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Determinants of Maturity Transformation Risk in Islamic Banks: A Perspective of Basel III Liquidity Regulations

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Abstract

Maturity transformation risk is highlighted as one of the major causes of recent global financial crisis. Basel III has proposed new liquidity regulations for transformation function of banks and hence to monitor this risk. Specifically, net stable funding ratio (NSFR) is introduced to enhance medium- and long-term resilience against liquidity shocks. Islamic banking is widely accepted in many parts of the world and contributes to a significant portion of the financial sector in many countries. Using a data-set of 68 fully fledged Islamic banks from 11 different countries, over a period from 2005 – 2014, this study attempts to analyze various factors that may significantly affect the maturity transformation risk in these banks. We utilize a 2-step system GMM estimation technique on unbalanced panel and find bank capital, credit risk, financing, size and market power as significant bank specific factors in determining maturity transformation risk. Furthermore, gross domestic product and inflation are found to be the significant macroeconomic factors that influence this risk. However, we find no evidence for the effect of bank profitability, cost efficiency and income diversity on maturity transformation risk in Islamic banking system.

Keywords: Basel III, Islamic banking, Maturity transformation risk, Net stable funding ratio.

1. Introduction

The importance of banking system is not only restricted to the economic development of a country, its scope is also extended to the stability and health of the overall financial environment (Halling and Hayden, 2006). Transformation of liquidity and risk is considered to be one of the fundamental functions of banking institutions. The theory that banks acquire short term deposits to finance loans for a longer term and thereby contributing towards the economic development, has long been established by Smith (1776). In contemporary banking, the idea that liquidity creation process is fundamental to banking institutions was prominently reincarnated by Bryant (1980) and Diamond and Dybvig (1983). Their studies argue that banks create liquidity by accepting relatively liquid liabilities (fund deposits) and making relatively longer term- illiquid assets (loans). While doing so, banks as intermediaries, hold illiquid assets and provide cash to the economy. Although, such transformation offers the underlying principle for the existence of the banks, this prime role is also attributed to the intrinsic maturity transformation risk (Berger and Bouwman, 2009).

A financial institution is said to be liquid when it is able to meet all legitimate demand for funds (Yeager and Seitz, 1989). Garber and Weisbrod (1992) refer liquidity as the banks' ability to transform illiquid assets into more liquid liabilities. In the financial system, bank's liquidity is broadly categorized into *asset liquidity* and *funding liquidity*. The former refers to the ability of a bank to offset its assets position either by selling or through securitizing a non-monetary asset, at market price without incurring unacceptable losses (Van Greuning and Bratanovic, 2009). Whereas the funding liquidity corresponds to the ability of banks to access external funding sources by attracting more deposits or by issuing debt or equity securities in interbank market (Gatev, Schuermann, and Strahan, 2009).

Due to some anomalies in the conventional banking system, banking crises occur more frequently with increased severity in recent times (Examples are: Asian Banking Crisis 1997, Collapse of Long-Term

Capital Management 1998, Russian Financial Crises 1998, and the US Sub-prime mortgage crisis lead to Global Crisis 2007). This augmented frequency of crises petitions for a review of risk management practices and policies at all levels including individual banks, their regulators and financial sector policy makers. Liquidity risk has emerged as a severe distress and challenge for the modern era banks (Comptroller of the Currency, 2001). A bank with a sufficient capital, strong earnings and good asset quality may be unsuccessful if it does not retain sufficient liquidity (Crowe, 2009). The recent global financial crisis has not only questioned on the appropriate functioning of the established conventional financial system, but has also amplified the consideration on a parallel neonatal financial system, Islamic banking, as some researchers have pointed to the superior performance of later during the crisis (Hasan and Dridi, 2010).

The world has witnessed an exponential growth of Islamic banking and finance over the last four decades with regards to its existence and the unrestricted geographical dispersion beyond the borