variables. Furthermore, to be able to observe the predictive performance of the models, we need to observe how the actual crisis episodes derived via BSFIs using sample data, and predicted crisis episodes are matched. On this basis, the predicted probabilities of the models are

[49] See Section 2.4 for detailed explanations.

revealed by conducting the logistic regressions that gives an opportunity to conduct statistical tests.

Logistic regression is a methodology that is used to examine the relationship of an outcome variable in binomial, ordinal or multinomial form with the explanatory variables. In this thesis, the dependent variables are binomial variables which distinguish the crisis and non-crisis episodes. Therefore, we employ binary logistic regression methodology first to examine the significant explanatory variables of crisis and then, the predictive performances of the EWS models.

In binary logistic regression, the dependent variable is dichotomous and take the value of 0 or 1 with respect to the occurrence of the considered event. In our case, the binary dependent variable, $Y_{i,t}$, is the occurrence of the Islamic banking crisis and takes the value 1 if the country experience banking crisis at time t and 0 otherwise.

$$Y_{it} = \begin{cases} 1, & if\ \exists\ banking\ crisis \\ 0, & otherwise \end{cases} \tag{9}$$

where i= 1,…,N denotes the number of countries and t=1,…,T is the number of time periods for the i^{th} country. Y_{it}represents the binary dependent variable and takes the value of 1 if banking crisis occurs and 0 otherwise. Therefore, the probability distribution of the dependent variable, Y_{it}can be given as:

$\boldsymbol{Y_{it}}$	**Probability**
0	$1 - P_{it}$
1	P_{it}
Total	1

where P_{it} is the probability of country *i* to experience a banking crisis at time *t* and $(1 - P_{it})$ is the vice versa. Therefore, $E(Y_{it})$ is the expected value of the dependent variable which is equal to the probability of banking crisis.

$$E(Y_{it}) = 0(1 - P_{it}) + 1(P_{it}) = P_{it} \quad (10)$$

Since the probability P_{it} varies between 0 and 1, the expected value of the banking crisis variable ranges between 0 and 1, i.e. $0 \leq E(Y_{it}|X_{it}) \leq 1$. Therefore, it can be given as a function of the explanatory variables as:

$$P_{it} = E(Y_{it} = 1|X_{it}) = f(\beta X_{it}) \quad (11)$$

The probability of the banking crisis for each country *i* at time period *t* is estimated by using logistic distribution function which can be given as:

$$Pr(Y_{it} = 1) = f(\beta X_{it}) = \frac{e^{\beta' X_{it}}}{1+e^{\beta' X_{it}}} \quad (12)$$

where X_{it} is a vector of explanatory variables, β represents the vector of coefficients and *f* denotes the cumulative logistic distribution. Equation 12 shows that the probability of banking crisis occurrence as a function of explanatory variables. The logistic model estimates the probability of the banking crisis event by maximizing the following likelihood function:

$$logL = \sum_{i=1}^{N} \sum_{t=1}^{T} [Y_{it} lnf(\beta' X_{it})) + (1 - Y_{it}) \ln (1 - f(\beta' X_{it}))] \quad (13)$$

Let $z_{i,t} = \beta X_{it}$ denote the cumulative distribution function and since z_{it} takes values between negative to positive infinity, P_{it} will take values between 0 and 1. In this respect, odds ratio can be used in linear regression analysis which is determined as:

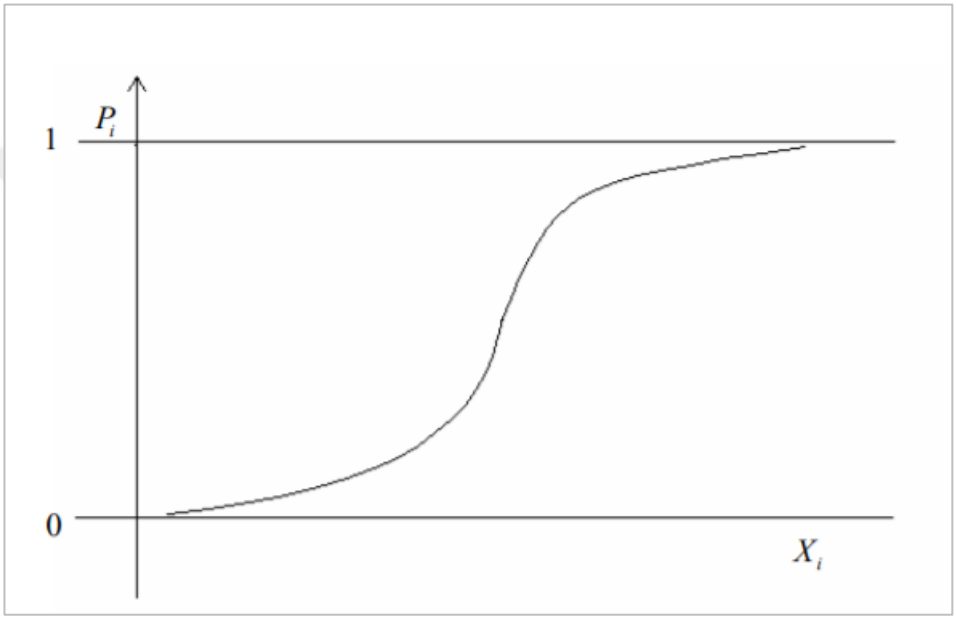
$$(Y_{it} = 1|X_{it}) = \frac{Pr(Y_{it}=1)}{1-Pr(Y_{it}=1)} = \frac{1+e^{z_i}}{1+e^{-z_i}} = e^{z_i} \quad (14)$$

As equation 14 interprets, the odds ratio is the ratio of the probability of banking crisis occurrence to probability of not occurrence. The value of the coefficient parameters reflects the unit changes in predictors on the odds of the banking crisis.

$$L_i = ln\left(\frac{P_{it}}{1-P_{it}}\right) = z_i = \beta X_{it} \quad (15)$$

Equation 15 shows that, the log of the odds ratio which is also the formal representation of the logit model, is linear in both the predictors, X_{it}, and the parameters, β. The graph of logistic model is given in Figure 23.

Figure 23: Logit Model



As it can be seen from the Figure 23, while z_i ranges between negative to positive infinity, probability lies between 0 and 1 and the logit ranges between negative to positive infinity. Furthermore, a positive logit means that the value of the indicator increases and the odds of occurrence of an event increase. On the other hand, if logit is negative, increasing value of the indicators decreases the odds of the occurrence of the event.

CHAPTER 5

EMPIRICAL RESULTS

In this part of the thesis, the empirical findings are presented. Before determining the predictive power of the EWS models for Islamic banks, we first examine the significant indicators for each model and show how the significant variables vary with respect to the dependent variable definition of the EWS models. Any EWS is designed to estimate the probability of a crisis event as a function of some explanatory variables. In this respect, in order to build a solid EWS, the first and the most important step is to make a precise definition of the crisis event. The definition of the crisis becomes the dependent variable of the EWS model where the identification of the significant indicators and predictive power of the model directly depend on this definition. On this basis, the other crucial steps include choosing the proper set of explanatory variables and using the correct estimation methodology.

In this thesis, our primary objective is to develop EWS models for Islamic banks which gives substantial predictive power results through investigating how different BSFIs effect the predictive power performances of EWS for Islamic banks. To this aim, we focus on the most essential step of the EWS model, namely the definition of the banking crisis. Since there is lack of consensus in the literature, we define 25 different banking crisis definitions by constructing BSFIs that show whether a country is experiencing a banking crisis or not. BSFIs are defined as the average standardized values of the main risk factors of Islamic banks as the credit risk, liquidity risk, market risk and profitability risk. The definitions differ in terms of proxies to measure these risk factors. On this basis, the liquidity risk is proxied by bank deposits. For the credit risk, domestic private sector and non-performing loans are considered. Market risk is measured by using banks' real foreign liabilities and tier proxies. Furthermore, different from the existing literature, we include profitability as a new risk factor into some of our crisis definitions which we measure by ROE.

Recent experiences of banking crises show that the bank runs do not play an important role in the emergence of the crises (Glick and Hutchison, 2010). For this reason, in order to examine whether bank runs play a major role in Islamic banking crises or not, we exclude bank deposits proxy (liquidity risk) in some of the banking crisis definitions. We also applied this elimination strategy to all of the risk factors to investigate which risk factor is crucial in explaining the Islamic banking crisis. That is, in order to explore the most substantial BSFI for Islamic banks, we use different combinations of the risk proxies and risk factors where we build twenty-five different EWS models. By this way, we are able to make a detailed banking crisis definition research for Islamic banks in the context of early warning systems.

5.1. INDICATORS OF ISLAMIC BANKING CRISES

Our dataset covers annual observations from 12 countries over the time period 2008-2018 holding information from 81 Islamic banks. In order to determine the significant indicators set for our EWS models, we incorporate bank specific and macroeconomic variables since they are both crucial in explaining the banking crises (International Monetary Fund, 1998). Following Cihak and Schaeck (2010), Beaton et al. (2016) and Yüksel et al. (2018), all bank specific variables are aggregated at country level. As previously explained, the empirical analyses for all EWS models are conducted with the same set of explanatory variables as prospective significant indicators as well as the same country set, time period and estimation methodology. Thereby, the EWS models differ only in BSFIs by providing us with an opportunity to observe the impact of definition differences on significant indicators of the fragility of Islamic banks to banking crisis and then on the predictive power of the EWS.[50]

In the EWS models, the dependent variable, BSFIs, become the binary dependent variables of the models. That is if the BSFI derived by using sample data is lower than a specified threshold value (in our case it is 0), then this period is identified as the crisis episode and the dependent variable of the EWS model takes the value 1. Otherwise, the

[50] All empirical elaborations are conducted using the software package Stata Version 16.

binary dependent variable of the model takes the value 0, indicating that there is no crisis and the country is in tranquil period. The results of the fragility episodes for each country are given in Table 14 and results for the BSFI are presented in Appendix C.[51] Before proceeding to identify the significant indicators of the banking crises, we first determine the fragility and tranquil episodes for Islamic banks using our BSFI definitions and sample data. That is, to identify the actual crisis periods we first calculate each of the BSFI using our sample data. Then we indicate the episodes as fragility and tranquil episodes if the calculated BSFI is lower than 0. Accordingly, Table 14 presents in which periods the Islamic banks in a specific country were fragile to banking crises over 2008-2018.

[51] The calculated values of all of the twenty-five BSFIs are given in Appendix C for each country.

Table 14: Fragility Episodes for Each Country[52]

Model 1

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2009, 2012, 2015	3
Bangladesh	2018	1
Brunei Darussalam	2014, 2015, 2016, 2018	4
Indonesia	2014, 2015, 2016, 2018	4
Jordan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	11
Kuwait	2008, 2009, 2011, 2015, 2016	5
Malaysia	2010, 2012, 2014, 2015, 2016, 2018	6
Pakistan	2009, 2010, 2011, 2012, 2014, 2015, 2018	7
Qatar	2008, 2009, 2011, 2012, 2013, 2014, 2017, 2018	8
Saudi Arabia	2008, 2009, 2011, 2014, 2015, 2016, 2017	7
Turkey	2012, 2015, 2017, 2018	4
United Arab Emirates	2011, 2012, 2013, 2015, 2018	5

Model 2

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2015	1
Bangladesh	2015	1
Brunei Darussalam	2013, 2014, 2015, 2016, 2018	5
Indonesia	2012, 2018	2
Jordan	2008, 2010, 2011, 2013, 2014, 2015, 2016, 2017, 2018	9
Kuwait	2008, 2009, 2011, 2013, 2015, 2016, 2018	7
Malaysia	2010, 2011, 2012, 2013, 2015, 2016, 2018	7
Pakistan	2009, 2010, 2011, 2012, 2014, 2015, 2016, 2017	8
Qatar	2008, 2009, 2011, 2012, 2013, 2014, 2015, 2017, 2018	9
Saudi Arabia	2008, 2009, 2011, 2014, 2015, 2016	6
Turkey	2011, 2012, 2014, 2015, 2017, 2018	6
United Arab Emirates	2010, 2011, 2012, 2013, 2014, 2015, 2017, 2018	8

Model 3

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2010, 2011, 2012, 2013, 2015, 2016	7
Bangladesh	2008, 2013, 2018	3
Brunei Darussalam	2008, 2012, 2014, 2016, 2017, 2018	6
Indonesia	2008, 2017, 2018	3
Jordan	2008, 2010, 2011, 2013, 2014, 2016, 2017, 2018	8
Kuwait	2008, 2011, 2012, 2013, 2016, 2017, 2018	7
Malaysia	2008, 2010, 2011, 2012, 2015, 2016, 2017	7
Pakistan	2008, 2009, 2010, 2011, 2012, 2014, 2015	7
Qatar	2008, 2011, 2012, 2017, 2018	6
Saudi Arabia	2008, 2011, 2014, 2015, 2016, 2017, 2018	7
Turkey	2008, 2015, 2017, 2018	4
United Arab Emirates	2008, 2010, 2011, 2012, 2013, 2017, 2018	7

Model 4

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2009, 2011	2
Bangladesh	2012, 2013, 2014, 2015, 2016, 2017, 2018	7
Brunei Darussalam	2010, 2012, 2013, 2015, 2016	5
Indonesia	2011, 2015, 2016, 2017, 2018	5
Jordan	2008, 2009, 2010, 2011 2012, 2013, 2014, 2015, 2016, 2017, 2018	11
Kuwait	2008, 2009, 2016	3
Malaysia	2013, 2014, 2015, 2016, 2018	5
Pakistan	2009, 2010, 2011, 2012, 2014, 2015, 2017, 2018	8
Qatar	2008, 2009, 2013, 2014, 2017, 2018	7
Saudi Arabia	2008, 2009, 2010, 2011, 2013, 2015, 2016, 2017	8
Turkey	2012, 2017	2
United Arab Emirates	2009, 2011, 2012, 2016, 2017, 2018	6

[52] Authors own calculations.

Model 5

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2010, 2011, 2012, 2013, 2014, 2015, 2016	8
Bangladesh	2008, 2013, 2018	3
Brunei Darussalam	2008, 2012, 2014, 2016, 2017, 2018	6
Indonesia	2008, 2014, 2015, 2016, 2017, 2018	6
Jordan	2008, 2010, 2011, 2012, 2013, 2014, 2015, 2017, 2018	9
Kuwait	2008, 2011, 2012, 2015, 2016, 2017, 2018	7
Malaysia	2008, 2010, 2011, 2012, 2014, 2015, 2016, 2017	8
Pakistan	2008, 2009, 2010, 2011, 2012, 2014, 2015	7
Qatar	2008, 2009, 2011, 2012, 2017, 2018	6
Saudi Arabia	2008, 2011, 2014, 2016, 2017, 2018	6
Turkey	2008, 2015, 2017, 2018	4
United Arab Emirates	2008, 2010, 2011, 2012, 2013, 2015, 2018	7

Model 6

	Fragility Episodes	# Fragility Episodes
Bangladesh	2012, 20131, 2014, 2015, 2016, 2017, 2018	7
Brunei Darussalam	2010, 2012, 2013, 2015, 2016	5
Indonesia	2011, 2012, 2016, 2017, 2018	5
Jordan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	11
Kuwait	2008, 2009, 2012, 2016	4
Malaysia	2013, 2015, 2016, 2018	4
Pakistan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	11
Qatar	2008, 2009, 2011, 2013, 2014, 2016, 2017, 2018	8
Saudi Arabia	2008, 2009, 2010, 2011, 2013, 2015, 2016	7
Turkey		0
United Arab Emirates	2011, 2012, 2016, 2017, 2018	5

Model 7

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2015	2
Bangladesh	2015, 2018	2
Brunei Darussalam	2013, 2015, 2016, 2018	4
Indonesia	2011, 2014, 2016, 2018	4
Jordan	2008, 2009, 2010, 2011, 2013, 2014, 2015, 2016, 2017, 2018	10
Kuwait	2008, 2009, 2010, 2015, 2016	5
Malaysia	2010, 2011, 2013, 2014, 2015, 2016, 2018	7
Pakistan	2009, 2011, 2012,2014	4
Qatar	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	11
Saudi Arabia	2008, 2009, 2013, 2014, 2015, 2016, 2017	7
Turkey	2012, 2014, 2015, 2016, 2017, 2018	6
United Arab Emirates	2011, 2013, 2015, 2018	4

Model 8

Country	Fragility Episodes	# Fragility Episodes
Bahrain		**0**
Bangladesh	2014, 2015, 2018	3
Brunei Darussalam	2013, 2016, 2018	3
Indonesia	2011, 2013, 2016, 2018	4
Jordan	2008, 2009, 2010, 2011, 2013, 2014, 2016, 2017, 2018	9
Kuwait	2008, 2009, 2011, 2016	4
Malaysia	2010, 2011, 2013, 2014, 2015, 2016, 2018	7
Pakistan	2009, 2011, 2012, 2014, 2015, 2016	6
Qatar	2008, 2009, 2010, 2011, 2012, 2014, 2015, 2016, 2017, 2018	10
Saudi Arabia	2008, 2009, 2014, 2015, 2016	5
Turkey	2012, 2014, 2015, 2016, 2017	5
United Arab Emirates	2015, 2016, 2018	3

Model 9

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2009, 2010, 2011, 2012, 2014, 2015, 2016, 2017	9
Bangladesh	2008, 2013, 2015, 2018	4
Brunei Darussalam	2008, 2010, 2016, 2018	4
Indonesia	2008, 2010, 2014, 2016, 2018	5
Jordan	2008, 2010, 2013, 2014, 2017, 2018	6
Kuwait	2008, 2009, 2011, 2016, 2017, 2018	6
Malaysia	2008, 2010, 2011, 2012, 2014, 2015, 2016, 2017	8
Pakistan	2008, 2009, 2011, 2012, 2014, 2015, 2016	7
Qatar	2008, 2009, 2010, 2011, 2012, 2017, 2018	7
Saudi Arabia	2008, 2009, 2010, 2011, 2014, 2016 2017	7
Turkey	2008, 2014, 2015, 2018	4
United Arab Emirates	2011, 2012, 2013, 2018	4

Model 10

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2010, 2011, 2012, 2016, 2017	6
Bangladesh	2008, 2012, 2013, 2018	4
Brunei Darussalam	2008, 2010 2011, 2012, 2018	5
Indonesia	2008, 2009, 2016, 2018	4
Jordan	2008, 2010, 2013, 2014, 2017, 2018	6
Kuwait	2008, 2011, 2013, 2016, 2017, 2018	6
Malaysia	2008, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017	9
Pakistan	2008, 2009, 2011, 2012, 2013, 2014, 2015, 2016	8
Qatar	2008, 2010, 2011, 2012, 2017, 2018	6
Saudi Arabia	2008, 2009, 2014, 2015, 2016	5
Turkey	2008, 2014, 2015, 2018	4
United Arab Emirates	2008, 2012, 2013, 2018	4

Model 11

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2009, 2010, 2011, 2017	4
Bangladesh	2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	9
Brunei Darussalam	2008, 2010, 2011, 2013, 2015, 2016	6
Indonesia	2011, 2013, 2016	3
Jordan	2008, 2009, 2010, 2011, 2012, 2014, 2015, 2016, 2017, 2018	10
Kuwait	2008, 2009, 2011, 2013, 2016	5
Malaysia	2014, 2015, 2018	3
Pakistan	2009, 2011, 2012, 2013, 2015, 2016, 2017, 2018	8
Qatar	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016	**9**
Saudi Arabia	2008, 2009, 2010, 2012, 2013, 2014, 2015, 2016	**8**
Turkey	2013, 2014, 2015	**3**
United Arab Emirates	2009, 2016, 2017, 2018	**4**

Model 12

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2009, 2011, 2017	3
Bangladesh	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	8
Brunei Darussalam	2010, 2013, 2015, 2016	4
Indonesia	2011, 2016	
Jordan	2008, 2009, 2010, 2011, 2012, 2014, 2015, 2016, 2017, 2018	10
Kuwait	2008, 2009, 2016	3
Malaysia	2013, 2014, 2015, 2016, 2018	5
Pakistan	2009, 2011, 2012, 2013, 2014, 2015, 2016, 2017	8
Qatar	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017	10
Saudi Arabia	2008, 2009, 2010, 2013, 2014, 2015, 2016	7
Turkey	2014, 2015, 2016	3
United Arab Emirates	2016, 2017, 2018	3

Model 13

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2009, 2010, 2011, 2012, 2016, 2017	7
Bangladesh	2008, 2009, 2012, 2013, 2014, 2015, 2018	7
Brunei Darussalam	2008, 2011, 2012, 2013	4
Indonesia	2008, 2009, 2010, 2011, 2016, 2017	6
Jordan	2008, 2009, 2010, 2012, 2014, 205, 2017, 2018	8
Kuwait	2008, 2011, 2012, 2016	4
Malaysia	2008, 2011, 2013, 2014, 2015, 2016, 2017	7
Pakistan	2008, 2009, 2011, 2012, 2014, 2015, 2017	7
Qatar	2008, 2010, 2011, 2012, 2017	5
Saudi Arabia	2008, 2009, 2010, 2011, 2013, 2016	6
Turkey	2008, 2016	2
United Arab Emirates	2008, 2012, 2016, 2007, 2018	5

Model 14

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2009, 2010, 2011, 2012, 2013,2016, 2017	8
Bangladesh	2008, 2011, 2012, 2013, 2014, 2015, 2018	7
Brunei Darussalam	2008, 2010, 2012, 2016	4
Indonesia	2008, 2010, 2011, 2016, 2017	5
Jordan	2008, 2009, 2010, 2012, 2013, 2014, 2015, 2017, 2018	9
Kuwait	2008, 2011, 2012, 2016,	4
Malaysia	2008, 2014, 2015, 2016, 2017	5
Pakistan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2017	9
Qatar	2008, 2010, 2012, 2013, 2017	5
Saudi Arabia	2008, 2009, 2010, 2011, 2013, 2016, 2017	7
Turkey	2008, 2015, 2016	3
United Arab Emirates	2008, 2009, 2012, 2013, 2017, 2018	6

Model 15

Country	High Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2009, 2010, 2011, 2012, 2014, 2016, 2017, 2018	9
Bangladesh	2008, 2011, 2012, 2013, 2016, 2018	6
Brunei Darussalam	2008, 2010,	2
Indonesia	2011, 2012, 2016	3
Jordan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2017	9
Kuwait	2008, 2010, 2011, 2012, 2016, 2018	6
Malaysia	2008, 2014, 2015, 2016, 2017	5
Pakistan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2017	9
Qatar	2008, 2013, 2017, 2018	4
Saudi Arabia	2010, 2011, 2017, 2018	4
Turkey	2008, 2018	2
United Arab Emirates	2008, 2009, 2011, 2012, 2013, 2017, 2018	7

Model 16

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2010, 2011, 2012, 2014, 2016, 2017, 2018	8
Bangladesh	2008, 2011, 2012, 2014, 2016, 2017, 2018	7
Brunei Darussalam	2008, 2010, 2011, 2012, 2016	5
Indonesia	2008, 2011, 2016, 2017	4
Jordan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2018	10
Kuwait	2008, 2010, 2011, 2012, 2016, 2018	6
Malaysia	2008, 2014, 2015, 2016, 2017	5
Pakistan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2017	9
Qatar	2008, 2013, 2017, 2018	4
Saudi Arabia	2008, 2010, 2011, 2013, 2016, 2018	6
Turkey	2008	1
United Arab Emirates	2008, 2010, 2011, 2012, 2013, 2017, 2018	7

Model 17

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2010, 2012, 2014, 2017, 2018	6
Bangladesh	2008, 2013, 2018	3
Brunei Darussalam	2008, 2010, 2012, 2016,2018	5
Indonesia	2008, 2009, 2010, 2014, 2015, 2016, 2017, 2018	8
Jordan	2008, 2009, 2010, 2011, 2012, 2013,2014, 2015	8
Kuwait	2008, 2010, 2011, 2012, 2017, 2018	6
Malaysia	2008, 2010, 2014, 2015, 2016, 2017	6
Pakistan	2008, 2009, 2010, 2012, 2013, 2014, 2015	7
Qatar	2008, 2010, 2012, 2017, 2018	5
Saudi Arabia	2008, 2010, 2011, 2017	4
Turkey	2008, 2015, 2017, 2018	4
United Arab Emirates	2008, 2011, 2012, 2013, 2017, 2018	6

Model 18

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2010, 2011, 2012, 2014, 2016, 2017	7
Bangladesh	2008, 2011, 2012, 2013, 2014, 2015, 2018	7
Brunei Darussalam	2008, 2010, 2012, 2018	4
Indonesia	2008, 2009, 2010, 2011, 2014, 2016, 2017	7
Jordan	2008, 2009, 2010, 2012, 2013, 2014, 2017, 2018	8
Kuwait	2008, 2011, 2017	3
Malaysia	2008, 2011, 2013, 2014, 2015, 2016, 2017	7
Pakistan	2008, 2009, 2012, 2013, 2014, 2015, 2016	7
Qatar	2008, 2010, 2011, 2012, 2018, 2018	6
Saudi Arabia	2008, 2009, 2010, 2011, 2013, 2014, 2016, 2017	8
Turkey	2008, 2014, 2016, 2018	4
United Arab Emirates	2008, 2012, 2013, 2018	4

Model 19

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2017	1
Bangladesh	2012, 2013, 2014, 2015, 2018	5
Brunei Darussalam	2016, 2018	2
Indonesia	2009, 2011, 2013, 2014, 2016, 2018	6
Jordan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2017, 2018	10
Kuwait	2008, 2009, 2011	3
Malaysia	2011, 2013, 2014, 2015, 2016, 2018	6
Pakistan	2009, 2011, 2012, 2014, 2015, 2016	6
Qatar	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	11
Saudi Arabia	2008, 2009, 2010, 2013, 2014, 2016, 2017	7
Turkey	2012, 2013, 2014, 2015, 2016	5
United Arab Emirates	2016, 2018	2

Model 20

Country	Fragility Episodes	# Fragility Episodes
Bahrain		0
Bangladesh	2012, 2013, 2014, 2015, 2017, 2018	6
Brunei Darussalam	2015, 2016, 2018	3
Indonesia	2009, 2010, 2011, 2013, 2014, 2016, 2017	7
Jordan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	11
Kuwait	2008, 2009	2
Malaysia	2010, 2011, 2013, 2014, 2015, 2016, 2018	7
Pakistan	2009, 2011, 2012, 2013, 2015, 2016	6
Qatar	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	11
Saudi Arabia	2008, 2009, 2014, 2015, 2016	5
Turkey	2010, 2012, 2013, 2014	4
United Arab Emirates	2016, 2018	2

Model 21

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2010, 2012, 2017, 2018	5
Bangladesh	2008, 2013, 2018	3
Brunei Darussalam	2008, 2010, 2012, 2016, 2018	5
Indonesia	2008, 2009, 2010, 2014, 2015, 2016, 2017, 2018	8
Jordan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015	8
Kuwait	2008, 2010, 2011, 2012, 2016, 2017, 2018	7
Malaysia	2008, 2010, 2014, 2015, 2016, 2017	6
Pakistan	2008, 2009, 2010, 2012, 2013, 2014, 2015	7
Qatar	2008, 2010, 2012, 2017, 2018	5
Saudi Arabia	2008, 2010, 2011, 2017	4
Turkey	2008, 2015, 2017, 2018	4
United Arab Emirates	2008, 2011, 2012, 2013, 2017, 2018	6

Model 22

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2010, 2011, 2012, 2014, 2017	6
Bangladesh	2008, 2011, 2012, 2013, 2015, 2018	6
Brunei Darussalam	2008, 2010, 2016, 2018	4
Indonesia	2008, 2009, 2010, 2014, 2016, 2017, 2018	7
Jordan	2008, 2009, 2010, 2012, 2013, 2014, 2015, 2017	8
Kuwait	2008, 2011, 2017	3
Malaysia	2008, 2011, 2014, 2015, 2016, 2017	6
Pakistan	2008, 2009, 2012, 2013, 2014, 2015	6
Qatar	2008, 2009, 2010, 2016, 2017, 2018	6
Saudi Arabia	2008, 2009, 2010, 2011, 2013, 2014, 2016, 2017	8
Turkey	2008, 2014, 2015, 2018	4
United Arab Emirates	2008, 2009, 2011, 2012, 2013, 2018	6

Model 23

Country	Fragility Episodes	# Fragility Episodes
Bahrain		0
Bangladesh	2015, 2016, 2018	3
Brunei Darussalam	2015, 2016	2
Indonesia	2011, 2014, 2015, 2016, 2017, 2018	6
Jordan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2018, 2018	11
Kuwait	2008, 2009, 2015, 2016	4
Malaysia	2010, 2013, 2014, 2015, 2016, 2018	6
Pakistan	2009, 2010, 2011, 2012, 2013, 2014, 2015, 2018	8
Qatar	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2018, 2018	11
Saudi Arabia	2008, 2009, 2011, 2014, 2016, 2017	6
Turkey	2012, 2014, 2015, 2016, 2017, 2018	6
United Arab Emirates	2011, 2012, 2016, 2017, 2018	5

Model 24

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2017	1
Bangladesh	2012, 2013, 2014, 2015, 2018	5
Brunei Darussalam	2015, 2016, 2018	3
Indonesia	2009, 2011, 2013, 2014, 2016, 2018	6
Jordan	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2018, 2018	10
Kuwait	2008, 2009, 2011	3
Malaysia	2011, 2013, 2014, 2015, 2006, 2018	6
Pakistan	2009, 2011, 2012, 2014, 2015, 2016	6
Qatar	2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	11
Saudi Arabia	2008, 2009, 2010, 2013, 2016, 2017	6
Turkey	2012, 2013, 2014, 2015, 2016	5
United Arab Emirates	2016, 2018	2

Model 25

Country	Fragility Episodes	# Fragility Episodes
Bahrain	2008, 2009, 2010, 2011, 2014, 2016, 2017	7
Bangladesh	2008, 2009, 2011, 2012, 2013, 2014, 2015, 2018	8
Brunei Darussalam	2008, 2010, 2013, 2018	4
Indonesia	2008, 2010, 2011, 2013, 2016	5
Jordan	2008, 2009, 2012, 2014, 2017, 2018	6
Kuwait	2008, 2009, 2011, 2016	4
Malaysia	2008, 2011, 2013, 2014, 2015, 2016, 2018	7
Pakistan	2008, 2009, 2012, 2013, 2015, 2016	6
Qatar	2008, 2009, 2010, 2012, 2013, 2015, 2016, 2017	8
Saudi Arabia	2008, 2009, 2010, 2013, 2014, 2016, 2017	7
Turkey	2008, 2009, 2013, 2014, 2015, 2016	6
United Arab Emirates	2008, 2009, 2015	3

The explanatory variables that are included in the empirical analyses capture both bank-specific and macroeconomic factors. In particular, we examine whether capital adequacy, asset quality, management adequacy, earnings ability, liquidity level and sensibility to market risk variables are significant to explain the fragility of Islamic banks to crisis or not. In addition, we investigate if capital account, debt profile, current account, and other financial and real sector variables are useful in explaining the probability of the occurrence of Islamic banking crises.[53] Following the studies of Vidal-Abarca and Ruiz (2015) and Coudert and Idier (2018), the explanatory variables are alternately included in the estimations where we test different combinations of them. By doing so, the best possible combinations of significant indicators for the fragility episodes of Islamic banking are tried to be determined.

The estimations to determine the significant indicators among the bank-specific and macroeconomic variables presented in Table 11 are made by employing binary logit methodology. While estimating the EWS models, our econometric methodology of logistic panel regressions enables us control for the unobserved individual heterogeneity by including country fixed effects in the regressions (Baltagi, 2003). We rely on Hausman test results where we reject the null hypothesis of there is no correlation between the error terms and the regressors in the model and, employ fixed effects in order to remedy unobserved heterogeneity among different countries. Indeed, incorporating macroeconomic variables and banking specific variables as independent variables in our

[53] The correlation matrix of the explanatory variables included in the empirical analyses is presented in Appendix A.

structural model of estimation deal with the possible heterogeneity issue among the countries in our data set as well.[54]

The general form of our structural model of estimation for all models is defined as in equation 16. In order to deal with the possible endogeneity issue, the regression of the fragility of Islamic banks to banking crisis run on the lagged values of each of the explanatory variable.

$$Y_{it} = \alpha_i + \beta_1' \mathrm{X}_{it-1} + \beta_2' \mathrm{Z}_{it-1} + \varepsilon_{it} \quad (16)$$

Where Y_{it} is the binary dependent variable defining the banking crisis for country *i* in year *t*, X_{it-1} denotes the vector of bank specific explanatory variables and, Z_{it-1} denotes the vector of macroeconomic explanatory variables. α_i stands for country specific fixed effects and, ε_{it} is independent and identically distributed error term. Particularly, the dependent variable is a binary variable that takes value 1 if there is a banking crisis in country *i* in year *t*, and zero otherwise. Vector of bank specific variables include the capital adequacy ratio (CAR), the ratio of total loans to total assets (TLtoTA), the ratio of total operating revenues to total operating expenses (TORtoTOE), the return on assets (ROA), the ratio of sensitive liabilities (securities) to total assets (SLtoTA), the ratio of total loans to total deposits (TLtoTD) and, the ratio of liquid assets to total assets (LAtoTA). Vector of macroeconomic variables include foreign direct investments as a percentage of GDP (FDI), total reserves as a percentage of the total external debt (TotRes), real effective exchange rate (REER), current account balance as a percentage of GDP (CAB), the ratio of M2 to international reserves as a percentage of GDP (M2toRes), the ratio of M2 to GDP (M2toGDP), real annual GDP growth (GDPGrwth) and, real interest rate (rir).

[54] Note that there exist well respected studies in the literature such as Comelli (2014) and Boonman et al. (2019) investigating early warning systems of currency crisis who deal with the possible heterogeneity problem employing fixed effects in logistic panel regressions as well as incorporating many country specific independent variables.

Table 15: Results of the Logistic Regression Estimations

	CAR	ROA	TOR/TOE	GDPGrowth	Rir	M2toGDP	M2toRes	CAB
Model1	-0.0395* (0.016)			-0.0156* (0.005)		-0.0243* (0.012)		
Model2				-0.0224** (0.005)	0.0350* (0.016)	-0.0131* (0.024)		
Model3	-0.0189** (0.005)	-0.0101* (0.005)		-0.0228** (0.0054)		-0.0247* (0.010)		-0.0175** (0.006)
Model4	-0.0476* (0.011		-0.07880* (0.034)	-0.0224** (0.006)		-0.0351** (0.013)		
Model5		-0.0103* (0.005)	-0.0481* (0.023)	0.0235*** (0.006)				
Model6		-0.0163** (0.005)		-0.0202** (0.00644)		-0.0116* (0.00475)		
Model7	-0.0338* (0.015)		-0.0581* (0.027)	0.0165** (0.006)		-0.0545** (0.018)	-0.0136* (0.0041)	-0.0159* (0.006)
Model8	-0.0234*** (0.006)	-0.0165** (0.005)		0.0148** (0.005)				
Model9			-0.0753** (0.027)	0.0136* (0.005)		-0.0116* (0.051)		
Model10		-0.0148** (0.005)		-0.0105* (0.005)	0.0449* (0.017)	-0.0297* (0.012)		
Model11	-0.0342* (0.021)	-0.0261* (0.011)		0.0239*** (0.007)		-0.0153* (0.005)	-0.0149** (0.0047)	-0.0131* (0.006)
Model12	-0.0648** (0.013)	-0.0443 (0.013)		-0.0125* (0.007)				
Model13	-0.0266*** (0.007)	-0.0130** (0.005)		-0.0153** (0.005)		-0.0148* (0.006)		

	CAR	ROA	TOR/TOE	GDPGrowth	Rir	M2toGDP	M2toRes	CAB
Model14		-0.0333** (0.012)	-0.0958** (0.032)	-0.0114* (0.005)				
Model15		-0.0331** (0.012)	-0.0895** (0.032)	-0.0118* (0.005)				
Model16		-0.0211*** (0.005)		-0.0395* (0.021)		-0.0315* (0.013)		-0.0121* (0.0060)
Model17				0.3462* (0.018)				
Model18		-0.0274 (0.011)		0.0256* (0.010)				
Model19	-0.0260* (0.006)		-0.0719* (0.028)	-0.0121* (0.005)		-0.0130* (0.005)		
Model20			-0.0161* (0.0029)	-0.0169** (0.005)	0.0237** (0.008)			
Model21			-0.0419* (0.234)	-0.0346* (0.012)		-0.0180** (0.0068)		
Model22			-0.0663* (0.027)	-0.0333* (0.012)		-0.0254* (0.011)		
Model23	-0.0122* (0.005)			-0.0329* (0.013)		-0.0154** (0.005)		
Model24	-0.0140* (0.005)		-0.0719* (0.028)	-0.0111* (0.005)		-0.0130* (0.005)		
Model25	-0.0131* (0.006)			-0.0132* (0.005)		-0.0151* (0.005)		-0.0161** (0.006)

Notes: Number of Observations is 115. White's heteroscedasticity consistent standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. Estimates are from fixed effect logistic regressions. Using a nonparametric bootstrap and producing bootstrapped standard errors, heteroscedasticity robust covariance is provided.

Table 15 summarizes estimation results of the logistic regressions for 25 EWS models showing the estimated coefficients for each explanatory variable and the statistical significance in each model.[55] To be more precise, for the analyzes, we construct 25 different EWS models which differ only in terms of their dependent variables, and employ logistic regression to each of the EWS models individually. We consider sixteen bank specific and macroeconomic variables in total. However, the estimation results show that eight of them i.e. the ratio of total loans to total assets, the ratio of the ratio of liquid assets to total assets, the ratio of total loans to total deposits, foreign direct investments, inflation, the ratio of sensitive liabilities (securities) to total assets, real effective exchange rate and total reserves as a percentage of the total external debt, are not associated with the fragility of Islamic banks to banking crisis. On the other hand, we find that among the bank specific variables, the capital adequacy ratio, the ratio of the ratio of total operating revenues to total operating expenses, return on assets; and among the macroeconomic variables, the ratio of M2 to GDP, the real annual GDP growth, the real interest rate, the current account balance as a percentage of GDP and the ratio of M2 to international reserves as a percentage of GDP are all found to have significant impacts on the probability of banking crisis of Islamic banks.

The results from the logistic regressions show that consistent with the related literature, the significances of the indicators differ with respect to the different BSFIs[56]. According to our results, GDP growth variable is consistently found significant in all EWS model regardless of which BSFI is used. The GDP growth is inversely related to the fragility of the Islamic banks which means that lower real GDP growth increases the fragility of Islamic banks to banking crises. Within the context of the early warning indicators of banking crises, low economic growth episodes has been observed before the banking crises (Angkinand and Willett, 2011; Demirgüç-Kunt and Detragiache, 1998, 2005; Von Hagen and Ho, 2007). As Kaminsky and Reinhart (1999) explains, about 8 months before the onset of the banking crisis, economic growth tends to decline. Furthermore, as Demirgüç-Kunt and Detragiache (1998) low GDP growth is significantly correlated with

[55] See Appendix B for the estimation results of each EWS model.

[56] For instance, Davis and Karim (2008) and Kindman (2010) use different banking crisis definitions and compare the significant variables of their models. They find that the significant variables vary with respect to the dependent variables adopted in each model.

the increased risk to the banking sector by increasing the likelihood of emergence of banking problems. Our results are consistent with the related literature and imply that similar to the case for a conventional banking system, lower economic growth environment makes the Islamic banks more fragile to banking crises (Hardy and Pazarbaşıoğlu, 1998; Rossi, 1999; Davis and Karim, 2008). Put differently, an increasing GDP growth is associated with improving the financial performance, since it reduces the NPF and thus the credit risk, that reflects higher credit quality. According to Gan (2010), higher economic growth promotes the development of the banking sector and thus decreases the fragility of the banks. Furthermore, Rabaa and Younes (2016) and Tabash (2017) address the positive impact of GDP growth on performance and profitability of the Islamic banks and emphasize that higher economic growth reduces the fragility Islamic banks similar to conventional banks.

Although Islamic banks operate based on the prohibition of interest, they cannot avoid the impacts of the interest rate changes especially in the dual banking systems. The changing interest rates affect the financings and profit margin, thus the performance of the Islamic banks (Adebola et al., 2011; Aysan et al., 2018; Ibrahim and Sukmana, 2011). The reason arises particularly due to the distinctive nature of Islamic banks' financing instruments as sale and leased-based financing instruments. Rosly (1999) explains that different from the conventional banks, Islamic banks are unable to adjust their profit margin in compliance with the changing interest rates. More precisely, the profits and losses are agreed based on a pre-determined rate through contractual agreements thus, the Islamic banks cannot change their profit margin freely since it is against those agreements. As a result, in case of the increasing interest rates, customers prefer to save their deposits in conventional banks which offer higher returns. If the interest rates decrease, the rates of the loans that are offered by the conventional banks fall. In this case, the financing instruments of the Islamic banks become more expensive than the loans thus the demand for these instruments decreases (Rosly, 1999). Furthermore, Seho et al. (2020) explain that as the interest rate has negative impacts on sale and leased based financing instruments of Islamic banks, Islamic banks become more resilient to crises. According to our results, interest rate is significant in Model2, Model10, Model20 and it is positively correlated with the fragility of Islamic banks in accordance with the evidence

in the related literature. Namely, similar to the case in conventional banks increasing interest rates increases the likelihood of Islamic banks to experience banking crises.

According to the results of the logit estimations, the ratio of M2 to GDP, the liquidity injection to the financial market, is statistically significant in most of the EWS models. The ratio of M2 to GDP, which gives information about the liquidity and financial depth of the financial market, is a prominent measure for the financial development. If financial depth is substantial, then there exist more funds and resources that are available for the banks (Lebdaoui and Wild, 2016). On the other hand, since time deposit accounts are also comprised in this ratio, it gives the extent of public use of the banking system. Furthermore, the variable is able to explain the development in the bank assets due to the fact that it is highly correlated with the total bank assets (Güneş, 2013). The negative coefficient of this ratio implies that increasing values of the ratio reduce the fragility by decreasing the possibility of Islamic banks to experience a banking crisis.

In the banking crisis literature, current account balance is seen as an important factor in the occurrence of the banking crises (Reinhart and Rogoff, 2009; Barrel et al. 2010). For instance, as Borio and Disyatat (2012) explains, excess savings exceeding the investments leads the emergence of the current account surpluses in the emerging countries which cause a downward pressure on the interest rate and trigger the credit boom in the developed countries. Our results indicate that the current account balance as a percentage of GDP is statistically significant in Model 3, Model 7, Model 16 and Model 25. The negative coefficient of the variable implies that decreasing values of current account balance as a percentage of GDP, increases the likelihood of the banking crisis for Islamic banks.

International reserves reflect the economic strength of an economy. The ratio of M2 to international reserves shows the strength of the central banks against the currency pegs in case of adverse foreign exchange speculations (Von Hagen and Ho, 2003, p. 7). In other words, this ratio is closely related to the exchange rate fluctuations. That is, when a country is experiencing serious depreciations, where central bank intervention is unavoidable, this situation triggers the reserve shortages which means that the central

bank does not hold sufficient amount of reserves to defend the national currency. Furthermore, it is associated with the ratio of the liabilities of the banking system that are supported by international reserves. Since the exchange of domestic currency for foreign currency will generally increase in crises periods, this ratio indicates the central bank's ability to meet foreign exchange demands. The results of our estimations indicate this ratio is a negatively significant indicator for Islamic banking crises in Model 7 and Model 11 and, is found to be insignificant in other models. The negative coefficient means that higher values of M2 to international reserves ratio makes Islamic banks less prone to experience banking crises similar to the case in conventional banks.

In order to measure the management quality of the Islamic banks, we use operating revenues as a percentage of the operating expenses. The ratio of the operating revenues to operating expenses is directly and negatively related with the profitability of Islamic banks. In other words, if the ratio of the operating revenues to operating expenses increases, the profitability of the banks decreases making them more fragile (Athanasoglou et al., 2008; Heffernan and Fu, 2011; Masood and Ashraf, 2012). Accordingly, decreasing value of the ratio increases the vulnerability of Islamic banks to banking crises. According to our estimation results, the variable in question is a significant indicator of Islamic banking crises in nine of our EWS models namely in Model 4, Model 5, Model 7, Model 14, Model 15, Model 19, Model 20, Model 21, Model 22 and Model 24.

As a measure for earnings ability, ROA reflects banks' ability to generate profits from their existing assets reflecting the efficiency and the performance of the banks. The results show that ROA is significant in twelve of the EWS models. Our results reveal that the ROA is negatively related with the fragility of Islamic banks in line with the existing literature emphasizing that ROA increases the strength of the Islamic banks and thus decreases the likelihood of experiencing a banking crisis (Baskoro Adi, 2014; Ismawati and Istria, 2015).

CAR shows the sufficient amount of total capital that banks have to preserve by considering their risk weighted assets. CAR is associated with the banking crises since it

reflects the strength of the banks against the risky assets and therefore the financial health and stability of the banks (Khan and Jabeen, 2011). In the related literature, CAR variable is a significant early warning indicator of Islamic banking crises (Asyikin et al., 2018). According to our results, it is statistically significant in twelve of our EWS models. The decreasing value of the variable implies that it is difficult for banks to control their capital strength with respect to the risks they take. As expected, it is negatively related with the probability of the occurrence of crises for Islamic banks indicating that decreasing CAR increases the likelihood of crisis.

So far, we have presented the results of the logistic regressions run for all twenty-five EWS models defined with respect twenty-five different BSFI. Thereby, we investigate how different BSFIs change the significance of the indicators for the fragility of Islamic banks to experience banking crises. Namely, before determining the predictive power of our EWS models for Islamic banks, we first examine the significant variables in each model by conducting logistic regressions to a panel of twelve countries.

According to our estimation results, out of sixteen explanatory variables, four macroeconomic variables; i.e. real effective exchange rate, total reserves as a percentage of the total external debt, foreign direct investments and inflation are found to be insignificant and do not have any significant impact on the fragility of the Islamic banks. Decline in GDP growth is consistently found to increase the fragility of Islamic banks to banking crises. In addition, the significance of the variables as capital adequacy ratio, the ratio of total operating revenues to total operating expenses, return on assets, ratio of M2 to GDP, real interest rate, current account balance as a percentage of GDP and the ratio of M2 to international reserves as a percentage of GDP vary with respect to the BSFI definitions which are the dependent variables used to construct the EWS models. Among bank-specific variables, the ratio of total loans to total assets, the ratio of the ratio of liquid assets to total assets, the ratio of total loans to total deposits, the ratio of sensitive liabilities (securities) to total assets are found to be the variables that are associated with the fragility of Islamic banks to banking crises.

In this part of the thesis, we consider a wide range of bank-specific and macroeconomic variables to investigate how different BSFIs, as a dependent variable, affect the significance of the crisis indicators. To the best of our knowledge, no prior related study has investigated the impact of the definition variations and the choice of the risk proxies to construct BSFI, on the significance of the crisis indicators of the EWS models for Islamic banking. Among the limited number of studies, most of them, construct a single EWS model for a specific country to obtain the significant indicators of the Islamic banks towards banking crisis. For instance, Wiranatakusuma and Duasa (2017) construct an EWS model to investigate the significant macroeconomic variables towards the resilience of Islamic banking in Indonesia. The authors find that the ratio of M2 to international reserves, inflation, real effective exchange and credit growth are significant indicators of crises. Anwar and Ali (2018) construct an EWS model in order to observe the financial performance of Islamic banks by employing 14 bank-specific and macroeconomic indicators. According to their findings, bank-specific variables such as total financing to total assets, debt-based financing to total funding, financing income to total asset, impairment loss for *Murabahah* financing to total financing, loan loss provision to non-*Murabahah* financing, liquidity risk parameters consist of total liquid asset to total asset, total financing to total debt and total non-core deposit to total deposit are significant and effect the profitability of Islamic banks in Indonesia. Further, they find inflation, interest rate and American dollar exchange rate to rupiah as significant macroeconomic variables. In addition to those studies, Khokher and Alhabshi (2019) also construct an EWS by using a panel of 65 banks from 13 countries to detect significant CAMELS determinants and macroeconomic variables that can be used to predict distress in Islamic banks. Their results indicate that CAMELS determinants reveal significant results without including the macroeconomic variables into the EWS model. According to our results, in accordance with the conventional banking and EWS literature[57], both bank-specific and macroeconomic variables can affect the fragility of Islamic banks to experience banking crises where the significance of the crisis indicators are sensitive to the dependent variable definition of the EWS model.

[57] Hardy and Pazarbaşıoğlu (1998).

5.2. PREDICTIVE PERFORMANCES OF THE EWS MODELS

As explained in the previous chapters, EWS is an essential tool for policy makers which provides an opportunity to prevent the occurrence of the crises or minimize the loss that is expected to be caused by the crisis via taking early precautions. The technical specifications of EWS models are built on the same common criteria. On this basis, constructing an EWS model must begin with a definition of the crisis event since it constitutes the dependent variable of the model where some relevant indicators indicate the crisis event (Kindman, 2010). The other crucial criteria to be determined are the country coverage set (within a single country or multi-country framework), time period covered, and conducting a proper estimation methodology.

In the previous section, we analyze a broad set of prospective banking sector-specific and macroeconomic indicators in order to show how BSFI definition affect the significant indicators of the fragility of Islamic banks in experiencing banking crises. Incorporating sixteen variables in total in our various EWS models that are constructed fundamentally on those various definitions of BSFI, we detect that while GDP growth is consistently and significantly related with the crisis occurrence; the significance of the ratio of M2 to GDP, the ratio of M2 to international reserves, real interest rate, current account balance as a percentage of GDP, ROA, CAR and the ratio of total operating revenues to total operating expenses vary with respect to the EWS models. Accordingly, in this part of the thesis, we first aim to explore the impact of BSFI variations and the choice of the proxies of risk factors for BSFI definition on the predictive power of EWS models for Islamic banking. Next, in order to obtain the most suitable BSFI for Islamic banks, we evaluate the predictive power results of the EWS models.

5.2.1. Predictive Performances

Within the framework of the EWS model construction, the first step is to make a precise definition of the dependent variable. In this thesis, we define the fragility of Islamic banks to banking crisis by using BSFI. To be able to compare the impact of BSFIs on the

predictive performance of the EWS models we define twenty-five different BSFIs and thereby we construct twenty-five different EWS models.

The fragile and tranquil episodes of the Islamic banks are obtained using the BSFIs calculated by employing our sample data from twelve countries. Next, as another step of the EWS construction, the significant indicators of the fragility of Islamic banks to crises are revealed based on our estimation methodology of logistic regressions. By conducting logistic regression estimations, the predicted probabilities of fragility and tranquil episodes are estimated for our data set as a function of the selected explanatory variables. On this basis, the predictive power indicates the ability of the estimated model to predict the fragility and tranquil episodes in the real data correctly. Namely, predictive performance reveals the accuracy of an EWS model based on its ability to accurately call the fragility and tranquil episodes. In order to evaluate the predictive performances of the EWS models, the actual fragility and tranquil episodes are compared with the predicted probability of the fragile and tranquil episodes. To be more precise, the predictive power of any EWS shows the percentage of correctly predicted fragility and tranquil episodes. Analytically, the predictive power of any EWS model is calculated as follows:

$$\text{Predictive Power} = \frac{(\text{Total Number of Correctly Predicted Fragility and Tranquil Episodes})}{\text{Total Number of Fragility and Tranquil Episodes}} \qquad (16)$$

At this juncture, the key critical issue is the determination of the optimal cut-off value for the probability of the fragility episodes. After obtaining the predicted probabilities of the episodes by conducting logistic regression, a cut-off value needs to be chosen to separate the fragility episodes from the tranquil episodes. Accordingly, when the estimated predicted probability exceeds the cut-off value for the chosen time period, then the system signals this episode as a fragility episode. Therefore, the cut-off value affects the predicted fragility and tranquil episodes since the forecasting errors, Type I error and the Type II error, is directly related to this value. Particularly, if a low cut-off value is determined, the early warning system produces more crisis signals (even if there is no crisis) which leads to an increase in the number of false alarms. This is referred as the Type II error. If a high cut-off value is set, less crisis signals are observed decreasing the

number of false alarms. However, in such case the system misses actual crisis episodes thus a crisis may occur even if no signal is issued by the system which leads to missing the crisis episodes. This type of error is referred as Type I error. For this reason, the cut-off value for the fragility episodes are determined considering Type I and Type II errors. We analyze the predictive power performances of the EWS models by setting a 50 percent cut-off value following the pioneering studies of Frankel and Rose (1996), Milesi et al. (1998), Davis and Karim (2008) and Comelli (2013).

In this study, we first define the fragility episodes of Islamic banking by constructing BSFIs. All of our BSFIs are based on liquidity risk, credit risk and market risk factors for 81 Islamic banks from 12 countries. We further include ROE as a profitability risk proxy which is an additional risk factor in some of the BSFIs. Accordingly, we construct twenty-five different BSFI indices; i.e. banking fragility definitions using the same risk factor proxies set. We proxy each factor by including different variables. The ratio of domestic credit to private sector and non-performing finance (NPF) is considered as proxies for credit risk; bank deposits (DEP) is considered as a liquidity risk proxy and; banks' real foreign liabilities (FL) and time interest earned ratio (TIER) are considered as proxies for market risk. To measure the profitability risk factor, we use return on equity (ROE) (Moussu and Petit-Romec 2018). In order to get substantial fragility definitions for Islamic banks through examining various risk factors and their proxies which will improve the predictive power of the EWS models; we construct alternative BSFIs by using different combinations of those proxies. That is in order to make robust analyses of whether the credit risk, market risk, liquidity risk and profitability risk factors play significant effects on the predictive power of our EWS models, we alternately include and exclude these risk factors in alternating BSFIs. Based on these definitions, we develop twenty-five different EWS models in total where the models differ in those definitions. This kind of strategy enables us to observe the impacts of various definitions on the predictive power of the EWS. Accordingly, the results for the predictive power performances of the EWS models are summarized in Table 16:

Table 16: Prediction Power Results of the EWS Models

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Total Number of Fragility Episodes	Correctly Predicted Fragility Episodes	Missed fragility episodes	Type I error	Prediction Power of the Fragility Episodes	Total Number of Tranquil Episodes	Correctly Predicted Tranquil Episodes	False alarms	Type II error	Prediction Power of the Tranquil Episodes	Prediction Power
Model 1	65	40	25	38%	62%	67	45	22	33%	67%	64.4%
Model 2	68	49	19	28%	72%	64	47	17	27%	73%	72.7%
Model 3	42	25	17	40%	60%	90	85	5	6%	94%	83.3%
Model 4	73	57	16	22%	78%	59	42	17	29%	71%	75.0%
Model 5	48	15	33	69%	31%	84	68	16	19%	81%	62.9%
Model 6	66	49	17	26%	74%	66	55	11	17%	83%	78.8%
Model 7	68	49	19	28%	72%	64	48	16	25%	75%	73.5%
Model 8	60	40	20	33%	67%	72	65	7	10%	90%	79.5%
Model 9	73	47	26	36%	64%	59	47	12	20%	80%	71.2%
Model 10	68	54	14	21%	79%	64	57	7	11%	89%	84.1%
Model 11	69	56	13	19%	81%	63	50	13	21%	79%	80.3%
Model 12	66	54	12	18%	82%	66	55	11	17%	83%	82.6%
Model 13	72	66	6	8%	92%	60	52	8	13%	87%	89.4%

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Total Number of Fragility Episodes	Correctly Predicted Fragility Episodes	Missed fragility episodes	Type I error	Prediction Power of the Fragility Episodes	Total Number of Tranquil Episodes	Correctly Predicted Tranquil Episodes	False alarms	Type II error	Prediction Power of the Tranquil Episodes	Prediction Power
Model 14	72	57	15	21%	79%	60	50	10	17%	83%	81.1%
Model 15	70	53	17	24%	76%	62	50	12	19%	81%	78.0%
Model 16	74	63	11	15%	85%	58	49	9	16%	84%	84.8%
Model 17	70	41	29	41%	59%	62	46	16	26%	74%	65.9%
Model 18	73	55	18	25%	75%	59	45	14	24%	76%	75.8%
Model 19	73	40	27	40%	60%	65	51	14	22%	78%	68.9%
Model 20	66	51	15	23%	77%	66	54	12	18%	82%	79.5%
Model 21	70	49	21	30%	70%	62	52	10	16%	84%	76.5%
Model 22	65	40	25	38%	62%	67	49	18	27%	73%	67.4%
Model 23	65	38	27	42%	58%	67	49	18	27%	73%	65.9%
Model 24	67	40	27	40%	60%	65	50	15	23%	77%	68.2%
Model 25	70	50	20	29%	71%	62	48	14	23%	77%	74.2%

To obtain the predictive probabilities of the models, we conduct fixed effect logistic regressions for our country panel. Logistic regressions are run for each of the twenty-five EWS model separately. In these regressions we exclude the eight variables that are found to be insignificant in the first round of the estimations where we are trying to determine the significant crisis indicators among our bank-specific and macro variables set. Accordingly, while we are predicting fragility probabilities in this second round of logistic regressions we only include the explanatory variables which are found to have significant explanatory power on the fragility of the Islamic banks to experience crisis.

Column (1) and Column (6) of Table 16 represent the actual number of the fragility and tranquil episodes of Islamic banks respectively. The correctly predicted fragility and tranquil episodes at the 50 percent cut-off value, are given in Column (2) and Column (7). In addition, the table provides information about the missed fragility episodes and false alarms. Missed fragility episodes show the difference between the total number of the actual fragility episodes that are obtained from the BSFI and the correctly predicted fragility episodes. The total number of the missed fragility episodes are crucial since the Type 1 error is calculated in accordance with missed fragility episodes. Type 1 error indicates the percentage of the total number of periods that the system does not issue any signal but a fragility episode is occurred (Column (4)). False alarms, on the other hand, represent the difference between the total number of tranquil episodes and correctly predicted tranquil episodes. This means that the system finds fragility episodes although a tranquil episode is observed which is called as Type 2 error. Therefore, Type 2 error gives the percentage of the number of false alarms in the total number of tranquil episodes (Column (8)).

Prediction power of the fragility episodes and the prediction power of the tranquil episodes are presented in Column (5) and Column (10) respectively. The estimated predicted probabilities are compared to actual fragility and tranquil episodes to achieve the predictive power of the models. The percentage of the correctly predicted fragility and tranquil episodes are identified when the predicted and actual episodes are matched. In other words, the correctly predicted fragility episodes represent the cases where the system successfully matches the predicted fragility episode and the actual fragility

episode. The correctly predicted tranquil episodes, on the other hand, occurred when the system predicts a tranquil episode and no fragility episode occurred. Finally, in Column (11), the overall prediction power, which shows how successful the EWS model is in terms of detecting the fragility and tranquil episodes correctly within the total number of fragility and tranquil episodes is given.

5.2.1.1. Impact of Risk Factor Proxies Used to Construct BSFIs on the Predictive Power of the EWS

One ultimate aim of this thesis is to compare the choice of different risk factor proxies for constructing the BSFI in terms of their effect on the predictive power performances of the EWS models. To this aim we define twenty-five different BSFIs which form the dependent variables of twenty-five different EWS models. Accordingly, in order to measure the credit risk factor, we use either one of the two proxies as NPF and BC. Market risk is proxied by considering either the TIER or FL proxies. We proxy liquidity risk and profitability risk factors using DEP and ROE respectively. For example, the BSFIs of Model 1 and Model 5 are constructed based on those factors of liquidity risk, credit risk and market risk. In Model 1 and Model 5, while market risk and liquidity risk are measured by using the same proxies as TIER and DEP respectively; in Model 1 the proxy for the credit risk is chosen as NPF whereas, in Model 5 credit risk is proxied by BC. In other words, these two models differ only in the credit risk proxies. Likewise, in Model 5 and Model 15, while the credit risk and liquidity risk are measured by the same proxies in both models; in Model 5 the market risk is measured by TIER and in Model 15 it is proxied by FL. The BSFIs of Model 9 and Model 14 are constructed on credit risk, liquidity risk, market risk and profitability risk factors. In both models the same proxies of BC, DEP and ROE are used to measure the credit, liquidity and profitability risk respectively. However, in Model 9, the market risk is measured by TIER but in Model 14 it is proxied by FL. According to the results given in Table 16, despite the fact that the BSFIs are defined considering the same risk factors for Islamic banks (i.e. credit risk, liquidity risk, market risk, profitability risk), the predictive power of different EWS models is highly sensitive to the proxies that are used to measure those risks and their combinations.

In terms of the proxies that are used to measure the credit risk, we use two different proxies as NPF and BC. To be able to identify which proxy has reveal more successful results in terms of the prediction power of the EWS models, we compare those models that we constructed with the same variables other than the credit risk proxy. For instance, while Model 1 is constructed with NPF, DEP and TIER proxies, the BSFI of the Model 5 is constructed using BC, DEP and TIER proxies. In addition, Model 2 and Model 3, Model 4 and Model 15, Model 6 and Model 16, Model 7 and Model 9, Model 8 and Model 10, Model 11 and Model 14, Model 23 and Model 17 and Model 20 and Model 21 are constructed in the same vein as the pair of Model 1 and Model 5 in order to provide an opportunity to analyze the marginal impact of the BC and NPF proxies on the predictive power rates of the EWS models while keeping other proxies of the risk factors fixed.

When we compare the models, we observe that although using BC as a proxy for the credit risk does not make a clear difference, however in the overall, it has a weak positive effect on the predictive power of the EWS model. For instance, when Model 4 and Model 15, Model 11 and Model 14, Model 8 and Model 10 are compared pairwise, it is seen that using BC as a proxy rather than NPF increases the predictive power rate only by 3%, 1% and 4% respectively. On the other hand, in some of the model comparisons (i.e. Model 1 and Model 5, Model 7 and Model 9 and Model 20 and Model 21), using NPF as a credit risk proxy instead of BC increases the predictive power by 1% and 3% respectively. In terms of Model 13 and Model 17, it is observed that both variables reveal the similar predictive power results. However, when Model 2 and Model 3 and; Model 6 and Model 16 are compared, it is observed that the using BC as a proxy for credit risk increases the predictive performance of the models by 10% and 6% respectively. While the BSFI of Model 3 is comprised of BC and TIER proxy, Model 16 is constructed with BC and FL proxies. Since both models are constructed with BC and market risk proxies, it can be concluded that if the fragility of Islamic banks is measured by considering credit risk factor and market risk factor, BC reveals more substantial results compared to the NPF proxy. This might stem from the strong link between the domestic credit to private sector and market risk. The domestic credit is triggered by markets risk factors as exchange rate changes and interest rate volatilities and it has significant effects on the economic activity

and financial stability (Yuafi and Bawono, 2017). Accordingly, the Islamic banks also become more fragile to crises. In the related literature NPF and BC are widely used and accepted as a prominent determinant for both conventional banking and Islamic banking system to measure the credit risk (Kibritçioğlu, 2003; Firmansyah, 2014; Salim et al., 2016; Khan et al.,2020). To sum up, credit risk can be proxied both by using CB or NPF variables in constructing a BSFI for Islamic banks. However, when the BSFI is constructed with a combination of credit risk and market risk, BC increases the predictive performance of the EWS rather than the NPF.

In terms of the market risk factor for Islamic banks, we consider FL and also, we try to measure this risk utilizing the size of the banks in terms of their eligible capital by using the TIER proxy. To compare the impact of the market risk proxies, the BSFIs are constructed by keeping the other risk factors and proxies rather than the market risk proxies as the same. This gives an opportunity to compare the EWS models that only differ in terms of the market risk proxy. For instance, while the BSFI of the Model 9 is constructed by using BC, DEP, TIER and ROE proxies, the BSFI of the Model 14 comprise of the BC, DEP, FL and ROE. Likewise, Model 1 and Model 4; Model 2 and Model 6; Model 3 and Model 16; Model 5 and Model 15; Model 7 and Model 11; Model 8 and Model 12; Model 9 and Model 14; Model 10 and Model 13 and; Model 22 and Model 24 can be compared pairwise to investigate the impact of the TIER and FL proxies on the predictive power rates of the EWS models while keeping other proxies of the risk factors same. According to our results, while including TIER variable into the BSFI as a measure for market risk decreases the predictive power of the EWS models; using the variable FL improves the ability of the models in predicting fragility and tranquil episodes correctly. For instance, when we change the market risk proxy to FL in Model 1, the predictive performance increases by 11% (that becomes Model 4). In addition, the predictive power of the EWS model 15 increases by 15% by including FL instead of TIER (that becomes Model 5). In a similar vein, while the predictive power of the Model 9 is 71%, it increases to 81% when we measure the market risk by FL. Furthermore, we observe the same results in all comparisons of the models.

Tier is used to calculate the eligible capital, i.e. minimum capital requirement to cover the market risk of banks. The eligible capital is the sum of Tier 1 (shareholders' equity and retained earnings) and Tier 2 (supplementary capital) (BCBS, 2006). Foreign liabilities, on the other hand, represents the total amount of the banks' liabilities in foreign currency items. Our results indicate that while constructing a BSFI to define the fragility and tranquil episodes of Islamic banking, measuring the market risk using FL rather than using Tier gives better prediction results. Within this framework, when the value of the assets of a bank falls below the value of its liabilities, the financial structure of that bank deteriorates. The currency mismatch that arises between a bank's foreign currency assets and its foreign currency liabilities is called a foreign currency position. In other words, if banks' short-term liabilities in foreign currency exceed their short-term assets in foreign currency, the banking system would be in a liquidity shortage on an international basis. In this regard, exchange rate risk is an important source of the market risk of the banking sector which mainly arises from the investments made by banks in foreign exchange transactions. Transactions as acquiring and distributing funds in foreign currency can be affected by the exchange rates movements. In cases where it is not expected an upcoming devaluation in the domestic currency, banks tend to acquire funds from international financial markets. However, if domestic banks have high amount of unhedged foreign currency debt, a sudden devaluation can cause a significant reduction in the bank's net worth and threatens its profitability by disrupting the financial structure of the banking system (Demirgüç-Kunt and Detragiache, 1998; Kibritçioğlu, 2003).

Furthermore, besides the banks' own balance sheet, Mishkin (1999) explains the impact of the domestic currency depreciation through firms balance sheet. According to his view, in case of the depreciation, the financial structure of firms deteriorates since their burden of debt increases more than their assets. As a result, this leads to problems in the return of debt to banks by causing capital depletions in banks (Mishkin, 1999). The basis of the Asian crisis is the growth of foreign currency openings of these countries. One of the reasons for this situation is the fact that a large amount of loans was provided to Asian countries, especially from foreign commercial banks, in the 1990s. Five Asian countries from international commercial banks as Indonesia, Korea, Malaysia, Philippines, and Thailand provided loans of approximately 150 billion dollars in 1990, while

approximately 390 billion dollars were extended in 1997, the beginning of the crisis. Most of the loans extended by foreign banks consist of short-term loans. The fact that this capital was made available by banks in local currency as loans for sectors that do not create value added and thus, the non-repayment of these loans contributed to the growth of the crisis (Chang and Velasco, 1998; Kaplan, 2002).

Note that, even the BSFIs defined in the EWS models are based on the same risk factors, the proxy variables that are used to measure these risk factors differ in each index. Indeed, our results show even if the same risk factors are utilized, the predictive powers of the EWS models differ with respect to the proxies used to measure those risk factors i.e. with respect to the BSFI definition of the crisis event.

5.2.1.2. Impact of Risk Factors Used to Construct BSFIs on the Predictive Power of the EWS

Besides the variations in the proxies to measure various risk factors we also compare those risk factors themselves that are used to construct the BSFIs, in terms of their effect on predictive power rates. For this aim, we alternately omit some of the risk factors from the BSFIs and compare the results. The determination of the importance of the risk factors are essential since the related literature suggests different views on this subject. For instance, according to Glick and Hutchison (1999), the majority of the banking crises that are experienced in the recent years are not linked to the bank runs. Related to this, Kibritçioğlu (2003) finds liquidity risk do not play a major role in triggering banking crises for some countries. On the other hand, the banking crises that are experienced in Indonesia in 1998 and Argentina in 2002, show that bank runs plays an important role in banking crises incidence (Ishihara, 2005). For this reason, we investigate the impact of each of the risk factor while determining the fragility of Islamic banks to crises in terms of their effect on the predictive performance of EWS.

In order to test whether bank runs are important in explaining the fragility of Islamic banks to crises or not, we omit liquidity risk factors in some of the BSFIs i.e. fragility definitions for Islamic banks. For instance, Model 13 is constructed by omitting the

liquidity risk factor (DEP proxy) from the Model 14. In addition, the models such as Model 1 and Model 2, Model 3 and Model 5, Model 4 and Model 6, Model 7 and Model 8, Model 9 and Model 10, Model 11 and Model 12, Model 13 and Model 14, Model 15 and Model 16, Model 18 and Model 21, Model 19 and Model 20 and; Model 22 and Model 25 are designed in a similar manner to evaluate the impact of liquidity risk factor on the predictive performance of the EWS models. According to our results, omitting DEP variable for the liquidity risk from the BSFI increases the predictive power of the EWS models. For instance, while Model 7 (constructed by using NPF, DEP, TIER and ROE variables) is able to predict the fragility and tranquil episodes of Islamic banking about 74% accuracy, the predictive performance of the Model 8 (constructed by omitting DEP variable from Model 7) increases to 80%. In fact, the case is valid for all of the pairwise compared models that are mentioned above. The results are in line with the Kibritçioğlu (2003) and Glick and Hutchison (1999) studies on conventional banking system suggesting that the liquidity risk do not play a major role in explaining banking crises.

Credit risk is one of the main risks that seriously causes financial instability and effects banks' vulnerability. It is considered as the main reason of bank failures (van Greuning and Iqbal, 2007). Considering the fact that the amount of bad debt in Islamic banking has been growing in the last decade[58]we examine whether the credit risk is an essential risk factor for Islamic banking in forecasting the crisis episodes for Islamic banks. In terms of the credit risk factor, our results show that the it plays a crucial role in predicting the fragility episodes for Islamic banks. For instance, in Model 22, the BSFI is defined employing proxies for liquidity risk, market risk and profitability risk factors omitting the credit risk factor. The BSFIs of the Model 7, Model 9, Model 11 and Model 14, on the other hand, are constructed with including credit risk factor into the Model 22 employing different combinations of the proxies. In other words, Model 22 and the Models 7, 9, 11 and 14 differ in terms of the credit risk factor. The results show that, including credit risk proxy enhances the predictive performance of the EWS models. For instance, when we include BC as a proxy for credit risk in Model 9, the predictive performance of the model

[58] See Sarker (1999).

increases to 71.2%. Additionally, including NPF also enhances the predictive performance to 73.5% in Model 7.

Islamic banks collect and distribute funds on the basis of profit and loss sharing (PLS). While conventional banks use interest as a tool against credit risk exposure, Islamic banks do not use interest since it is prohibited. While conventional banks provide debt-based products relying on interest, Islamic banks use funds on the basis of PLS where they provide funds with mainly sale and lease-based products such as *Murabahah, Ijarah, Salam, Istisna', Musharakah* and *Mudarabah*. Thus, it is argued that they are exposed to higher credit risk compared to conventional banks since they have limited risk sharing practices (Chong and Liu, 2009; Abdul-Rahman et al., 2014; Kabir et al., 2015). For this reason, the fragility episodes of the Islamic banks are highly dependent on the credit risk. As expected, our results indicate that the credit risk is an important factor for the BSFI of Islamic banks as it is in conventional banking (see Kibritçioğlu, 2003). We find that no matter which market risk, liquidity risk or profit risk variable is used, the BSFI for Islamic banks should include the credit risk factor. If the BSF index is constructed considering the credit risk, the EWS captures the fragility and tranquil episodes more successfully and reveals better forecasting results.

In this thesis, apart from the existing studies, we explore whether the profitability risk factor has a significant impact on the predictive power of EWS models for Islamic banks. In the related literature, the BSFI is constructed by using credit risk factor, market risk factor and liquidity risk factor (or by omitting liquidity risk proxy) and these risk factors are also employed to BSFIs for Islamic banks (Kibritçioğlu, 2003; Ahmad and Mazlan, 2015; Kusuma and Duasa, 2016). However, due to their distinctive nature, Islamic banks are also vulnerable to profitability risk different from the conventional banks.

As the conventional banks operate based on interest, on the asset side of their balance sheet, they have fixed income securities and also the return on their deposits are predetermined which means that the conventional banks have fixed rate of returns. However, since the Islamic banks operate based on PLS, the rate of returns are not certain. The investments are based on mark-up and equity implying that there is no fixed rate of

return. And, since there is no pre-agreed return on deposits the uncertainties of the rate of return on investments is higher (van Greuning and Iqbal, 2007). For this reason, Islamic banks are also supposed to be exposed to profitability risk. Therefore, we further incorporate profitability risk factor in order to test whether it has an impact on the predictive power of EWS models. To this aim we use ROE, since ROE is accepted as the most important indicator of a bank's profitability and widely-used also for Islamic banking (see Moin, 2008; Bilal et al., 2016; Ekinci and Poyraz, 2019).

To be able to investigate if profitability risk has any impact on the predictive power results of EWS for Islamic banks, we construct different BSFIs that only differ in terms of the profitability risk proxy. For instance, while the BSFI of Model 2 is comprised of credit risk (NPF) and market risk (Tier) factors, Model 7 is constructed by considering credit risk (NPF), market risk (Tier) and profitability risk factors. Correspondingly, we are able to compare Model 1 and Model 7, Model 2 and Model 8, Model 3 and Model 10, Model 4 and Model 11, Model 5 and Model 9, Model 6 and Model 12, Model 13 and Model 16, Model 14 and Model 15 as well as Model 17 and Model 18.

Our findings indicate ROE-the proxy for the profitability risk-improves the predictive power performances of the EWS models for Islamic banks as expected. Put differently, involving the profitability risk factor into a BSFI in defining the fragility of Islamic banks to crises, expands the ability of the EWS model to make consistent predictions. In all of the models, it is observed that profitability proxy enhances the predictive performance of the system. For instance, while Model 2 correctly predicts the fragility and tranquil episodes by 73%; including profitability risk factor into the BSFI increases the predictive performance of the EWS model by 7%. Furthermore, this outcome is valid for all of the pairwise compared EWS models. Therefore, the results suggest that, as an important risk factor for Islamic banking, profitability risk increases the correctly called fragility and tranquil episodes of banking crises. That is, in constructing BSFIs for Islamic banking system profitability risk factor should not be omitted.

As opposed to conventional banks, since the financial instruments of the Islamic banks are asset-based rather than debt-based, Islamic banks are exposed to higher market risk

than conventional banks. The market risk in Islamic banking arises mainly due to mark-up rates and price fluctuations. For instance, within the context of *Salam*, market risk arises due to price differences in the period between the delivery and sale of the goods. In *Murabahah*, on the other hand, even though the benchmark rate may vary, the mark-up rate is fixed during the contract. Therefore, when prevailing mark-up rate exceeds the rate that is agreed in the contract, then the bank cannot benefit from this price change (van Greuning and Iqbal, 2007). For this reason, it is important to investigate whether including the market risk factor into the BSFI enhances the predictive power performances of the EWS of Islamic banks.

To investigate the impact of market risk proxy on the predictive power rate of the EWS models of Islamic banks, we compare the models: Model 1 and Model 23, Model 5 and Model 17, Model 7 and Model 19, Model 8 and Model 20, Model 9 and Model 18, Model 10 and Model 21, Model 12 and Model 20, Model 11 and Model 19, Model 13 and Model 21, Model 14 and Model 18 and; Model 15 and Model 17. Although the BSFIs of these models are built by using credit risk, liquidity risk and profitability risk, we omit market risk from some of them. For instance, while the BSFI of the Model 12 is built by credit risk (NPF), market risk (FL) and profitability risk (ROE), the BSFI of the Model 20 is constructed by omitting the market risk proxy and constructed by considering the credit risk (NPF) and profitability risk (ROE) only. Therefore, the models differ only in terms of the market risk factor. We find that, as in the case for conventional banking, market risk is an important risk factor for Islamic banks (see Kibrirçioğlu, 2003). Once we include market risk factor by using FL proxy into the models, the predictive power of the EWS models increases. However, we observe a weak evidence for the models where the BSFIs are constructed by tier proxy as a market risk factor. As we investigate in the Section 5.3.1, the FL proxy reveals better predictive power results than the tier proxy. We believe that our interpretations about the FL and tier proxy are also binding at this point. More precisely, in term of the predictive power performances, the foreign currency liabilities of Islamic banks reflect the market risk of Islamic banks better than the minimum capital requirement to cover the market risk of banks. Therefore, we observe constructing the BSFI with market risk factor increases the predictive ability of the EWS model even if the risk factor is measured by the FL proxy.

5.2.1.3. Comparison of the Predictive Power Results by EWS Models

The predictive power shows the ability of the EWS models to correctly detect the fragility episodes and tranquil episodes. As explained earlier, the predictive performances are sensitive to the definition of BSFIs as a dependent variable of the models. The predictive power rates of the 25 EWS models are presented in Figure 24.

Figure 24: Predictive Powers of the EWS Models

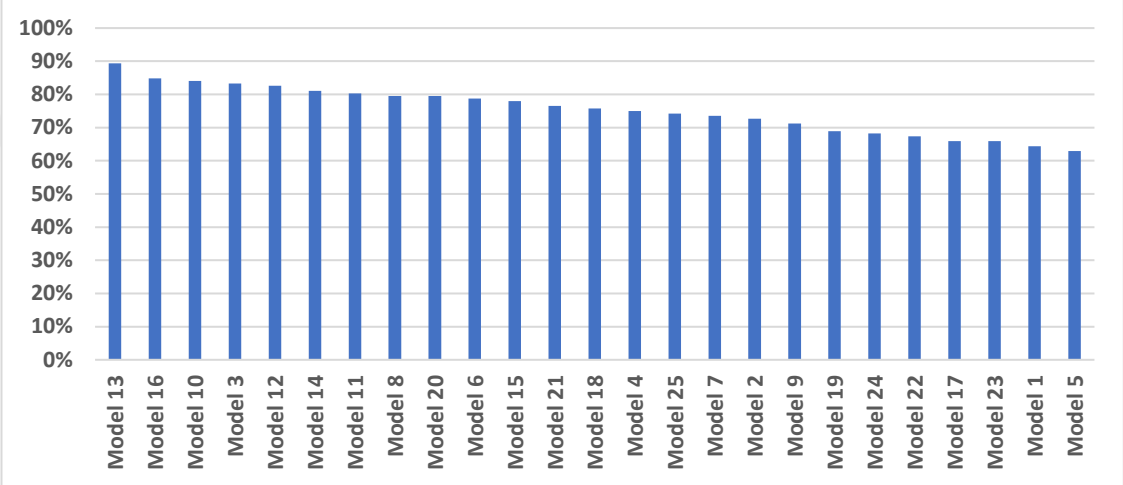


Figure 24 summarizes the predictive power rates of the EWS models. According to this figure, once we rank the models from high to low prediction performance, the most relevant is Model 13. The BSFI of the Model 13 is constructed by using credit risk, market risk and profitability risk factors proxying these risk factors by the variables of BC, FL and ROE, respectively. Particularly, the BSFI of the model is as follows:

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/BC_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{3} \quad (17)$$

According to the results of Table 16, the EWS which is constructed by using this BSFI correctly predicts the fragility episodes of Islamic banks by 92% and tranquil periods by 87%. In overall, the model correctly captures the fragility and tranquil periods of the Islamic banks by 89%. Accordingly, the model is also considered as successful in terms of the ratio of missed fragility episodes to total number of fragility episodes and i.e. false

alarm, where Type 1 error is 8% and Type 2 error is 13%. This indicates that the model reveals 72 fragility episodes whereas 6 episodes are missed. On the other hand, while the model finds 60 tranquil periods, 8 of them are false alarms.

The second-best model is the Model 16. The BSFI of the model is constructed with credit risk and market risk proxying these risk factors by the variables of BC and FL respectively. The BSFI of the Model 16 is:

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(FL_t - FL_{t-1})/FL_{t-1}] - \mu_{FL}}{\sigma_{FL}}\right)}{2} \quad (18)$$

Model 16 captures the fragility episodes of Islamic banks by 85% and tranquil episodes by 84%. The overall predictive performance of the model is 85% where Type 1 and Type 2 errors of the model are reported as 15% and 16%, respectively.

Looking at the third best model in terms of the predictive performance, Model 10, the BSFI of the model is constructed by using credit risk, market risk and profitability risk factors by using BC, Tier and ROE respectively. That is:

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right) + \left(\frac{[(ROE_t - /ROE_{t-1}] - \mu_{ROE}}{\sigma_{ROE}}\right)}{3} \quad (19)$$

While the predictive performance of the model for the fragility episodes is 79%, it is 89% for the tranquil episodes. As one can see, the model captures the tranquil episodes better than the fragility episodes. Further, the Type 1 error of the model is 21% while the Type 2 error is 11%.

Note that the first three EWS models in Figure 24 which give the highest predictive power results among our EWS models are constructed by employing the credit risk factor. In addition, in all of these three models, credit risk is proxied by BC rather than the NPF. Although including the FL as a proxy to measure the market risk reveals higher predictive power results, there is a slight difference in the predictive power of the Model 16 and

Model 10. This is due to the impact of the profitability risk factor. Using ROE as a profitability risk factor enhances the predictive power of the EWS models for Islamic banking system. Moreover, all of these models are built by omitting the liquidity risk from the BSFIs.

It should be noted that the first 14 models are constructed incorporating the credit risk factor. Accordingly, the results reveal that omitting credit risk from any crisis definition for Islamic banks reduces the predictive power of the constructed EWS. In addition, Model 5 appears to be the model with the lowest predictive power. The BSFI of the model is constructed by using credit risk (BC), liquidity risk (DEP) and market risk (tier) factors as follows:

$$BSFI_{i,t} = \frac{\left(\frac{[(BC_t - BC_{t-1})/NPF_{t-1}] - \mu_{BC}}{\sigma_{BC}}\right) + \left(\frac{[(DEP_t - DEP_{t-1})/DEP_{t-1}] - \mu_{DEP}}{\sigma_{DEP}}\right) + \left(\frac{[(tier_t - tier_{t-1})/tier_{t-1}] - \mu_{tier}}{\sigma_{tier}}\right)}{3} \quad (20)$$

Although the model is comprised of credit risk factor (BC), we believe that such outcome of low performance stems from the impact of the liquidity risk factor (DEP). In other words, as explained above, the bank runs do not significantly associate with the fragility of Islamic banks to banking crisis between 2008 and 2018. Thus, the DEP proxy does not enhance the predictive power performances of the models. The same result is also valid for the second and the third worst models (Model 1 and Model 23). Therefore, one can conclude that bank runs do not play a significant role in defining the BSFI for Islamic banks. In other words, the liquidity risk factor does not increase the rate of correctly predicted crisis episodes of the EWS.

In this chapter, we thoroughly examine the impact of BSFI definition on the predictive performance of the EWS models for Islamic banks. The changing impacts are elaborated in two sub sections as the in terms of the choice of the risk factors and the choice of the proxies to measure those risk factors while defining BSFIs. Our results indicate that, despite the fact that the banking fragility indices are defined considering the same risk factors, the predictive power of EWS is highly sensitive to the proxies that are used to measure those risks and their combinations.

To identify which proxies, reveal more successful results in terms of the prediction power of the EWS models, we make pairwise comparisons between models. For example, to measure credit risk, we employ two different proxies i.e. NPF and BC. In addition, we use either FL or Tier to measure the market risk factor. According to our findings, using CB or NPF in a BSFI for Islamic banks do not reveal very different predictive power results. Therefore, the credit risk can be proxied by both proxies. However, if the BSFI is constructed by considering only the credit risk and market risk factors, BC proxy increases the predictive performance of the EWS rather than that of NPF. In terms of the market risk, on the other hand measuring the market risk using FL rather than using Tier gives better prediction results.

To examine the impact of the risk factors variations themselves on the predictive power rates, we alternately omit some of them from BSFI definitions. For instance, to test whether bank runs are important in explaining the fragility of Islamic banks to banking crises, we omit liquidity risk factors in some of the BSFIs. We find that omitting the liquidity risk factor does not reduce the predictive power of the EWS models. This finding is in line related literature on the conventional banking system suggesting that liquidity risk do not play a major role in explaining banking crises. Regarding the credit risk factor, the results indicate that regardless of the choice of the proxy to measure the market risk, liquidity risk or profit risk; including the credit risk factor increases the predictive performance. In terms of the market risk factor, we observe that including FL into the BSFIs increases the predictive power of the EWS models. On the other hand, we observe weak evidence for the models that the BSFIs that are constructed by tier proxy as a market risk factor. Apart from the existing literature, we further incorporate profitability risk in our performance analyses. We find that profitability risk plays significant roles in constructing a successful BSFI for Islamic banks. When we include ROE into the BSFIs, the predictive performances of all models increase. This is indeed consistent with the related literature emphasizing Islamic banks are more vulnerable to profitability risk than conventional banks, where there is uncertainty in the context of forthcoming returns on their assets (Elgari 2003; Kozarevic e al., 2014).

CHAPTER 6

CONCLUSION

In this study, we construct various banking sector fragility indices (BSFIs) for Islamic banks and detect early warning system (EWS) models to produce substantial predictive power results for Islamic banking crises for 81 banks from 12 countries over a recent time period 2008-2018. Particularly, we employ twenty-five different definitions of BSFI and thereby examine twenty-five different EWS models. While the significant indicators of the crises and predictive power rates of the models differ from model to model, this study tries to provide a solid BSFI definition for Islamic banks. BSFIs are defined as the average standardized values of the main risk factors of Islamic banks i.e. the credit risk, liquidity risk and market risk. The BSFIs differ both in terms the risk factors incorporated and the proxies to measure these risk factors. Furthermore, apart from the existing literature, we include profitability as a new risk factor into some of our crisis definitions which we believe to be essential for Islamic banks since their operations are based on profit and loss sharing (PLS) principle.

To identify which risk factors and proxies reveal more successful prediction results for the EWS models, we make pairwise comparisons between models. To proxy the risk factors that Islamic banks incur we consider a wide range of bank-specific and macroeconomic variables. For example, to measure the credit risk, we employ two different proxies i.e. non-performing financing (NPF) and domestic credits to private sector (BC). In addition, we use either FL or Tier to measure the market risk factor. To examine the impact of the risk factors variations on the predictive power rates, we alternately omit some of them from BSFI definitions. For instance, to test whether bank runs are important in explaining the fragility of Islamic banks to banking crises, we omit liquidity risk factors in some of the BSFI definitions. Likewise, we exclude credit risk and market risk from some of the BSFIs to investigate the role of these risk factors on the predictive performances of the EWS models.

Before proceeding to the predictive performances of the models, we first detect significant indicators of crises varying with different BSFIs that stands as the dependent variable of the EWS models. The identification of the indicators is crucial since they provide early signals about a banking crisis. Accordingly, we identify different indicators of banking crisis with different BSFI definitions. One important outcome of this stage of the analyses is that GDP growth is found to be a significant crisis indicator regardless of the BSFI definition. This is indeed consistent with the related literature implying that similar to the case for the conventional banking system, higher economic growth makes Islamic banks less fragile to crises since it is associated with decreasing NPF and thus, the credit risk and increasing credit quality.

In order to measure the predictive performances of the EWS models, we first determine the actual fragility and tranquil episodes of Islamic banks using our sample data and BSFIs we construct. After calculating the crisis probabilities of the episodes, we cover via BSFIs, we match those with the predicted probabilities by our EWS models. Our results suggest that even if the same risk factors are utilized, the predictive powers of the EWS models are sensitive to the proxies used to measure those risk factors. For instance, although we consider banks' real foreign liabilities and time interest earned ratio to measure the market risk factor of Islamic banks, we find that real foreign liabilities give better predictive performance. Our findings also suggest that, if the foreign currency liabilities of Islamic banks are utilized rather than the minimum capital requirement to cover the market risk of banks, the EWS can capture the crisis episodes more successfully. This implies Islamic banks should precisely observe their foreign currency positions and be attentive of the currency mismatches that emerge from the foreign currency assets and liabilities to prevent the market risk. On the other hand, using BC as a proxy for the credit risk does not make a clear difference where it has a weak positive effect on the predictive power of the EWS model. Nevertheless, we find strong evidence that when the BSFI is constructed by using credit and market risk, BC proxy improves the predictive performance of the EWS rather than the NPF.

To examine the impact of various risk factors on the predictive power rates of the EWS models. we alternately omit some of these risk factors from the BSFIs and compare the

outcomes. According to the recent theories of banking crises, the crises emerge from asset price bubbles or credit booms rather than bank runs or panics. Our results indicate that, as in line with the conventional banking literature, liquidity risk does not play a major role in Islamic banking crises. In terms of the market risk factor, we observe incorporating market risk factor improves the predictive ability of the EWS model. In addition, no matter which proxy is utilized to measure the market risk, liquidity risk or profit risk; omitting the credit risk factor decreases the performance of the EWS models for Islamic banking. This result might be arose by the nature of the Islamic banks' functioning, namely the principle of PLS, prohibition of interest and funding methods. For instance, while conventional banks protect themselves from the credit risk by adjusting the interest rates, Islamic banks do not use interest since it is prohibited by the Islamic law. In addition, based on the principle of PLS, the Islamic banks share the profit and loss that emerges from any enterprise that money is lent. Furthermore, they provide funds based fundamentally on sale and lease rather than debt-based financing of conventional banking. Due to these facts, and limited risk sharing practices, Islamic banks are exposed to higher credit risk than the conventional banks. For this reason, in order to increase the ability of any EWS to capture the crises, the credit risk should be integrated into the models.

Apart from the existing studies on EWSs for Islamic banking sector, in this thesis, we explore whether the profitability risk factor has any significant impact on the predictive power of EWS for Islamic banks. Profitability risk is essential for Islamic banking since their operations are based on the PLS principle. While conventional banks use interest and thus they have fixed rate of return on asset side of their balance sheet, the rate of return is not certain in Islamic banking. In other words, in the Islamic banking system, the investments are based on mark-up and equity implying that there is no fixed rate of return and, since there is no pre-agreed return on deposits the uncertainty of the return on investments is higher. According to our results, profitability risk proxied by return on equity (ROE) improves the performance of EWS models by increasing the correctly predicted crisis episodes of Islamic banks.

Related to the ultimate aim of this study, we uncover that among the alternatives, the BSFI constructed by employing the credit risk (proxied by BC), market risk (proxied by FL) and profitability risk (proxied by ROE) together provides the most valid EWS model. This model correctly predicts the fragility and tranquil episodes for Islamic banks by 87%. The BSFI definition of the second-best model incorporates credit risk and market risk with a predictive power rate of 85%. While these models reveal substantial predictive power performances, we believe that those risk factors and proxies chosen to construct regarding BSFIs should be considered and followed by the authorities regulating and auditing the Islamic banks. That is, our key findings in identifying the fragility of Islamic banks to crises highlight a number of critical points that require attention from policy makers and researchers concerned with Islamic banking services. In this regard, first of all, low GDP growth makes Islamic banks more prone to face crises as it is the case for conventional banks. That is, while macroeconomic outlook worsens in a country, Islamic banking system cannot be exempted from this depression. Secondly, to successfully monitor the fragilities of Islamic banks, various risk factors should be carefully considered and these risk factors should be proxied by the most proper measures. In other words, within the framework of the index-based approaches, the risk factors and their proxies should be elected taking the unique nature and functioning of Islamic banks into account.

It is of particular importance for policymakers to monitor the fragility of the Islamic banks by concentrating more on the foreign currency liabilities as a market risk proxy. In this study, while employing this proxy as a market risk measure, the correctly predicted fragility and tranquil episodes of our EWS models have increased. Therefore, the variable could be a substantial measure for the market risk of Islamic banks while the fragilities are investigated by constructing a BSFI. Furthermore, the event-based studies consider the certain events as banking crises. That is, the event-based approach determines the banking crisis only when the impact on the market events is felt seriously. However, the BSFIs allow policymakers to obtain more information about the business cycles within the banking system. In other words, a correctly defined BSFI gives an opportunity to detect an approaching fragility episode by monitoring the value of the index. Although conventional banks and Islamic banks share similar objectives, they perform their

functions in different manners which make their risk exposure idiosyncratic in terms of their funding methods, principles and prohibitions. For this reason, defining a BSFI specific to Islamic banks is crucial where policymakers may prevent approaching crises and take early precautions to minimize its losses.

To sum up, this study draws attention to several essential points regarding early warning systems for Islamic banks. First of all, constructing a substantial index definition i.e. BSFI for a solid EWS model paves the way for predicting an approaching crisis successfully. Since we use data from the leading countries of Islamic banking, the index definitions and models in our analyses can also be applied to other countries that are not included into our dataset but have Islamic banking operations. Thereby, our study can guide the future studies to make relevant researches on the subject. As further research, we may suggest a number of extensions to our study. For instance, future studies might be conducted by utilizing different methodologies such as machine learning techniques of regression trees and random forest methods which will need more frequent and bigger datasets. Since machine learning techniques use and handle big datasets, a comprehensive investigation of leading indicators of banking crises can be made by including various financial ratios. Furthermore, comparison of the prediction power results from traditional techniques such as logistic regressions with the new techniques can significantly contribute to the literature. Additionally, the models that we have developed in this study can be used to construct a country-specific EWS model including other crucial explanatory variables measuring the contagion effect which will indicates the possibility of spillover effects. Contagion effect would be particularly important in constructing country-specific EWS models due to the strong linkages between countries and the financial systems. Last but not least, our novel investigation of different crisis definitions and EWS models can also be conducted for the conventional banks hypothesizing similar or different outcomes in terms of the predictive performances.

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APPENDIX A: CORRELATION MATRIX OF EXPLANATORY VARIABLES

	FDI	TotRes	reer	CAB	M2toGDP	M2toRes	inflation	GDPGrwth	rir	CAR	TLtoTA	TORtoTOE	ROA	LAtoTA	TLtoTD	TStoTA
FDI	1															
TotRes	0.1764	1														
reer	0.0928	-0.0998	1													
CAB	-0.2741	0.0429	-0.2597	1												
M2toGDP	-0.3043	-0.1326	0.1557	-0.2803	1											
M2toRes	-0.1526	-0.3713	0.1414	-0.2463	0.4101	1										
inflation	0.2074	0.018	0.1114	-0.2515	0.0403	0.2835	1									
GDPGrwth	0.2511	0.0261	-0.0681	-0.0856	-0.2629	0.0646	-0.1915	1								
rir	0.1704	-0.1304	0.0328	-0.2363	-0.0631	0.0236	0.0506	-0.1831	1							
CAR	-0.2081	0.0504	-0.3725	0.0932	0.1982	0.2094	-0.2308	0.0805	-0.0427	1						
TLtoTA	-0.1381	0.0161	-0.0376	-0.1685	0.2411	0.4756	-0.0079	0.2024	-0.0328	0.5944	1					
TORtoTOE	-0.0501	0.6197	-0.1349	0.3951	-0.0182	-0.4956	-0.2507	-0.1845	-0.1567	-0.0408	-0.2999	1				
ROA	-0.1551	0.1853	-0.2839	0.0313	0.1938	0.1155	-0.0281	0.1498	-0.0405	0.4438	0.3824	0.1577	1			
LAtoTA	-0.2927	-0.039	-0.2485	0.0029	0.3893	0.4853	0.1203	0.087	-0.1467	0.4725	0.7414	-0.2869	0.3495	1		
TLtoTD	0.1105	-0.0408	0.2073	-0.234	0.1305	-0.1257	-0.1052	-0.1049	0.0794	-0.0242	-0.1232	-0.0012	-0.0565	-0.1643	1	
TStoTA	0.2156	-0.0468	0.4325	-0.1582	-0.3171	-0.0077	0.082	0.2421	0.0501	-0.0962	0.1387	-0.2794	-0.1144	-0.0462	-0.0519	1

APPENDIX B. LOGISTIC REGRESSION RESULTS OF THE MODELS

Empirical Results (Model 1 to Model 5)

	Model 1	Model 2	Model 3	Model 4	Model 5
CAR	-0.0395*	-0.0231	-0.0189**	-0.0476*	-0.0054
	(0.016)	(0.12)	(0.005)	(0.011)	(0.011)
ROA	-0.0084	-0.0038	-0.0133*	-0.0012	-0.0103*
	(0.011)	(0.01)	(0.005)	(0.012)	(0.005)
TOR/TOE	-0.0521	-0.0063	-0.0282	-0.0788*	-0.0481*
	(0.028)	(0.025)	(0.023)	(0.034)	(0.023)
GDPGrwth	-0.0152*	-0.0224**	-0.0228**	0.0424**	0.0235***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
rir	0.0260	0.0350*	0.0137	0.0010	0.0052
	(0.017)	(0.016)	(0.013)	(0.019)	(0.012)
M2toGDP	-0.0243*	-0.0131*	-0.0247*	-0.0351**	-0.0040
	(0.012)	(0.024)	(0.010)	(0.013)	(0.009)
FDI	-0.0434	-0.0166	-0.0013	-0.0878	-0.0611
	(0.027)	(0.028)	(0.024)	(0.037)	(0.022)
TotRes	-0.0824	-0.0091	-0.0274	-0.109	-0.0019
	(0.08)	(0.042)	(0.036)	(0.080)	(0.003)
CAB	-0.0067	0.0009	-0.0175**	-0.0090	-0.0050
	(0.15)	(0.013)	(0.006)	(0.018)	(0.012)
inflation	-0.0063	-0.0053	-0.0132	-0.0141	-0.0100
	(0.015)	(0.008)	(0.008)	(0.012)	(0.008)
M2toRes	-0.0048	-0.0036	-0.00561	-0.0109*	-0.00043
	(0.01)	(0.010)	(0.009)	(0.011)	(0.009)
reer	-0.0503	-0.0302	-0.0173	-0.0927	-0.0029
	(0.03)	(0.034)	(0.345)	(0.050)	(0.036)
TLtoTA	0.0056	0.0043	0.00862	0.0112	0.0051
	(0.013)	(0.010)	(0.011)	(0.015)	(0.009)
TLtoTD	0.0066	0.0154	0.0108	0.0054	0.0050
	(0.010)	(0.008)	(0.008)	(0.009)	(0.007)
TLAtoTA	0.0037	-0.0026	-0.0034	-0.0065	-0.0040
	()0.011)	(0.010)	(0.009)	(0.018)	(0.012)
SLtoTA	0.0038	0.1312	0.0028	0.0220	0.0800
	(0.073)	(0.081)	(0.071)	(0.083)	(0.065)

Notes: Number of Observations is 115. White's heteroscedasticity consistent standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates are from fixed effect logistic regressions. Using a nonparametric bootstrap and producing bootstrapped standard errors, heteroscedasticity robust covariance is provided.

Empirical Results (Model 6 to Model 10)

	Model 6	Model 7	Model 8	Model 9	Model 10
CAR	-0.0262	-0.0338*	-0.0234***	-0.0060	-0.0074
	(0.016)	(0.015)	(0.006)	(0.012)	(0.013)
ROA	-0.0163**	-0.0040	-0.0165**	-0.0012	-0.0148**
	(0.005)	(0.011)	(0.005)	(0.009)	(0.005)
TOR/TOE	-0.0291	-0.0581*	-0.0355	-0.0753**	-0.0443
	(0.031)	(0.027)	(0.030)	(0.027)	(0.024)
GDPGrwth	-0.0202**	0.0165**	0.0148**	0.0158*	-0.0105*
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
rir	0.0304	0.0107	0.0198	0.0114	0.0449*
	(0.016)	(0018)	(0.015)	(0.013)	(0.017)
M2toGDP	-0.0116*	-0.0545**	-0.00597	-0.0116*	-0.0297*
	(0.004)	(0.018)	(0.013)	(0.051)	(0.012)
FDI	-0.00671	-0.0113	-0.0254	-0.0207	-0.0137
	(0.029)	(0.037)	(0.032)	(0.025)	(0.025)
TotRes	-0.111	-0.0192	-0.0258	-0.0982	-0.0540
	(0.082)	-0.48	(0.042)	(0.056)	(0.042)
CAB	-0.00314	-0.0150*	-0.0112	-0.0039	-0.0036
	(0.014)	(0.006)	(0.016)	(0.011)	(0.014)
inflation	-0.0118	-0.0001	-0.00811	-0.0067	-0.0330
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
M2toRes	-0.0072	-0.0093*	-0.00686	-0.0012	-0.0045
	(0.010)	(0.0041)	(0.011)	(0.010)	(0.010)
reer	-0.0380	-0.0186	-0.0218	-0.0120	-0.0247
	(0.040)	(0.035)	(0.037)	(0.036)	(0.039)
TLtoTA	0.0211	0.00944	0.0583	0.0012	0.0110
	(0.012)	(0.011)	(0.010)	(0.009)	(0.012)
TLtoTD	0.00160	0.00653	0.0003	0.0027	0.0068
	(0.010)	(0.009)	(0.011)	(0.008)	(0.008)
TLAtoTA	-0.00622	-0.00512	-0.0063	-0.0014	-0.0074
	(0.014)	(0.012)	(0.012)	(0.012)	(0.013)
SLtoTA	0.0827	0.0715	0.0989	0.0405	0.0178
	(0.083)	(0.122)	(0.097)	(0.077)	(0.071)

Notes: Number of Observations is 115. White's heteroscedasticity consistent standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates are from fixed effect logistic regressions. Using a nonparametric bootstrap and producing bootstrapped standard errors, heteroscedasticity robust covariance is provided.

Empirical Results (Model 11 to Model 15)

	Model 11	Model 12	Model 13	Model 14	Model 15
CAR	-0.0342* (0.021)	-0.0648** (0.021)	-0.0266*** (0.007)	-0.0243 (0.014)	-0.0157 (0.013)
ROA	-0.0261* (0.011)	-0.0131 (0.013)	-0.0130** (0.005)	-0.0333** (0.012)	-0.0331** (0.012)
TOR/TOE	-0.0340 (0.026)	-0.0646 (0.030)	-0.0509 (0.025)	-0.0958** (0.032)	-0.0895** (0.032)
GDPGrwth	0.0239*** (0.007)	-0.0105* (0.007)	-0.0153** (0.005)	-0.0114* (0.005)	-0.0114* (0.005)
rir	0.0186 (0.014)	0.0283 (0.017)	0.0038 (0.013)	0.00238 (0.012)	0.0004 (0.013)
M2toGDP	-0.0153* (0.005)	-0.0028 (0.010)	-0.0098* (0.006)	-0.00457 (0.010)	-0.0091 (0.010)
FDI	-0.0505 (0.026)	-0.0312 (0.039)	-0.0029 (0.023)	-0.0303 (0.023)	-0.0269 (0.023)
TotRes	-0.0171 (0.047)	-0.0834 (0.047)	-0.0244 (0.042)	-0.0045 (0.043)	-0.0700 (0.046)
CAB	-0.0131* (0.006)	-0.0043 (0.016)	-0.0067 (0.011)	-0.0014 (0.012)	-0.0012 (0.012)
inflation	-0.0008 (0.009)	-0.0164 (0.011)	-0.0039 (0.008)	-0.008 (0.009)	-0.0081 (0.009)
M2toRes	-0.0149** (0.0047)	-0.0086 (0.012)	-0.0009 (0.008)	-0.0072 (0.009)	-0.0029 (0.010)
reer	-0.0518 (0.040)	-0.0562 (0.086)	-0.0456 (0.041)	-0.0363 (0.044)	-0.0083 (0.043)
TLtoTA	0.0020 (0.010)	0.00044 (0.011)	0.0052 (0.008)	0.0014 (0.010)	0.0066 (0.009)
TLtoTD	0.0042 (0.0008)	0.0039 (0.009)	0.0057 (0.008)	0.0081 (0.009)	0.0153 (0.010)
TLAtoTA	-0.0005 (0.010)	-0.0003 (0.0112)	-0.0049 (0.011)	-0.0070 (0.0142)	-0.0082 (0.012)
SLtoTA	0.0320 (0.083)	0.0805 (0.010)	0.0637 (0.074)	0.0206 (0.078)	0.1932 (0.111)

Notes: Number of Observations is 115. White's heteroscedasticity consistent standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates are from fixed effect logistic regressions. Using a nonparametric bootstrap and producing bootstrapped standard errors, heteroscedasticity robust covariance is provided.

Empirical Results (Model 16 to Model 20)

	Model 16	Model 17	Model 18	Model 19	Model 20
CAR	-0.0031	-0.0008	-0.0080	-0.0140*	-0.0161*
	(0.020)	(0.012)	(0.014)	(0.006)	(0.018)
ROA	-0.0211***	-0.0078	-0.0074	-0.0166	-0.0160
	(0.005)	(0.010)	(0.011)	(0.010)	(0.045)
TOR/TOE	-0.0114	-0.0300	-0.0097	-0.0719*	-0.0084
	(0.034)	(0.024)	(0.026)	(0.028)	(0.0029)
GDPGrwth	-0.0395	0.0462*	0.0256*	-0.0111*	-0.0169**
	(0.021)	(0.018)	(0.010)	(0.005)	(0.005)
rir	0.0283	0.0122	0.0263	0.0162	0.0237**
	(0.017)	(0.013)	(0.016)	(0.016)	(0.008)
M2toGDP	-0.0315*	-0.0017	-0.0015	-0.0130*	-0.0106
	(0.013)	(0.010)	(0.011)	(0.005)	(0.023)
FDI	-0.0116	-0.0114	-0.0033	-0.0005	-0.0146
	(0.030)	(0.021)	(0.023)	(0.031)	(0.050)
TotRes	-0.0643	-0.0057	-0.0097	-0.0393	-0.0057
	(0.056)	(0.032)	(0.031)	(0.039)	(0.118)
CAB	-0.0121*	-0.0053	-0.0038	-0.0078	-0.0087
	(0.006)	(0.012)	(0.012)	(0.014)	(0.022)
inflation	-0.0541	-0.0053	-0.0043	-0.0110	-0.0132
	(0.012)	(0.008)	(0.008)	(0.009)	(0.013)
M2toRes	-0.0028	-0.0001	-0.0279	-0.0077	-0.0091
	(0.011)	(0.009)	(0.009)	(0.012)	(0.017)
reer	-0.0223	-0.0050	-0.0635	-0.0030	-0.0143
	(0.041)	(0.033)	(0.042)	(0.034)	(0.041)
TLtoTA	0.0025	0.0048	0.0062	0.0129	0.0156
	(0.011)	(0.010)	(0.009)	(0.011)	(0.015)
TLtoTD	0.0150	0.0007	0.0063	0.0021	0.0079
	(0.013)	(0.007)	(0.007)	(0.008)	(0.017)
TLAtoTA	-0.0207	-0.0254	-0.0039	-0.0008	-0.0004
	(0.018)	(0.010)	(0.011)	(0.013)	(0.015)
SLtoTA	0.0421	0.0841	0.0901	0.0202	0.0363
	(0.010)	(0.063)	(0.064)	(0.118)	(0.220)

Notes: Number of Observations is 115. White's heteroscedasticity consistent standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates are from fixed effect logistic regressions. Using a nonparametric bootstrap and producing bootstrapped standard errors, heteroscedasticity robust covariance is provided.

Empirical Results (Model 21 to Model 25)

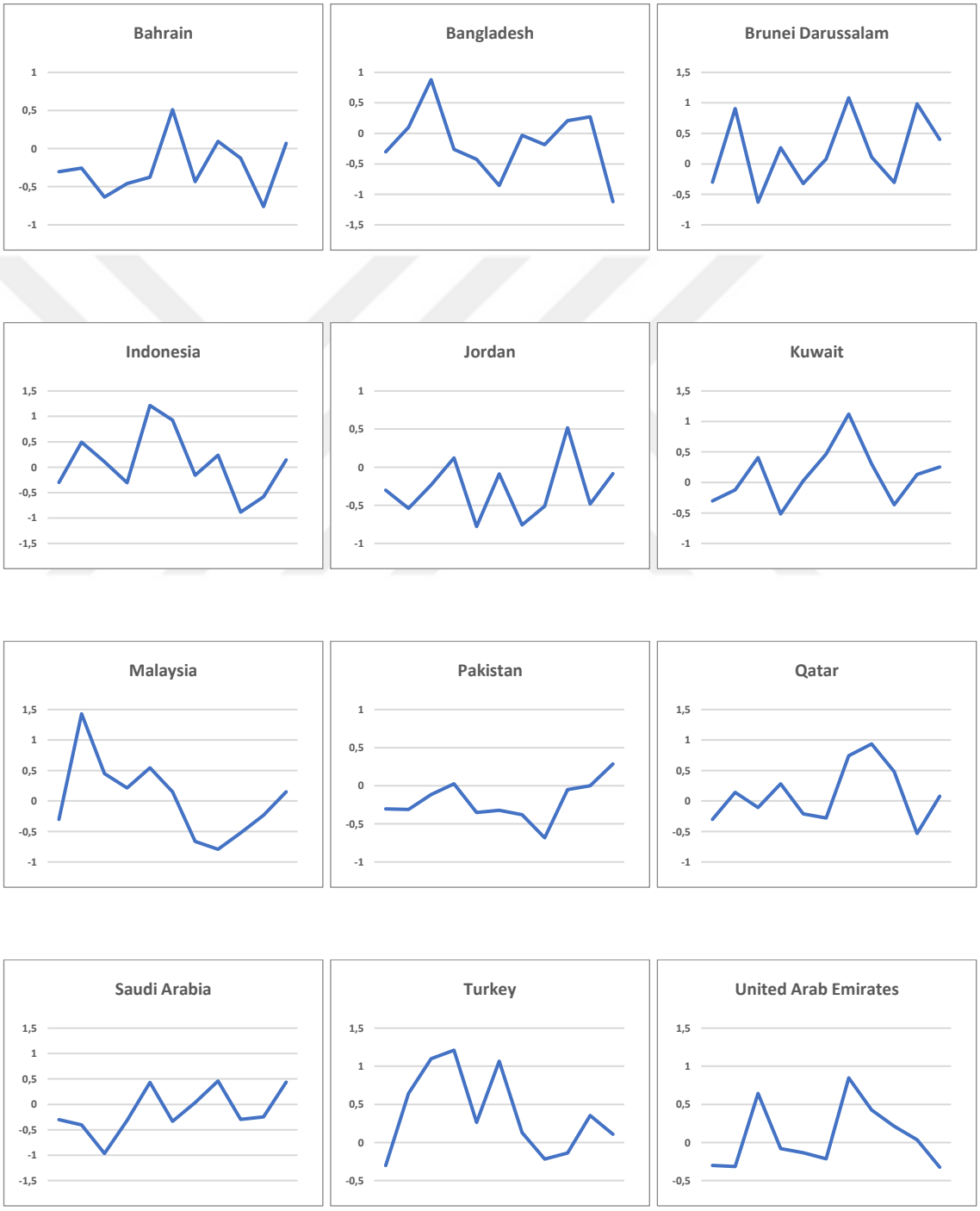
	Model 21	Model 22	Model 23	Model 24	Model 25
CAR	-0.0139	-0.0062	-0.0122*	-0.0140*	-0.0131*
	(0.012)	(0.017)	(0.005)	(0.005)	(0.006)
ROA	-0.0170	-0.0107	-0.0221	-0.0170	-0.0027
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
TOR/TOE	-0.0060	-0.0663*	-0.0047	-0.0719*	-0.0015
	(0.234)	(0.027)	(0.027)	(0.028)	(0.023)
GDPGrwth	-0.0256*	-0.0333*	-0.0329*	-0.0111*	-0.0112*
	(0.012)	(0.012)	(0.013)	(0.005)	(0.005)
rir	0.0206	0.0122	0.0297	0.0162	0.0067
	(0.013)	(0.016)	(0.016)	(0.016)	(0.013)
M2toGDP	-0.0180**	-0.0254*	-0.0154**	-0.0130*	-0.0151*
	(0.0068)	(0.011)	(0.005)	(0.005)	(0.005)
FDI	-0.0114	-0.0181	-0.0181	-0.0005	-0.0257
	(0.021)	(0.027)	(0.027)	(0.031)	(0.023)
TotRes	-0.0724	-0.0066	0.0080	-0.0067	-0.0115
	(0.032)	(0.041)	(0.041)	(0.039)	(0.034)
CAB	-0.0053	-0.0159*	-0.0159	-0.0078	-0.0161**
	(0.012)	(0.015)	(0.015)	(0.014)	(0.006)
inflation	-0.0053	-0.0036	-0.0061	-0.004	-0.0028
	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)
M2toRes	-0.0015	-0.0068	-0.0064	-0.0077	-0.0080
	(0.009)	(0.010)	(0.010)	(0.012)	(0.009)
reer	-0.0052	-0.0423	-0.0429	-0.0030	-0.0499
	(0.033)	(0.035)	(0.035)	(0.039)	(0.038)
TLtoTA	0.0485	0.0087	0.0075	0.0131	0.0092
	(0.008)	(0.010)	(0.010)	(0.011)	(0.008)
TLtoTD	0.0007	0.0105	0.0115	0.0023	0.0064
	(0.007)	(0.009)	(0.009)	(0008)	(0.007)
TLAtoTA	-0.004	-0.0025	-0.0053	-0.0117	-0.0113
	(0.010)	(0.013)	(0.013)	(0.013)	(0.011)
SLtoTA	0.084	0.0523	0.0527	0.0206	0.0658
	(0.063)	(0.082)	(0.082)	(0.118)	(0.067)

Notes: Number of Observations is 115. White's heteroscedasticity consistent standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Estimates are from fixed effect logistic regressions. Using a nonparametric bootstrap and producing bootstrapped standard errors, heteroscedasticity robust covariance is provided.

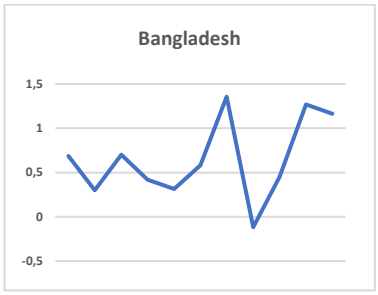
APPENDIX C

Figure C.1: Banking Sector Fragility Index by Country

Model 1



Model 2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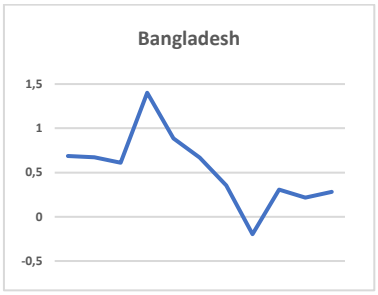
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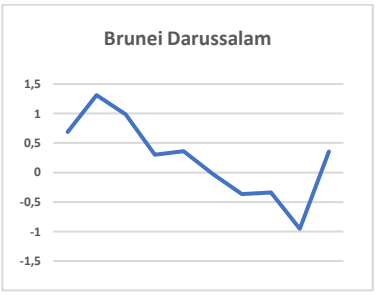
-0,5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-1,5


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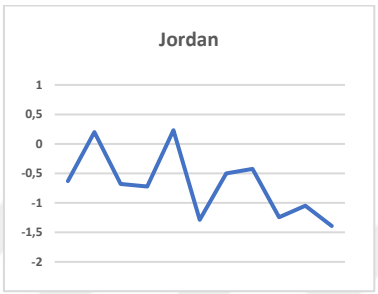
-2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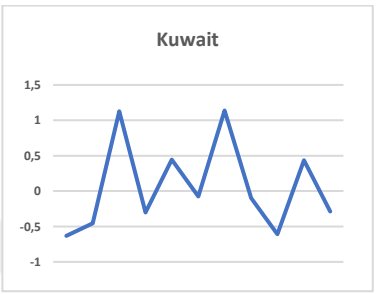
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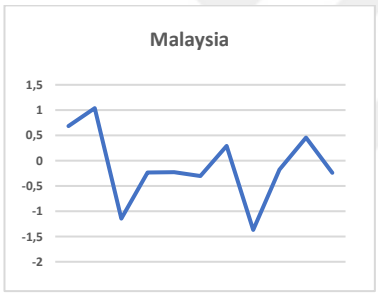
-1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-1,5
-2


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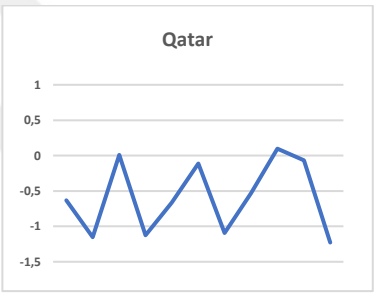
-0,5
-1
-1,5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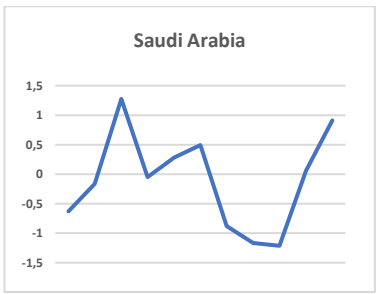
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Turkey
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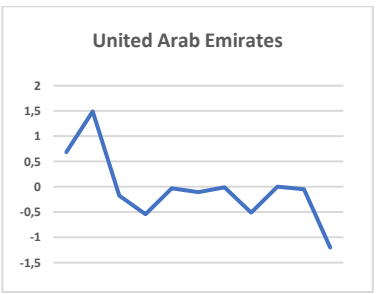
-1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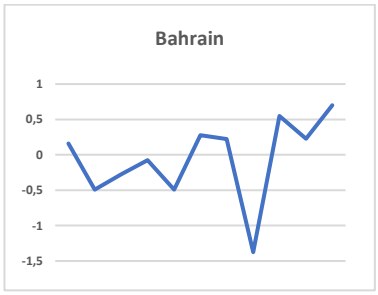
-1,5

Model 3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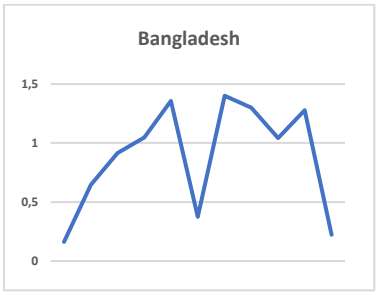
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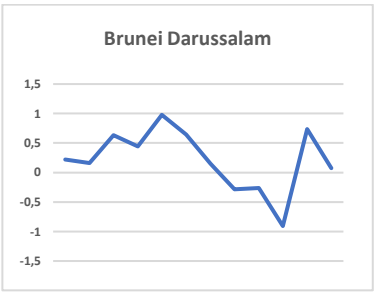
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Indonesia
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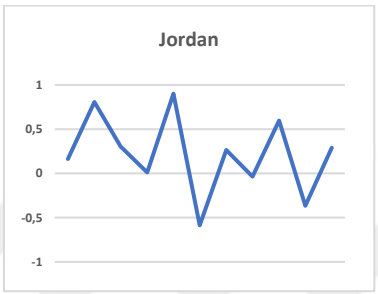
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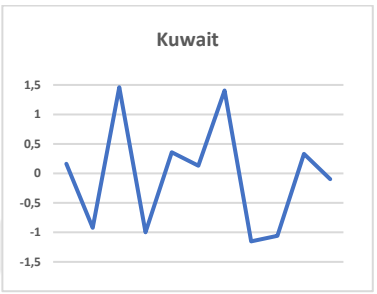
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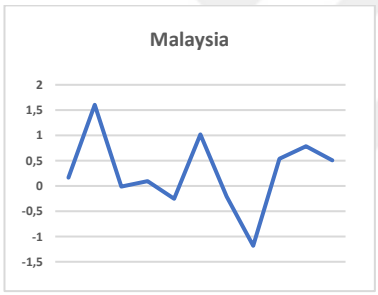
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Pakistan
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-1,5


Qatar
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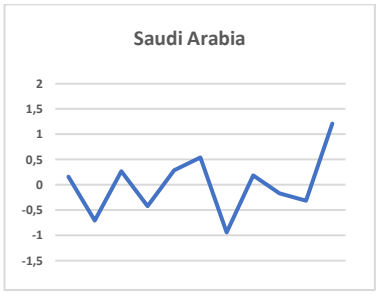
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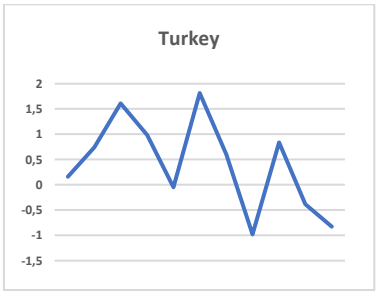
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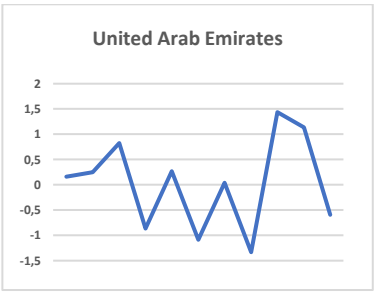
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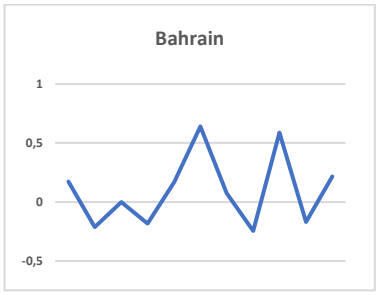
Model 4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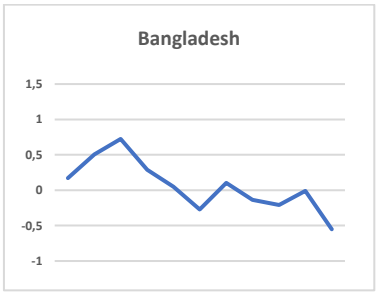
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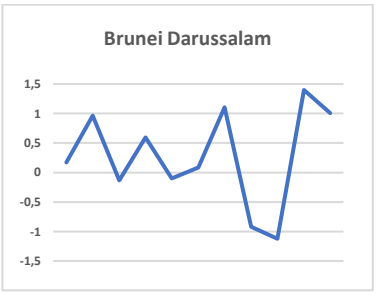
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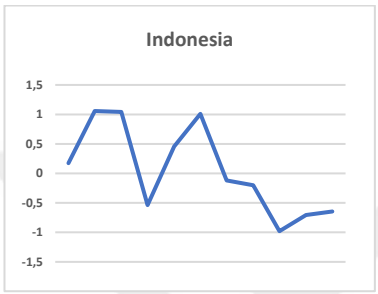
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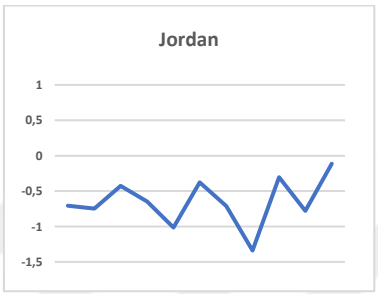
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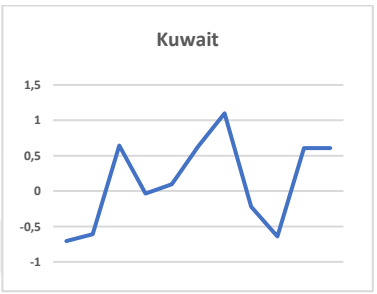
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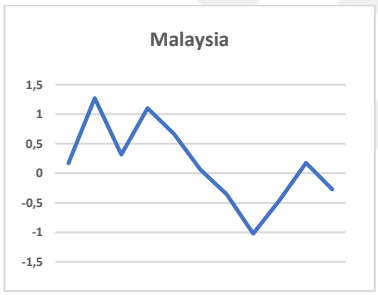
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Pakistan
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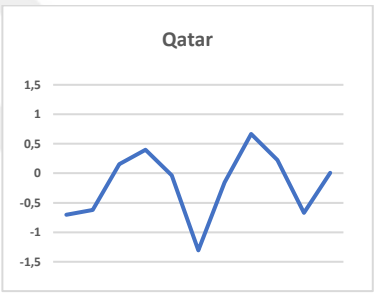
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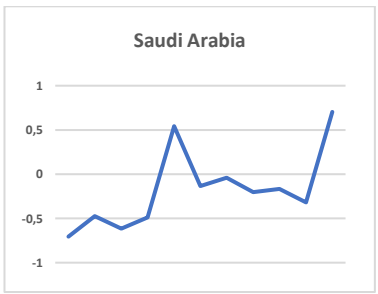
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Turkey
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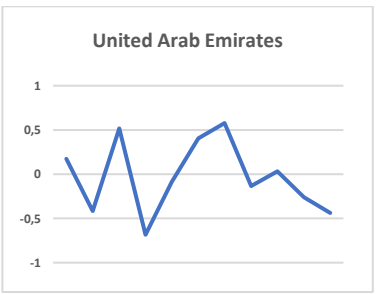
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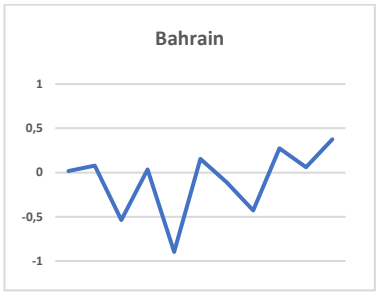
Model 5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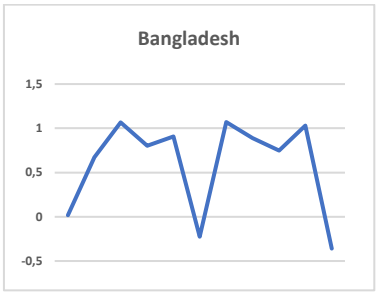
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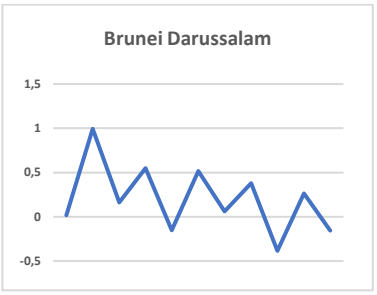
Brunei Darussalam
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Indonesia
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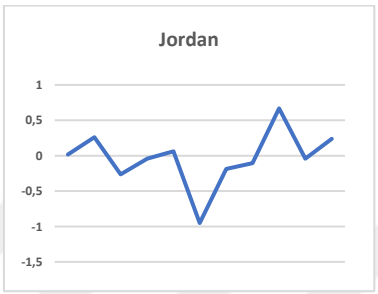
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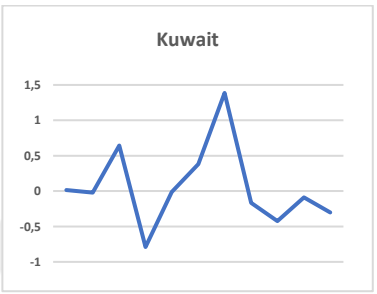
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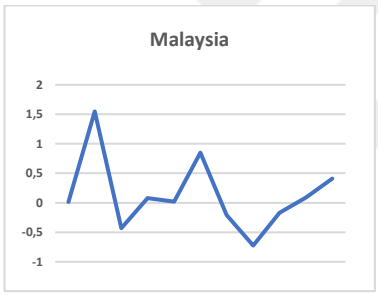
Malaysia
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-1


Pakistan
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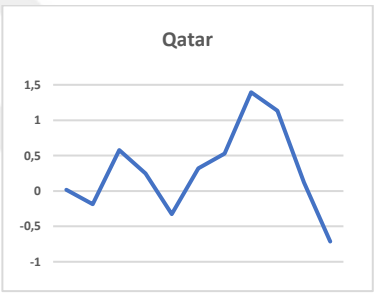
Qatar
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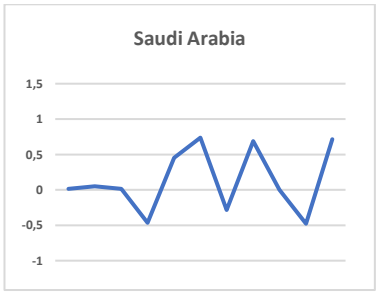
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Turkey
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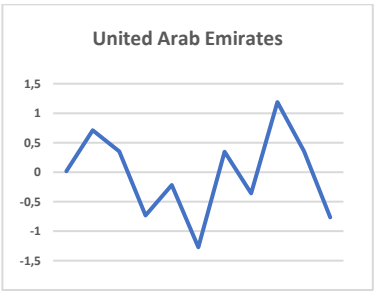
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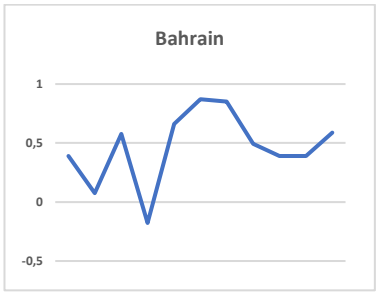
-1,5

Model 6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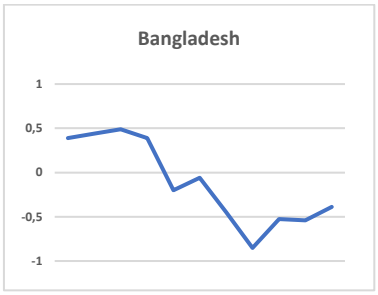
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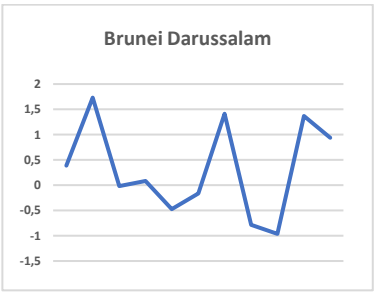
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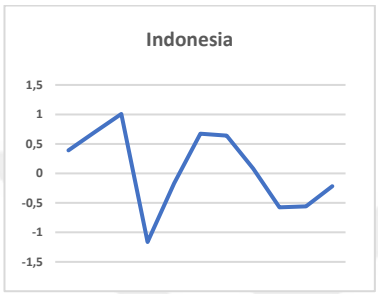
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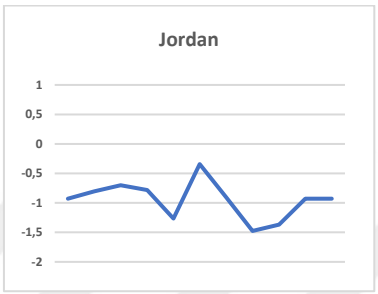
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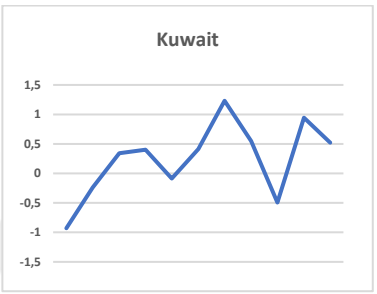
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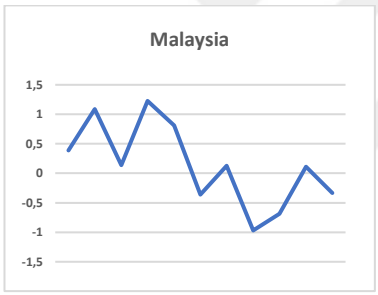
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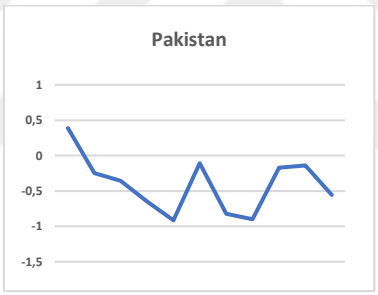
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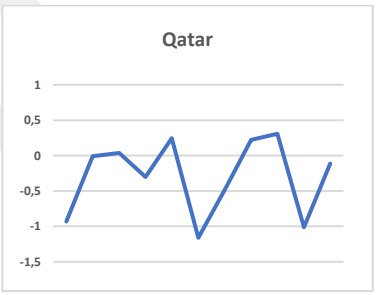
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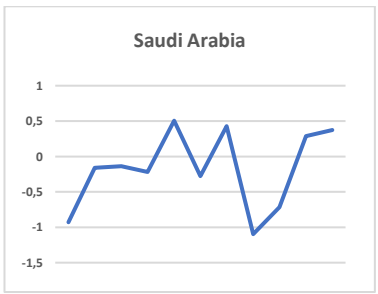
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Turkey
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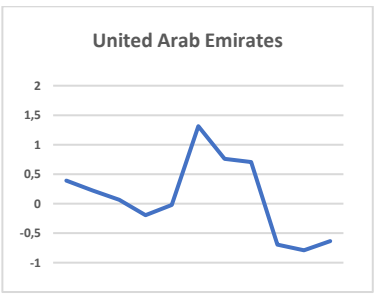
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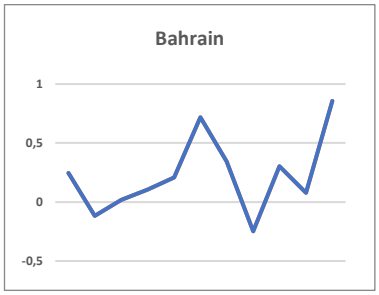
Model 7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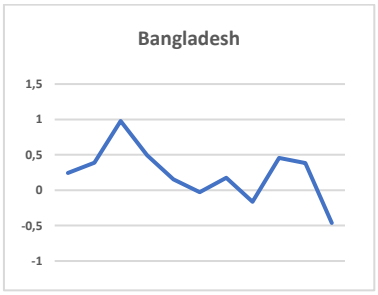
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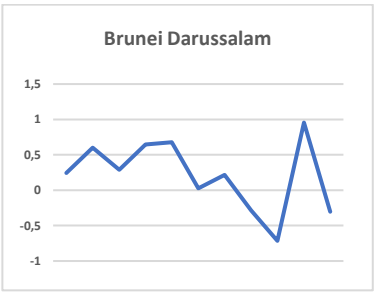
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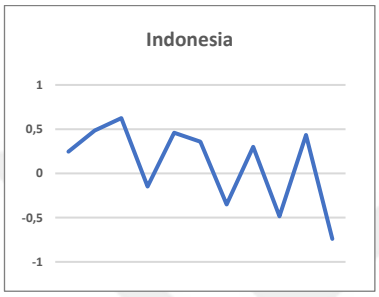
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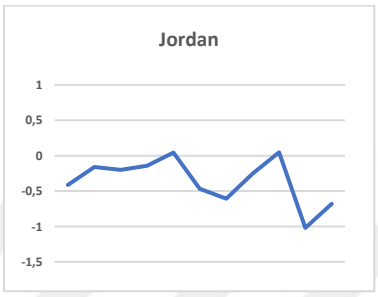
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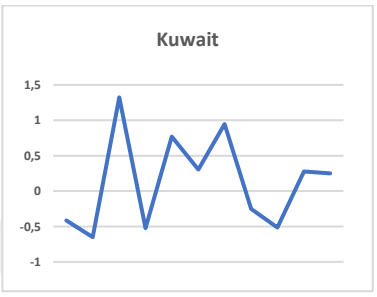
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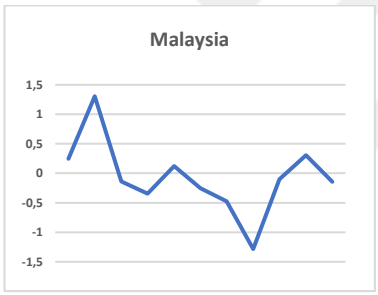
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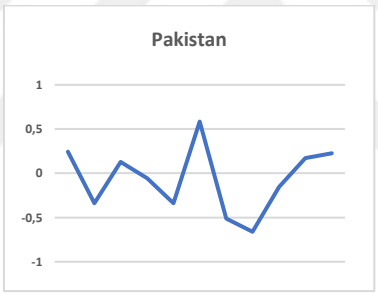
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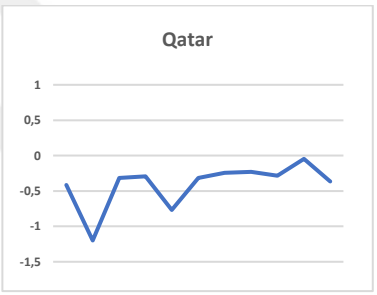
Qatar
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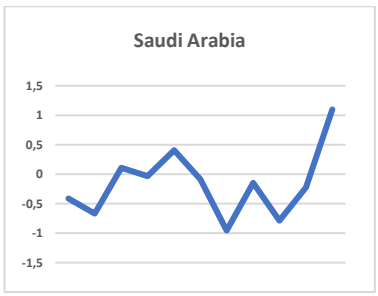
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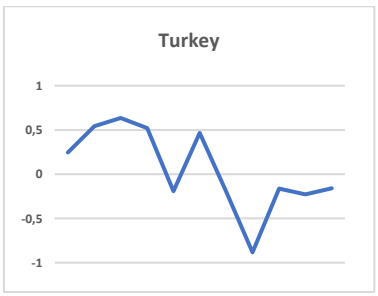
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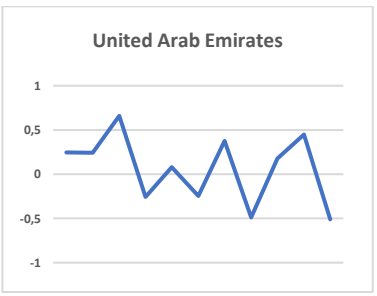
United Arab Emirates
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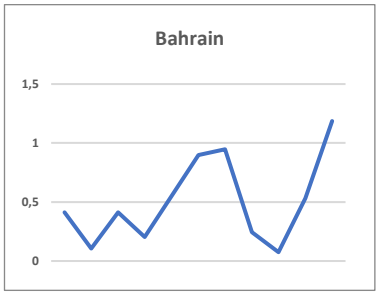
Model 8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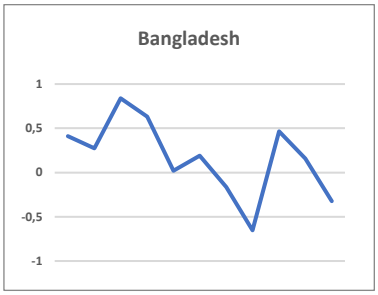
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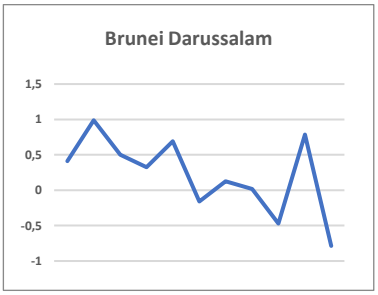
Brunei Darussalam
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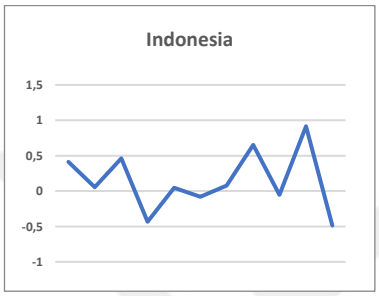
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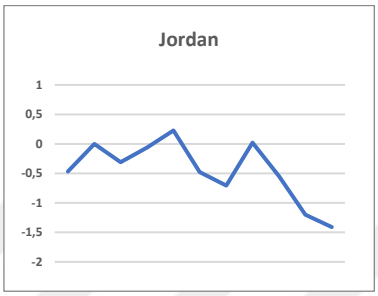
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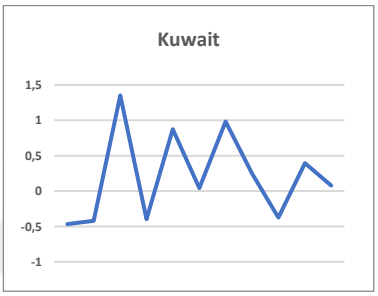
Kuwait
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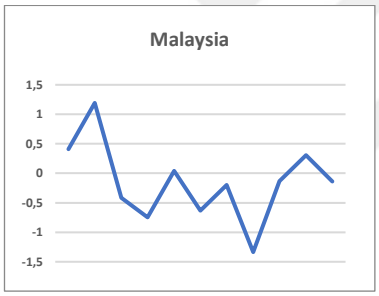
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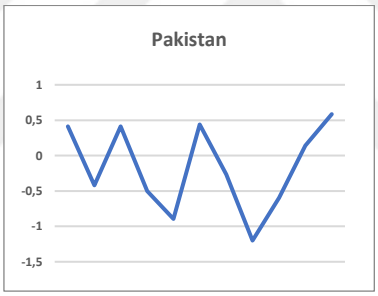
Pakistan
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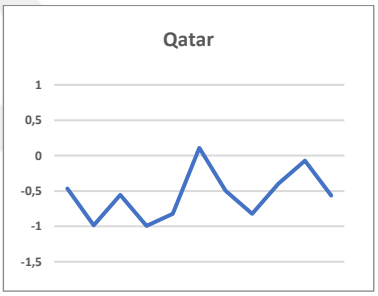
Qatar
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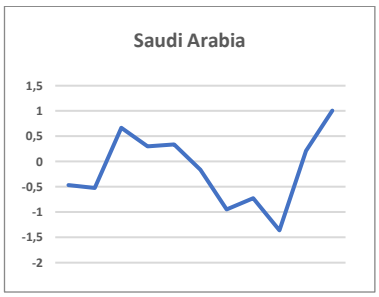
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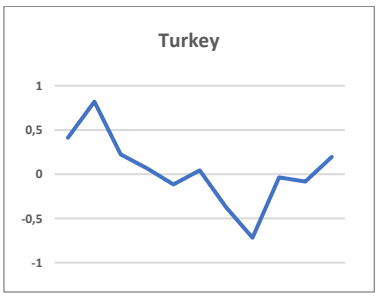
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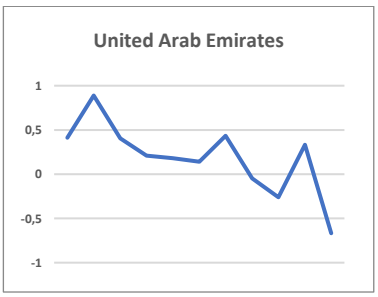
United Arab Emirates
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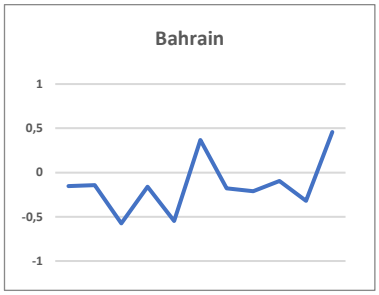
Model 9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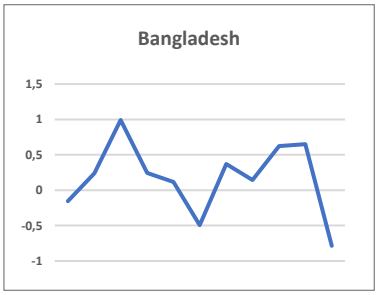
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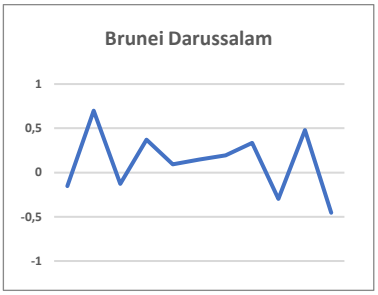
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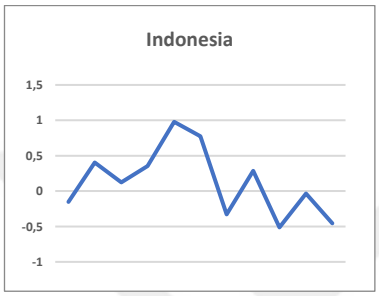
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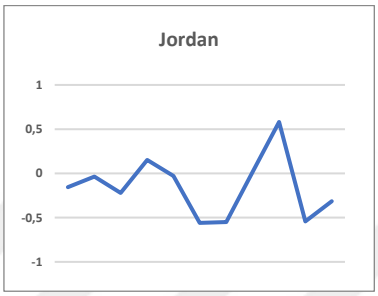
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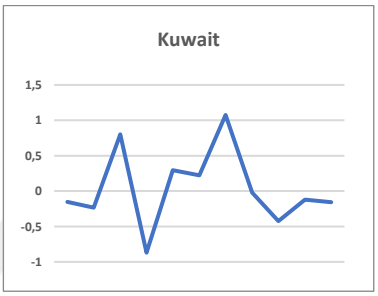
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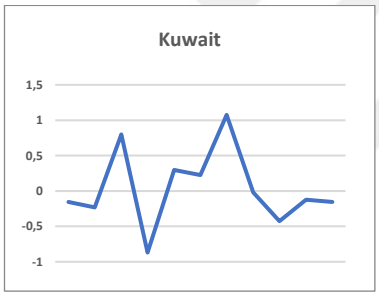
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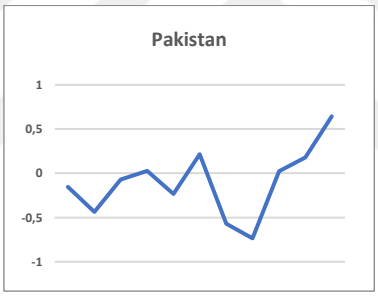
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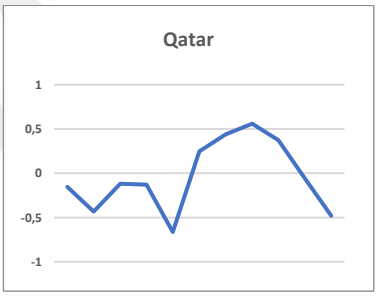
Qatar
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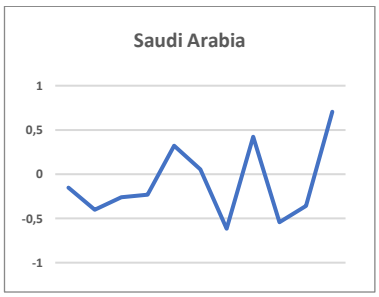
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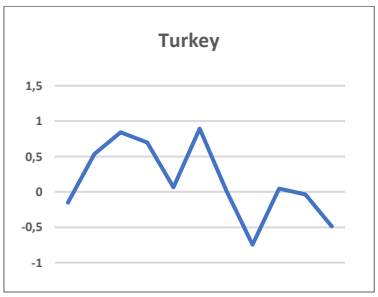
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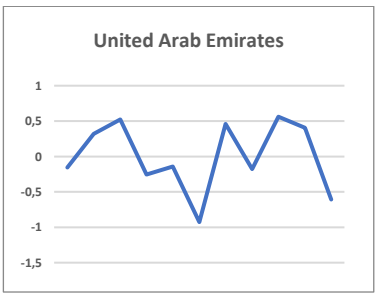
United Arab Emirates
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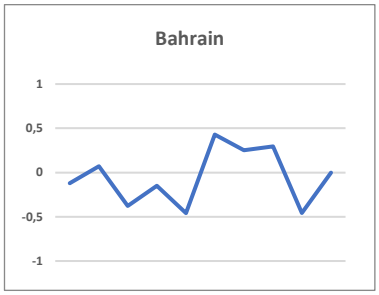
-1,5

Model 10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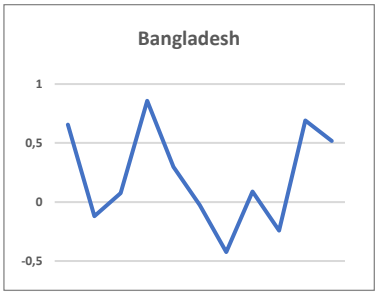
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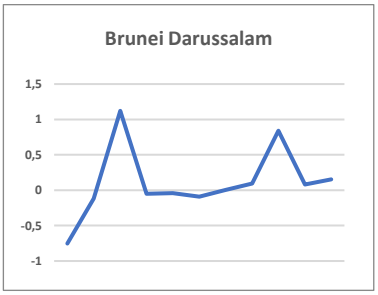
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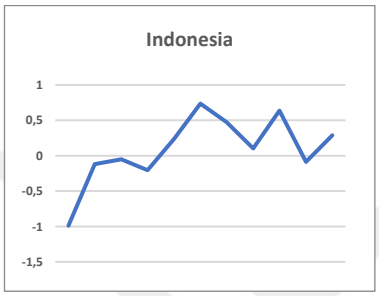
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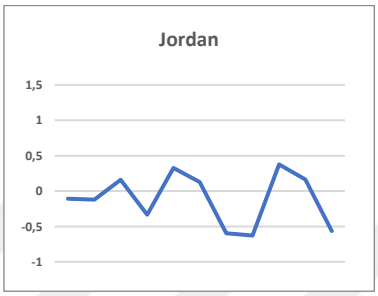
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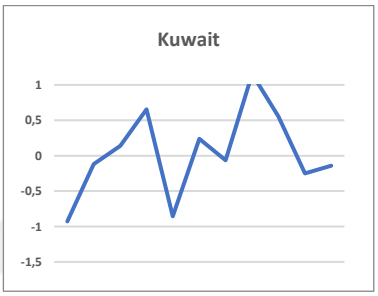
Kuwait
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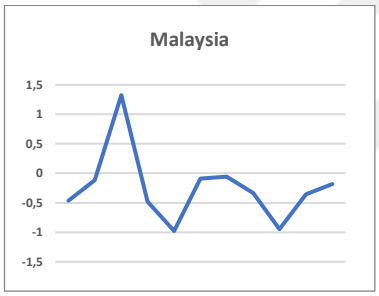
-1,5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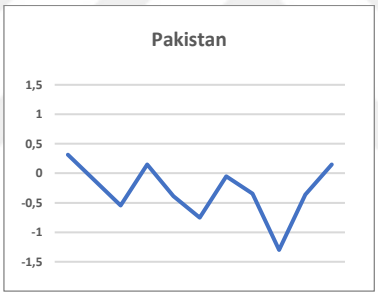
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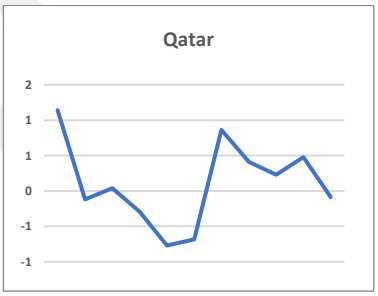
-1,5


Qatar
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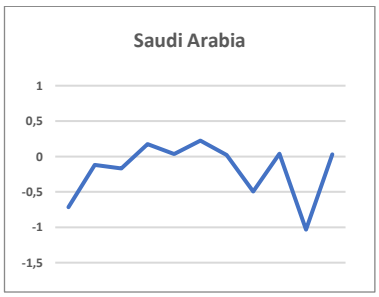
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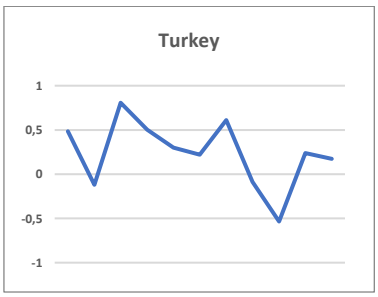
-1,5


Turkey
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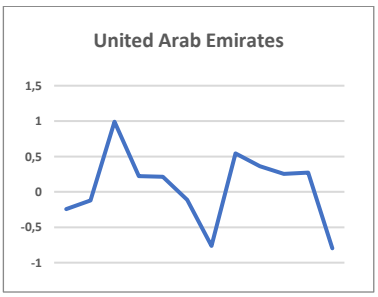
United Arab Emirates
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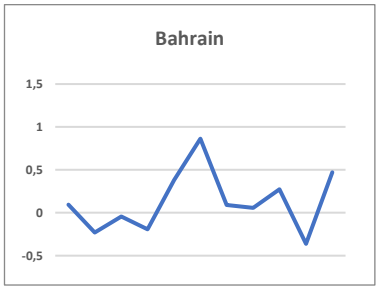
-0,5
-1

Model 11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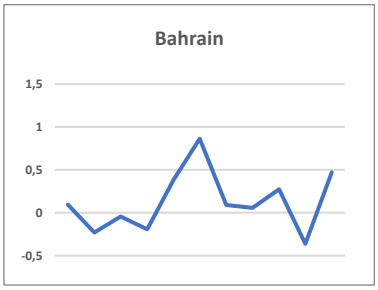
Bahrain
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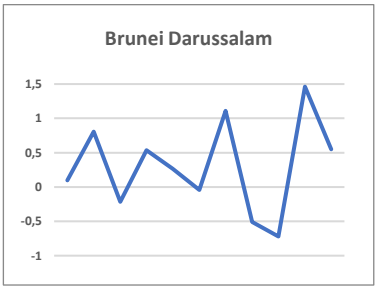
Brunei Darussalam
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0
-0,5
-1


Indonesia
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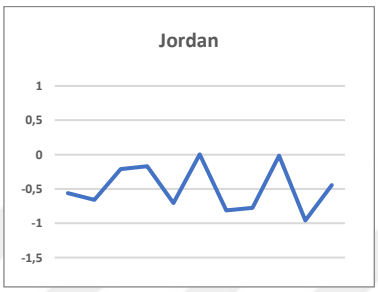
0
-0,5
-1


Jordan
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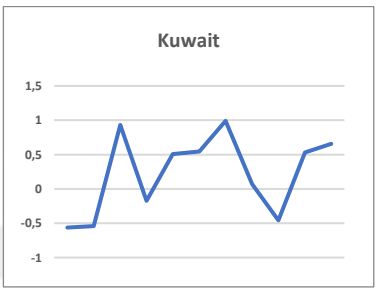
Kuwait
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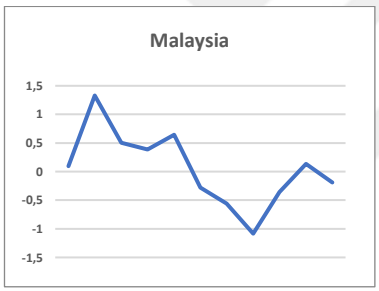
-0,5
-1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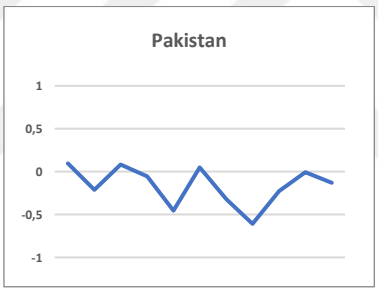
-1
-1,5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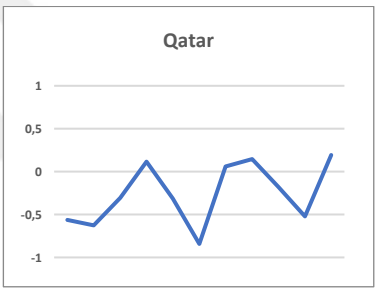
Qatar
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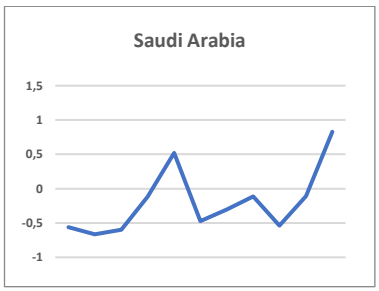
Saudi Arabia
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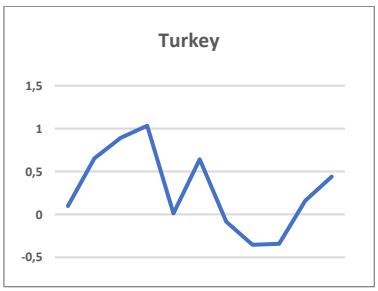
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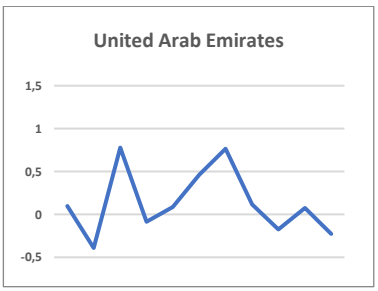
United Arab Emirates
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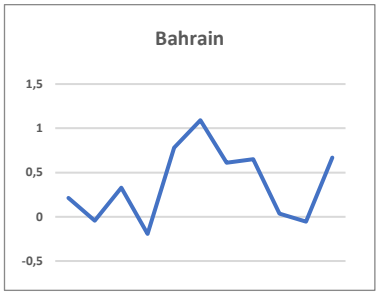
Model 12


Bahrain
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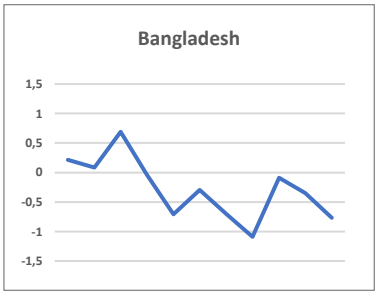
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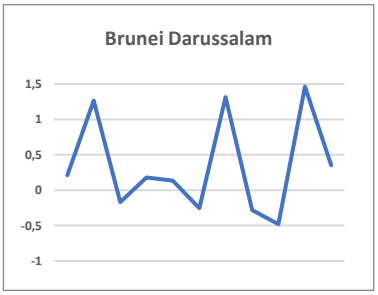
Brunei Darussalam
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0,5
0
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-1


Indonesia
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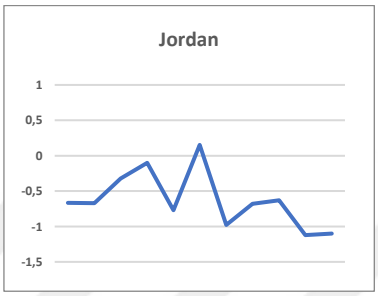
0
-0,5
-1
-1,5


Jordan
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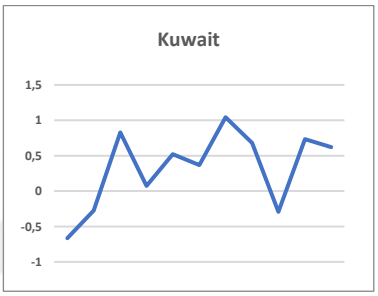
-1,5


Kuwait
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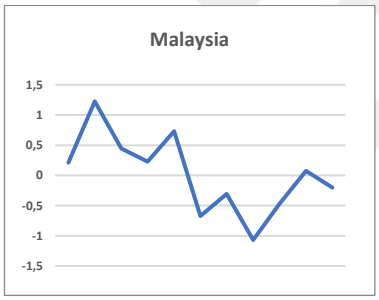
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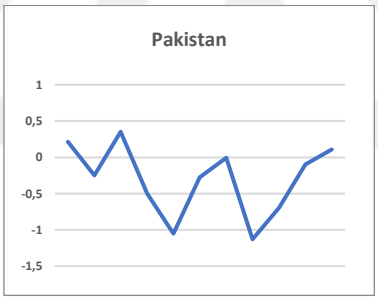
-1,5


Pakistan
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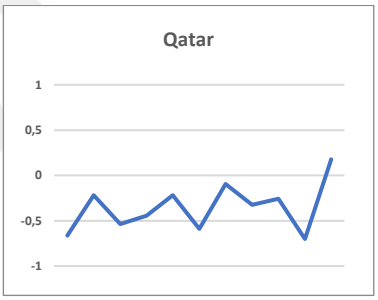
-1
-1,5


Qatar
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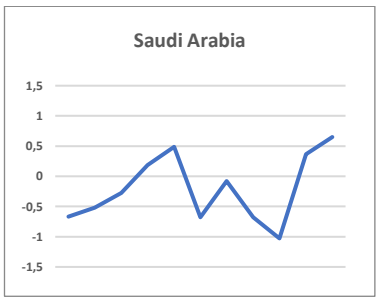
Saudi Arabia
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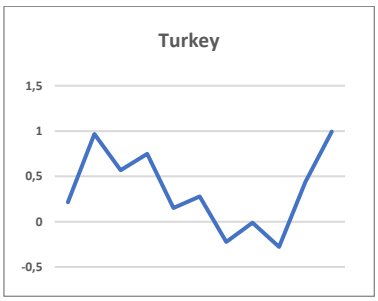
Turkey
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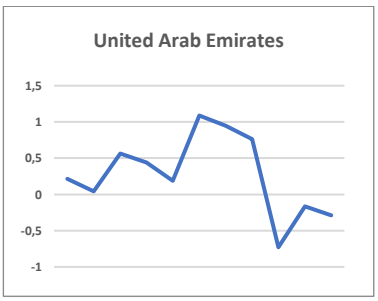
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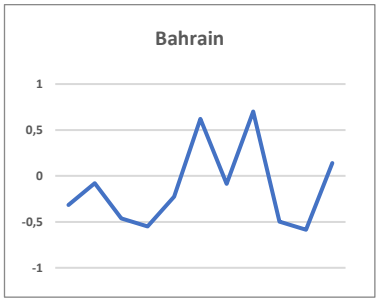
Model 13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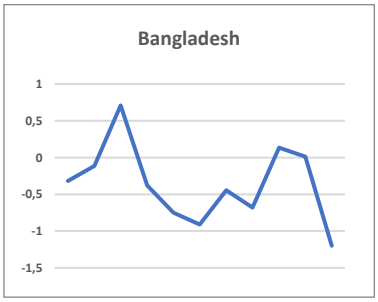
Bangladesh
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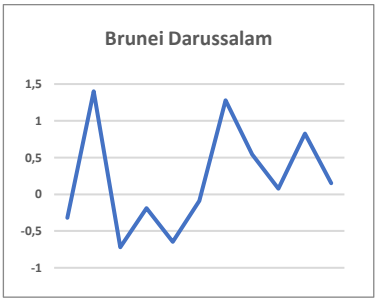
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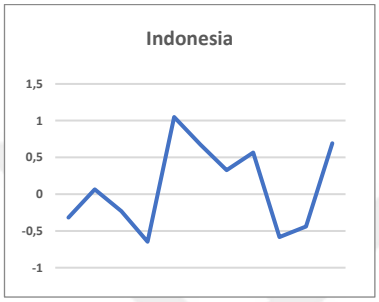
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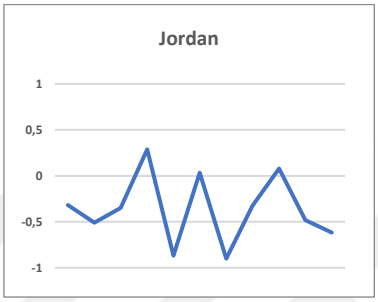
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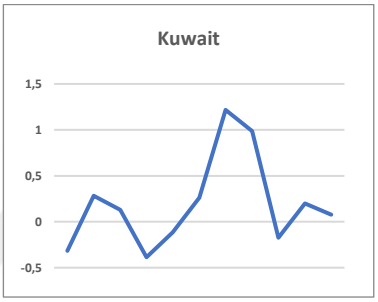
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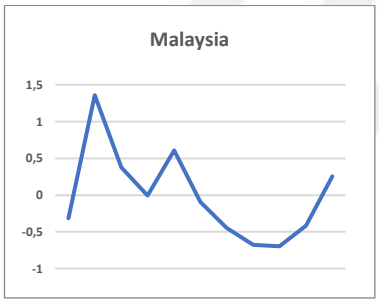
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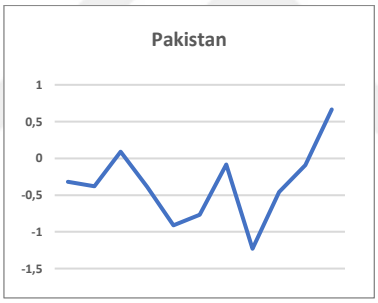
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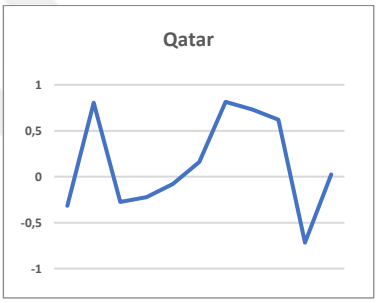
Qatar
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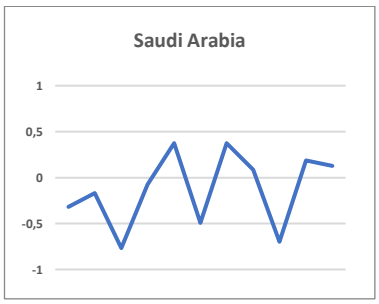
Saudi Arabia
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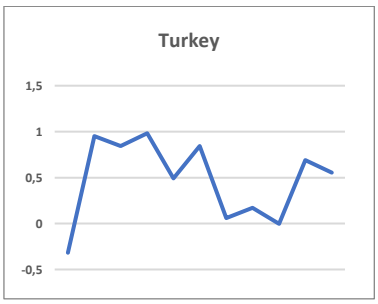
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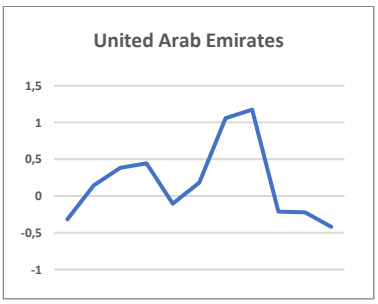
United Arab Emirates
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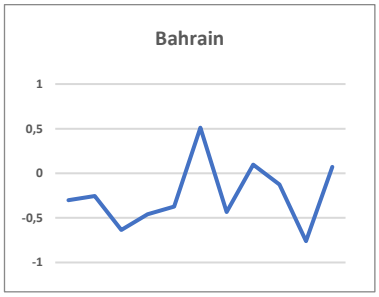
-1

Model 14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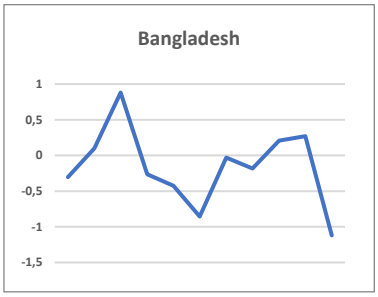
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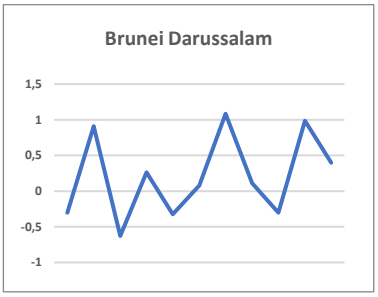
-1,5


Brunei Darussalam
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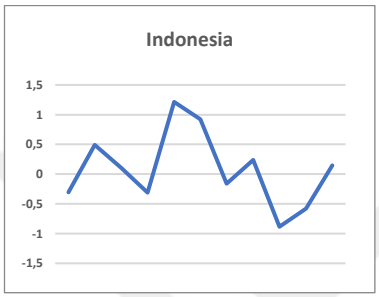
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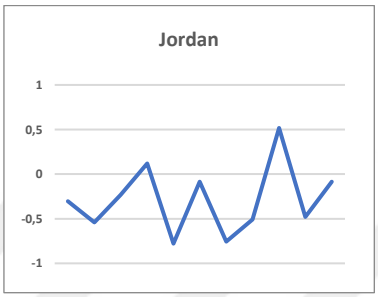
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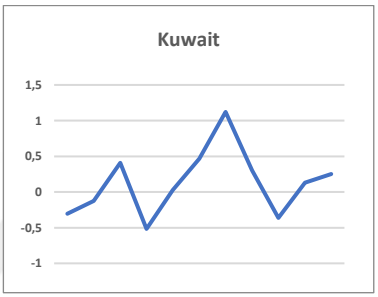
Kuwait
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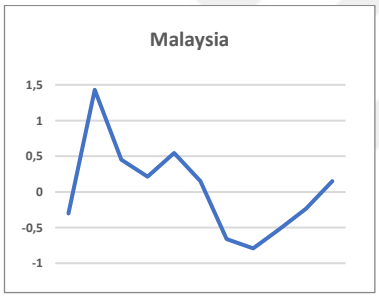
-0,5
-1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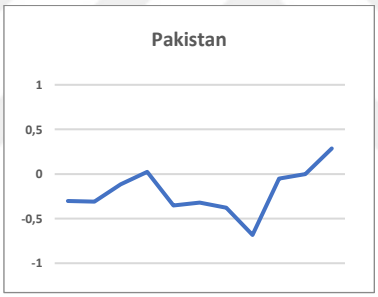
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-0,5
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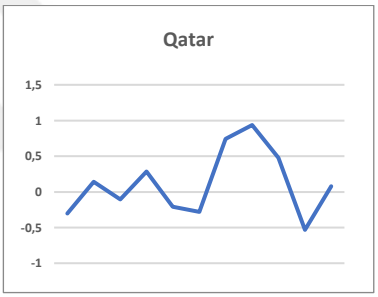
Qatar
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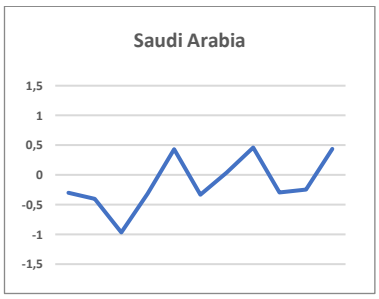
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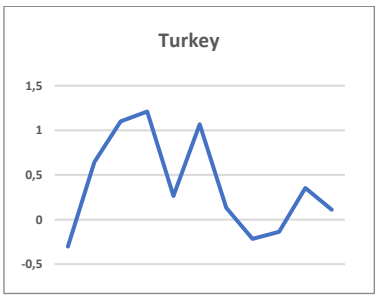
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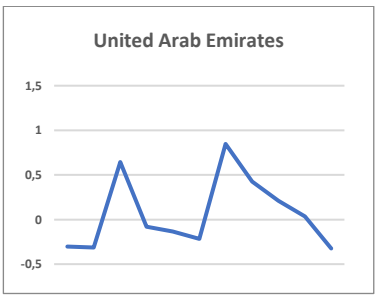
United Arab Emirates
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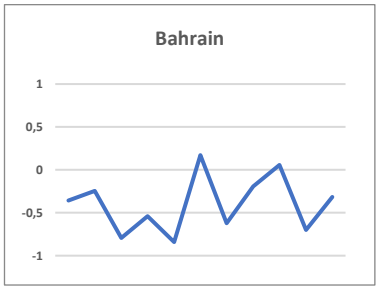
Model 15


Bahrain
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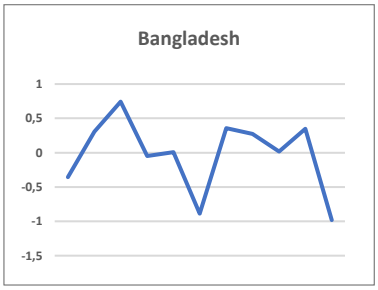
Bangladesh
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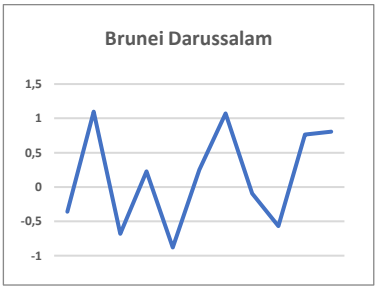
Brunei Darussalam
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1
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0
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-1


Indonesia
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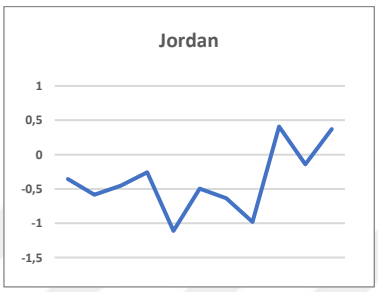
-1
-1,5
-2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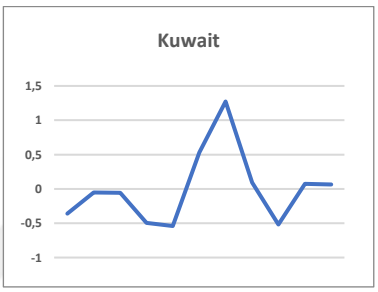
Kuwait
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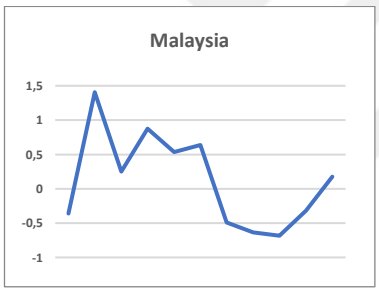
Malaysia
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0,5
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-0,5
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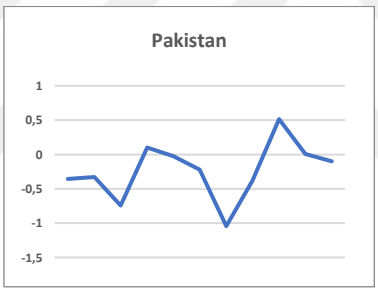
Pakistan
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-0,5
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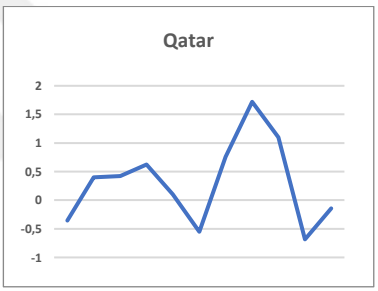
-1,5


Qatar
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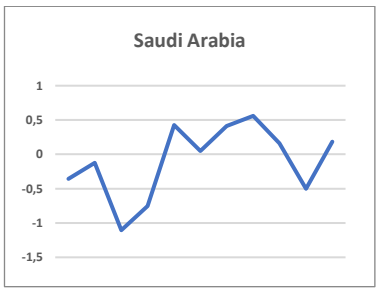
Saudi Arabia
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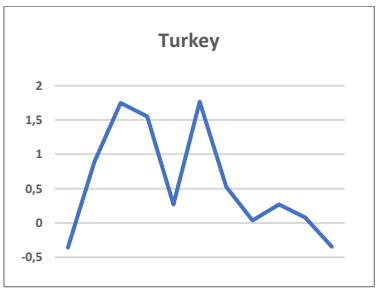
Turkey
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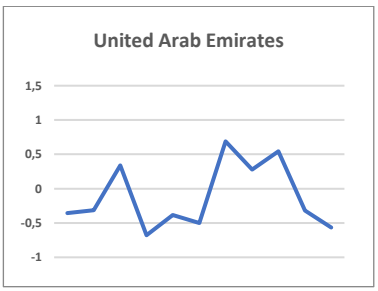
United Arab Emirates
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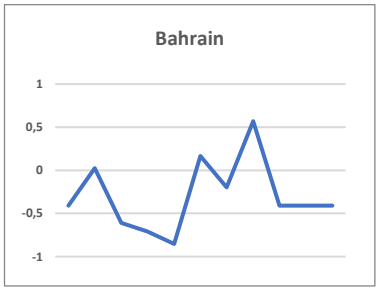
Model 16


Bahrain
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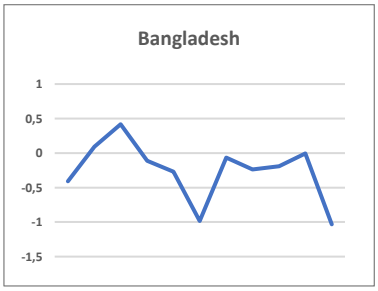
Bangladesh
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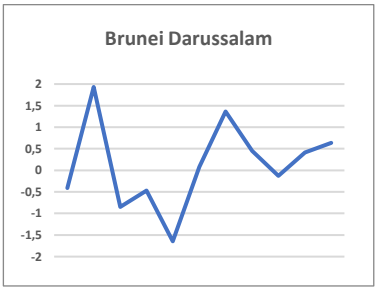
Brunei Darussalam
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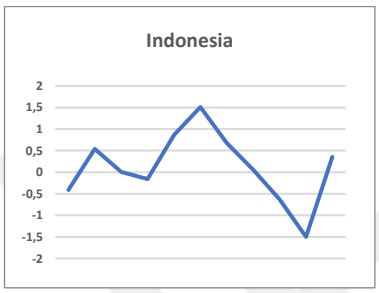
-1
-1,5
-2


Indonesia
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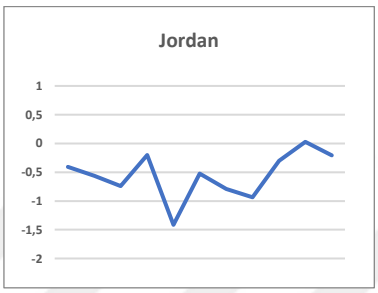
-1
-1,5
-2


Jordan
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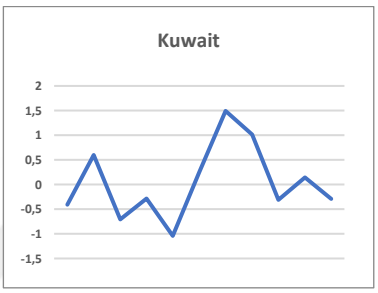
-0,5
-1
-1,5
-2


Kuwait
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1
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0
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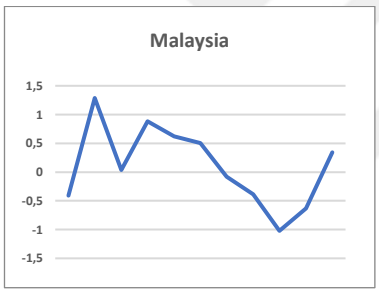
-1
-1,5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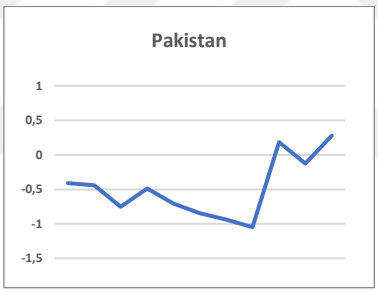
-1
-1,5


Pakistan
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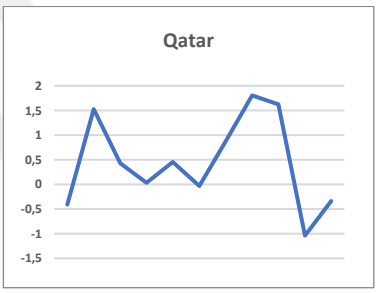
-1
-1,5


Qatar
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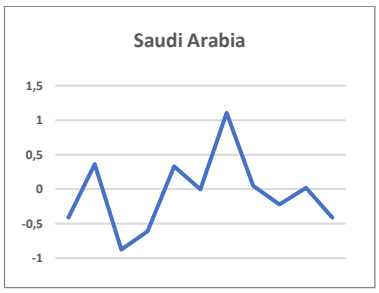
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-0,5
-1


Turkey
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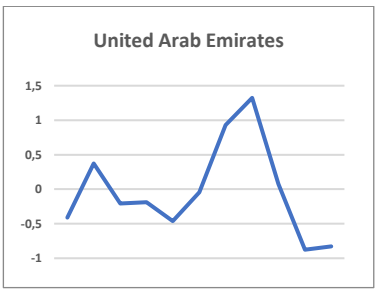
-1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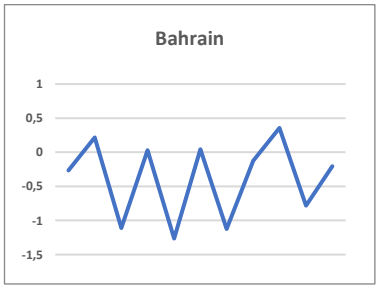
Model 17


Bahrain
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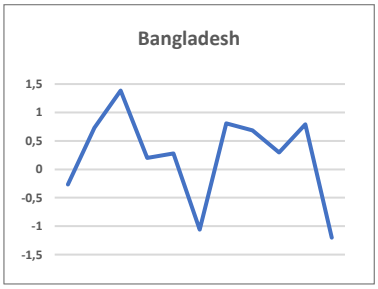
-1,5


Bangladesh
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-0,5
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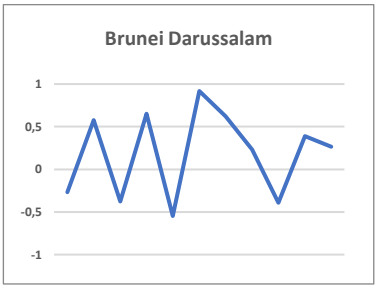
-1,5


Brunei Darussalam
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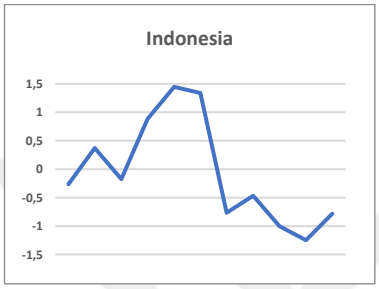
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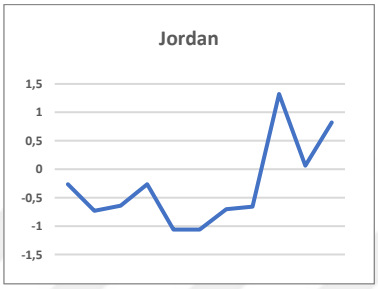
Jordan
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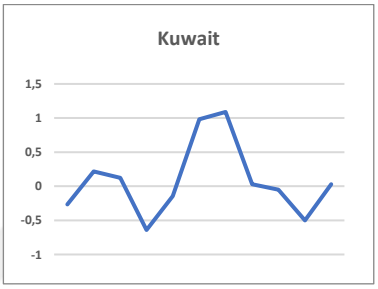
Kuwait
1,5
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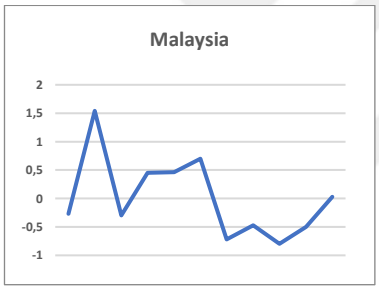
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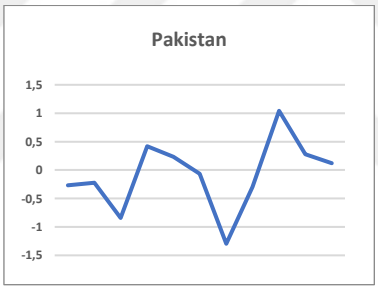
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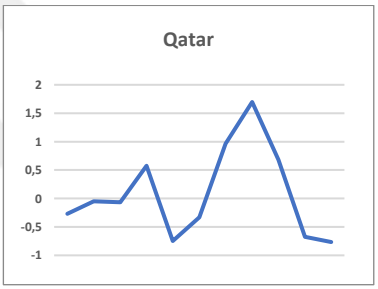
Qatar
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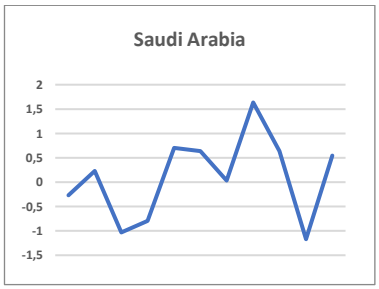
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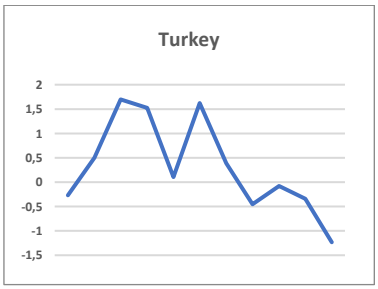
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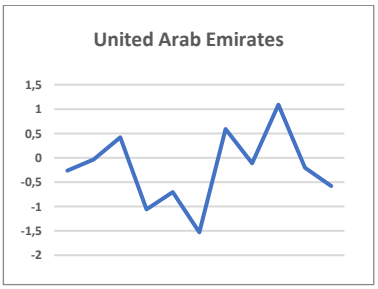
United Arab Emirates
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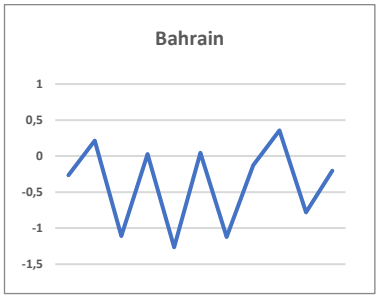
-1,5
-2

Model 18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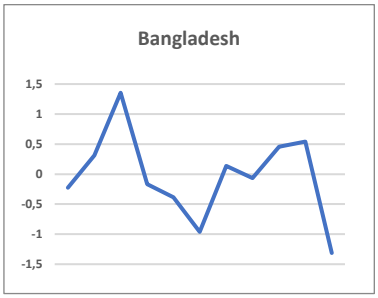
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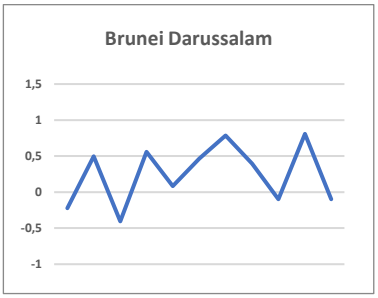
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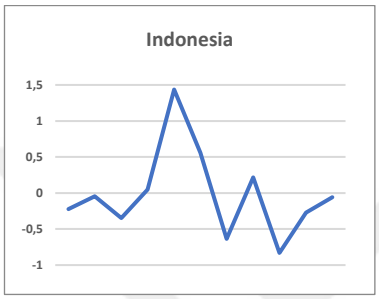
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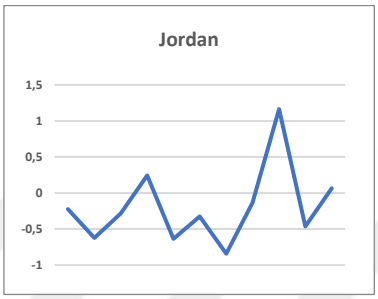
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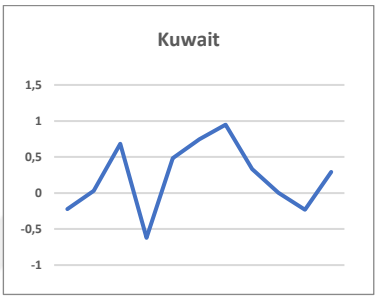
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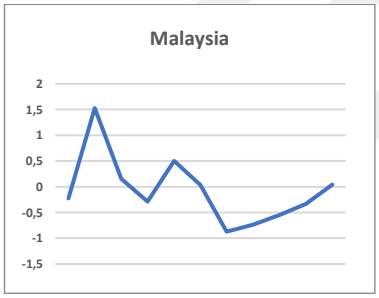
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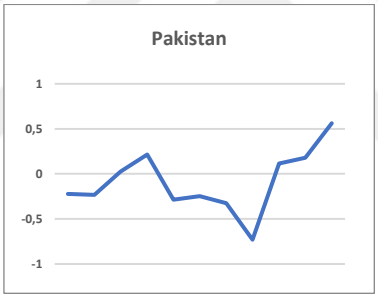
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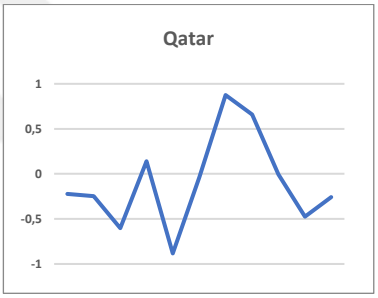
Qatar
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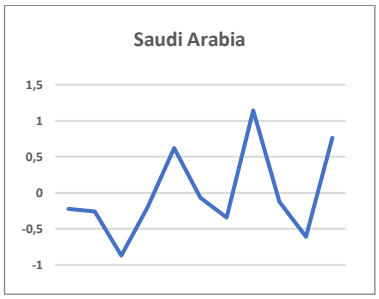
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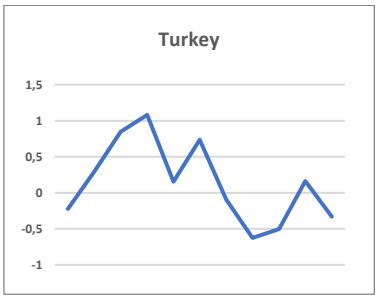
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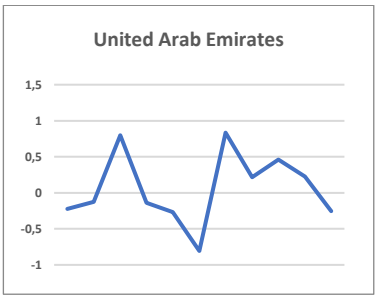
United Arab Emirates
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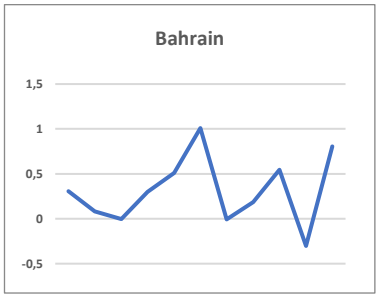
Model 19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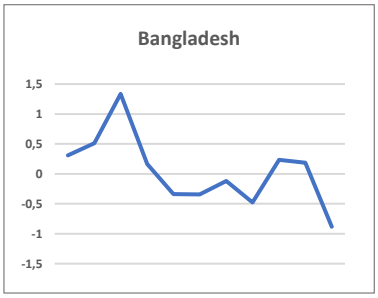
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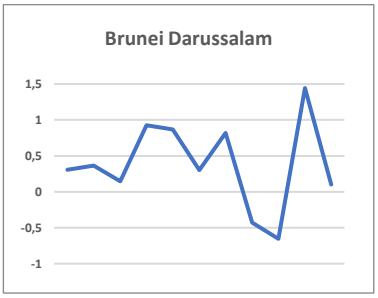
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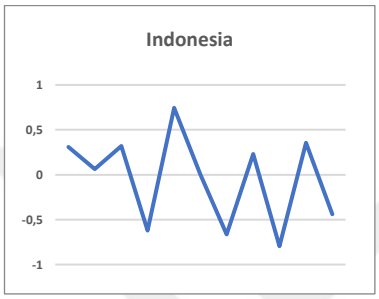
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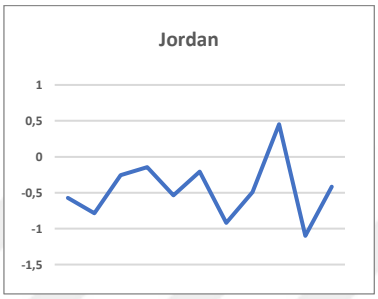
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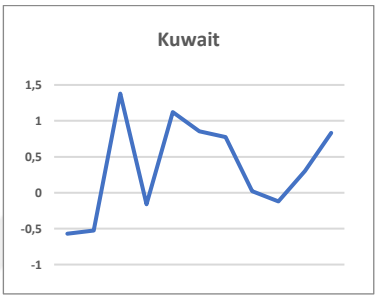
Kuwait
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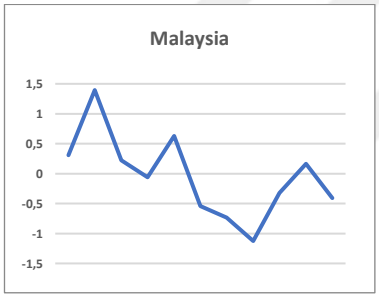
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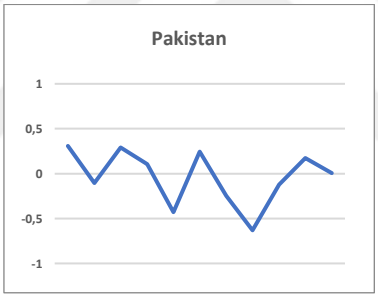
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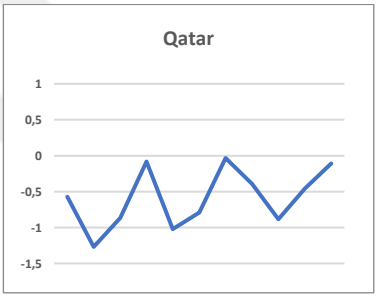
Qatar
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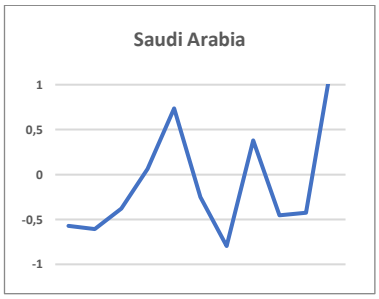
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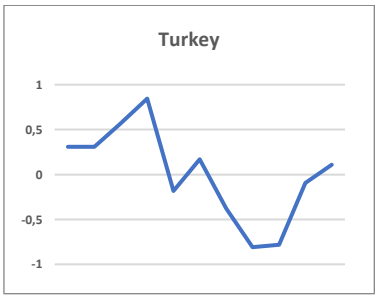
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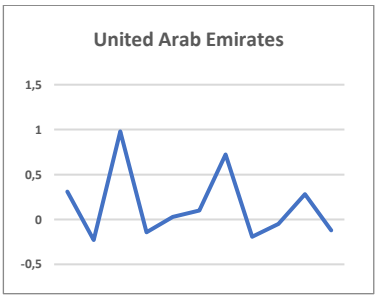
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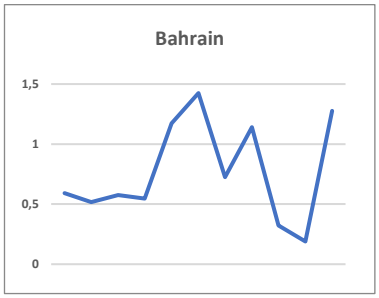
Model 20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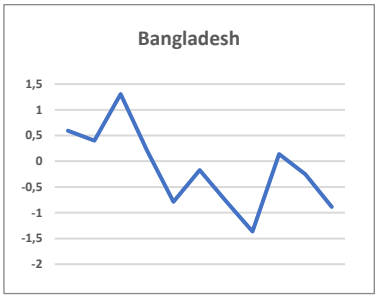
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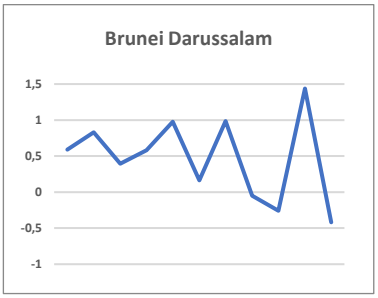
Brunei Darussalam
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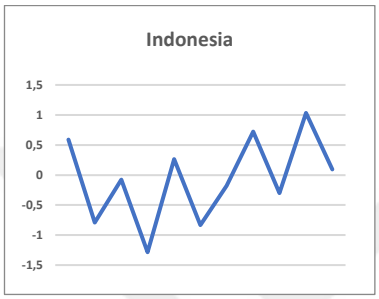
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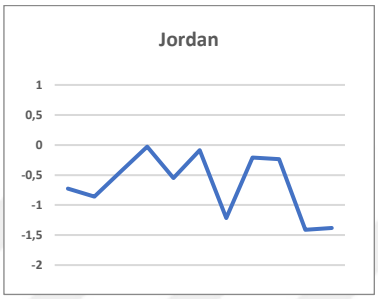
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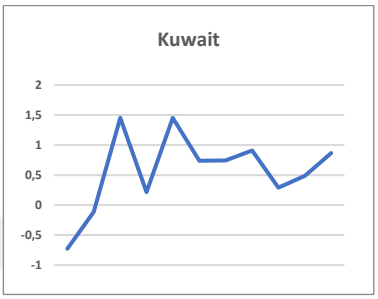
Kuwait
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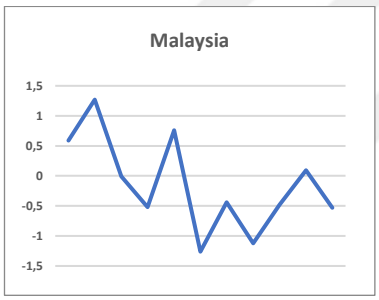
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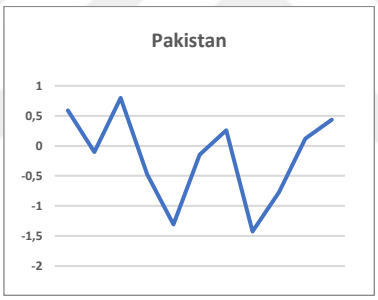
Pakistan
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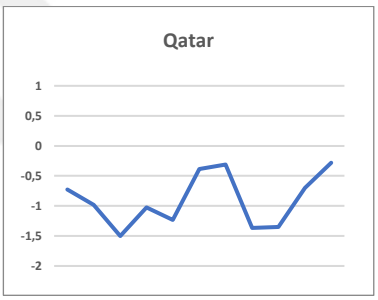
Qatar
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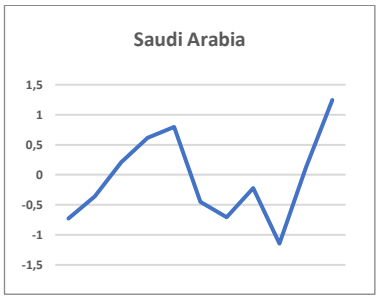
Saudi Arabia
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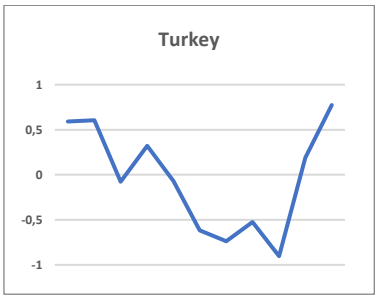
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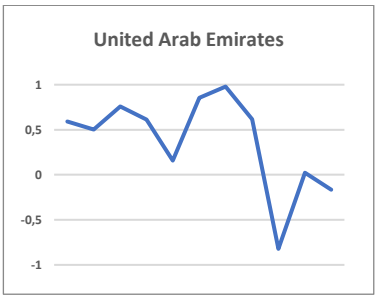
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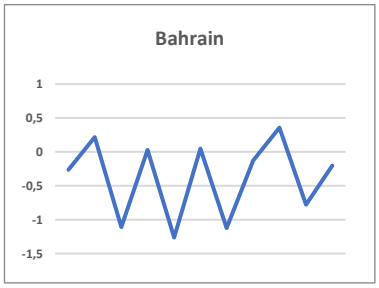
Model 21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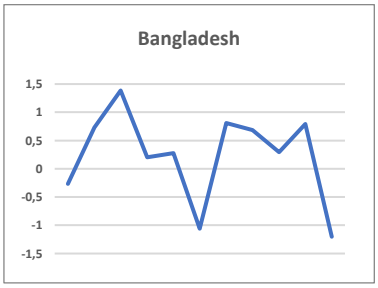
Bangladesh
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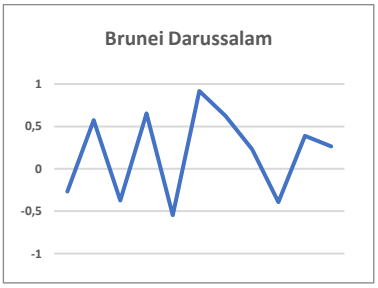
Brunei Darussalam
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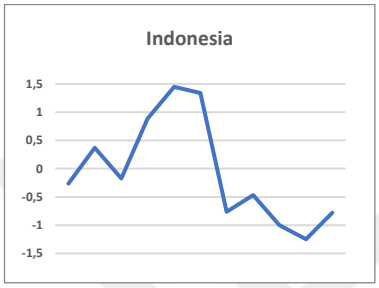
Indonesia
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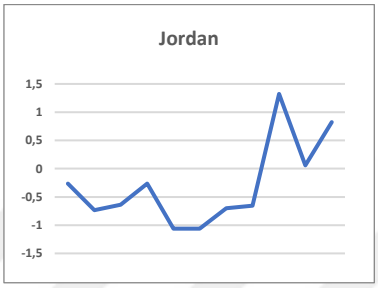
Jordan
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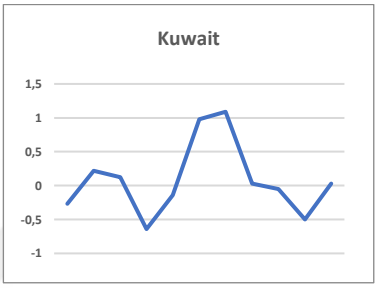
Kuwait
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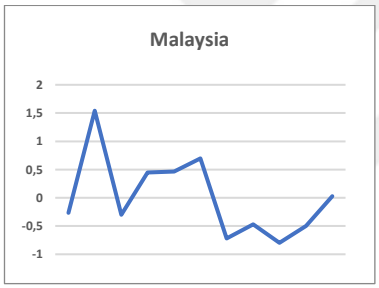
Malaysia
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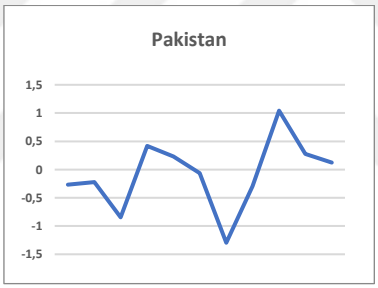
Pakistan
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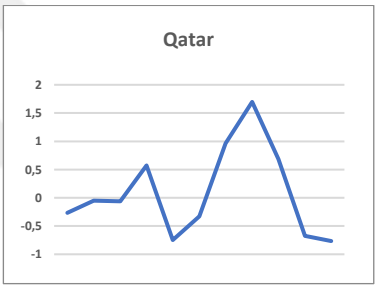
Qatar
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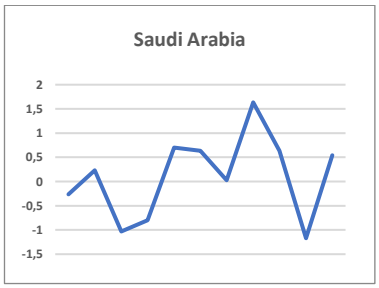
Saudi Arabia
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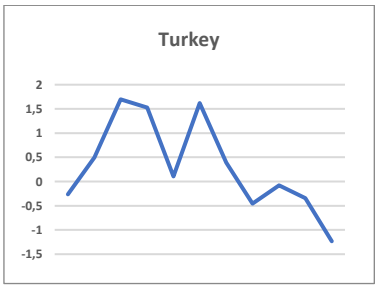
Turkey
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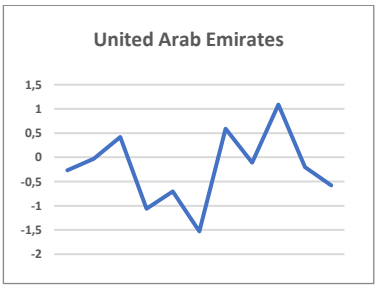
United Arab Emirates
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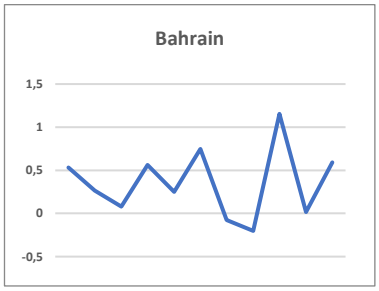
-2

Model 22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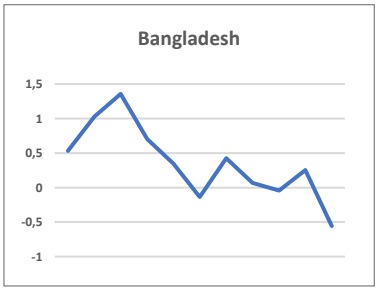
Bangladesh
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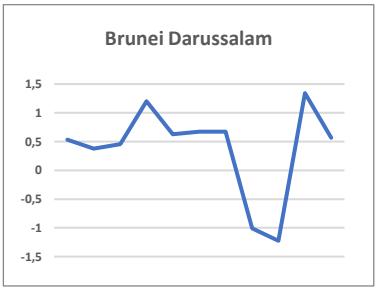
Brunei Darussalam
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-1,5


Indonesia
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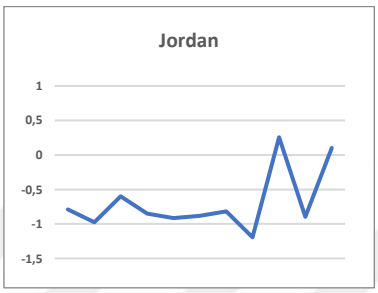
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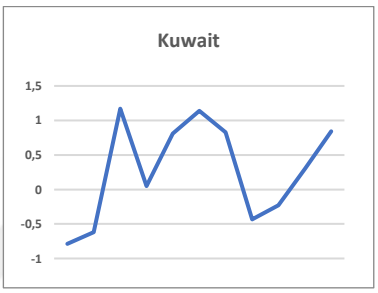
Kuwait
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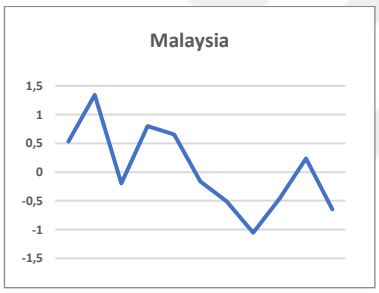
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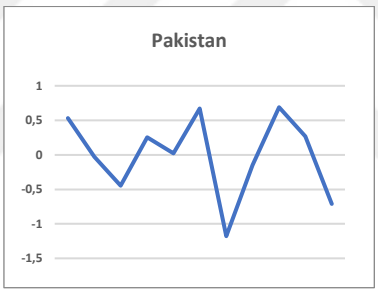
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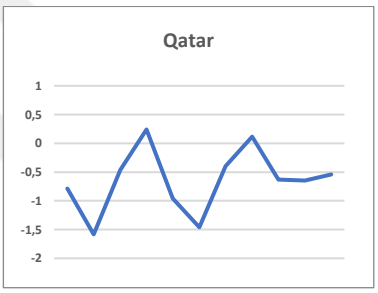
Qatar
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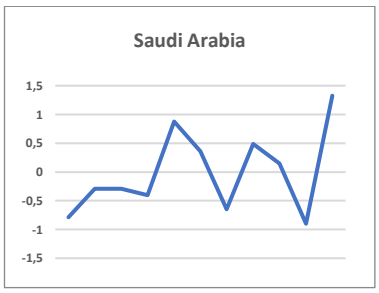
Saudi Arabia
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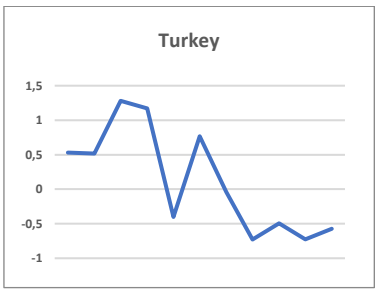
Turkey
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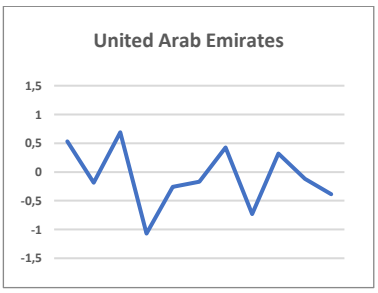
United Arab Emirates
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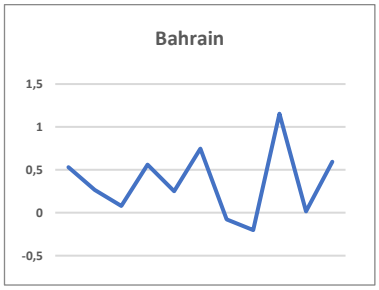
Model 23


Bahrain
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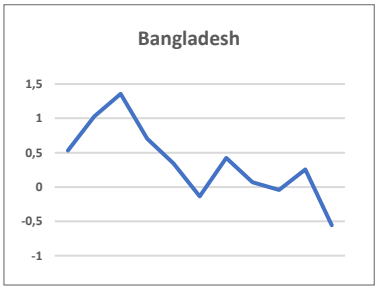
Bangladesh
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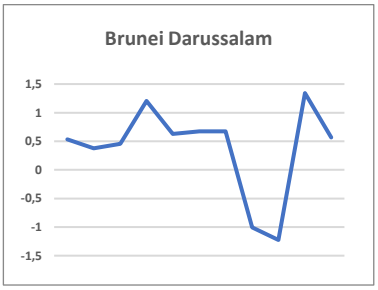
Brunei Darussalam
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Indonesia
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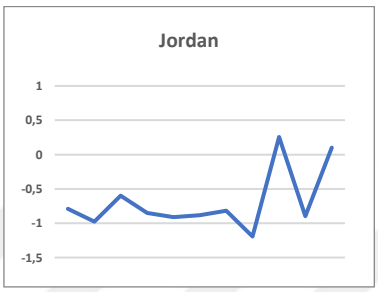
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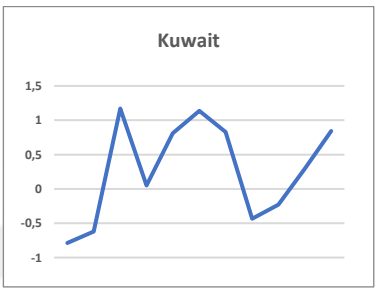
Kuwait
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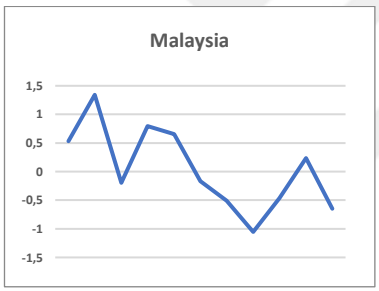
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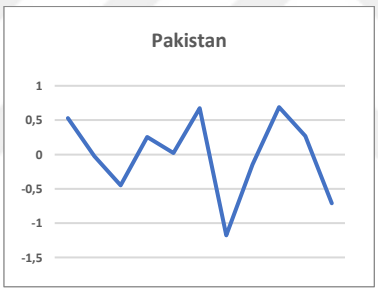
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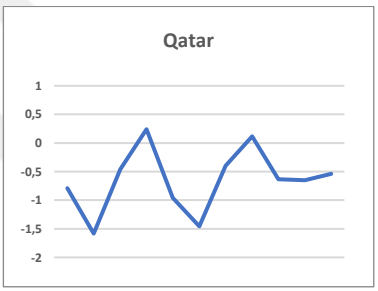
-1,5


Qatar
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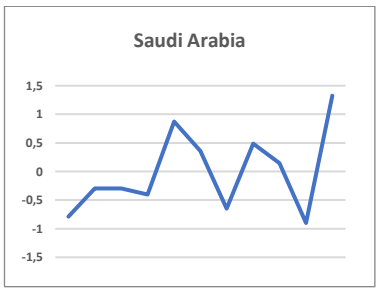
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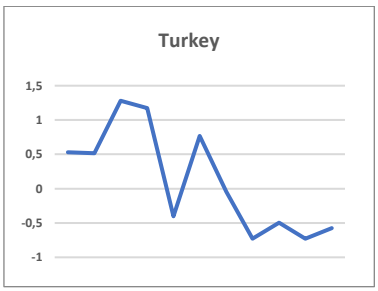
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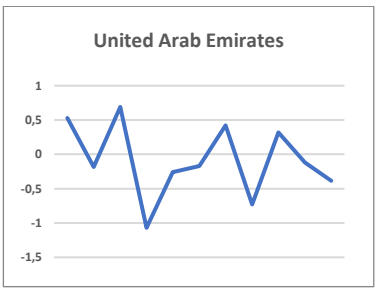
United Arab Emirates
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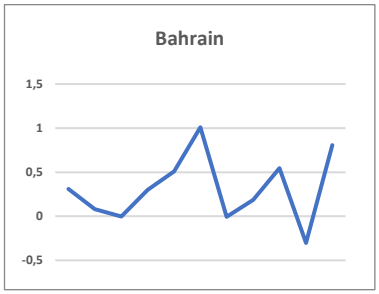
Model 24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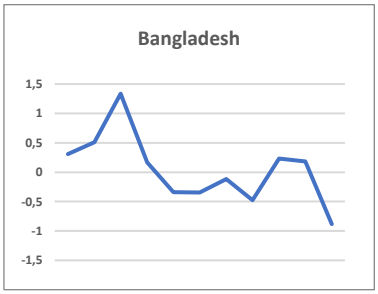
Bangladesh
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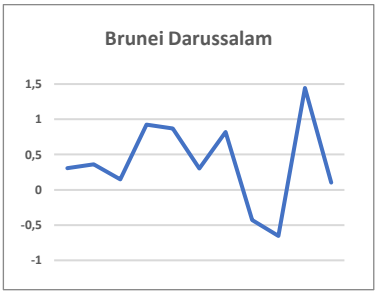
Brunei Darussalam
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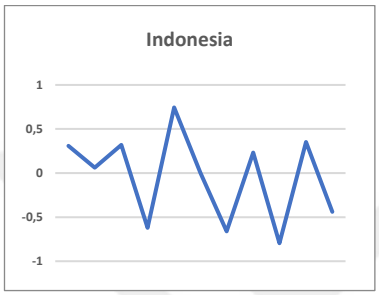
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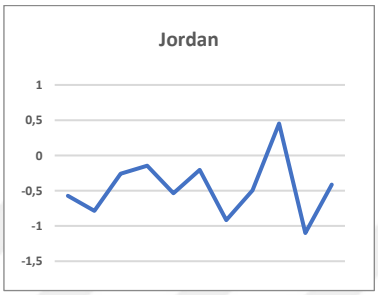
Jordan
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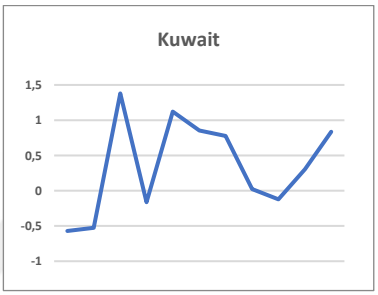
Kuwait
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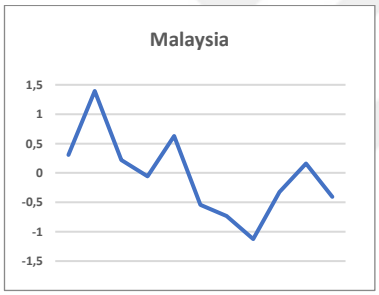
-0,5
-1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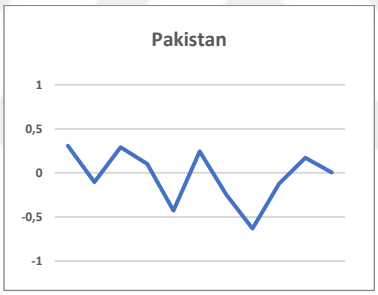
Pakistan
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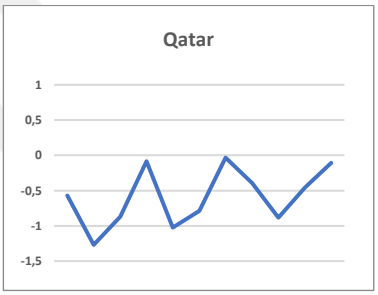
Qatar
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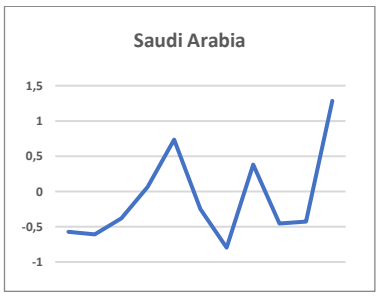
Saudi Arabia
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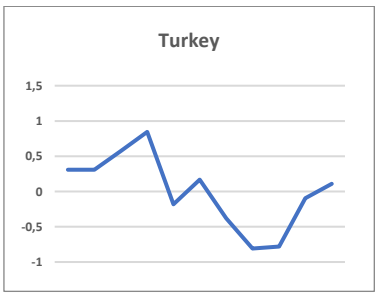
Turkey
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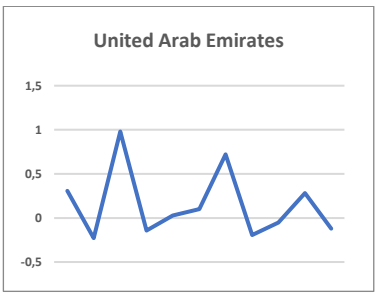
United Arab Emirates
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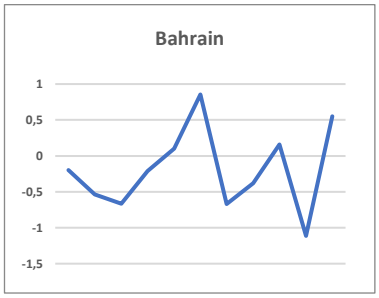
Model 25


Bahrain
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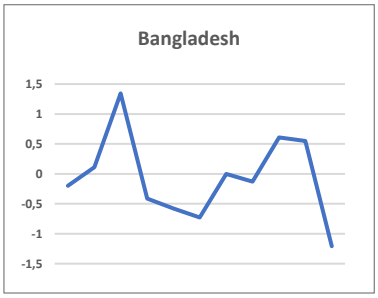
Bangladesh
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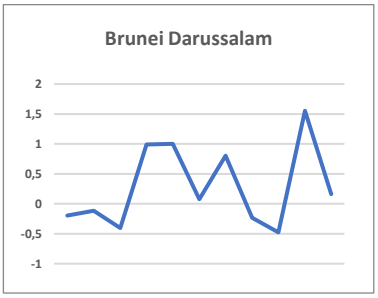
Brunei Darussalam
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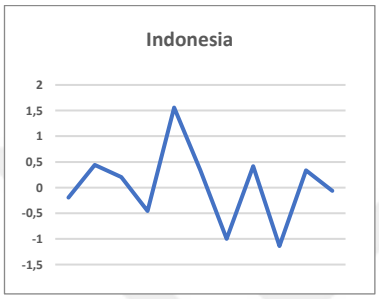
Indonesia
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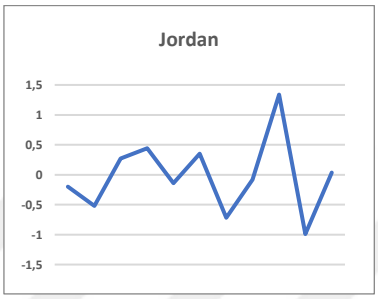
Jordan
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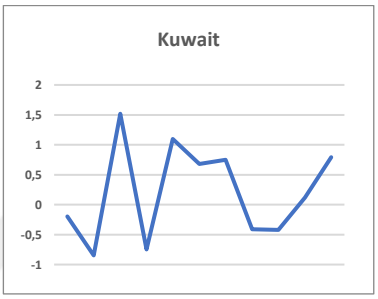
Kuwait
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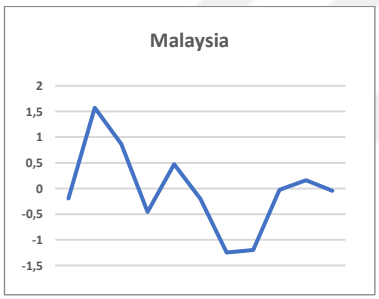
Malaysia
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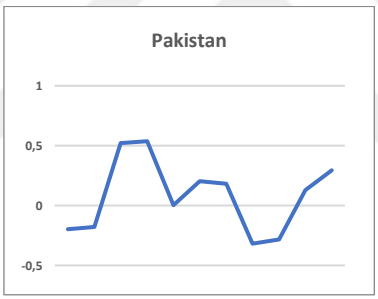
Pakistan
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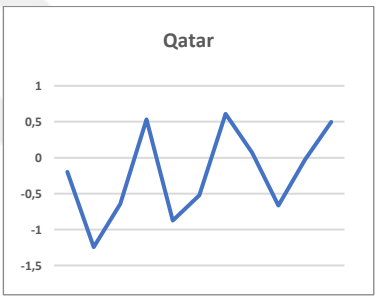
Qatar
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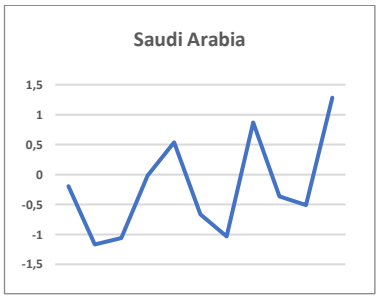
Saudi Arabia
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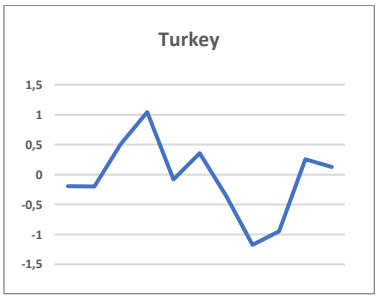
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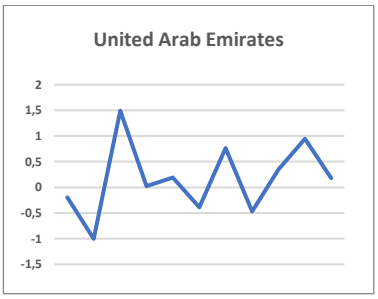
United Arab Emirates
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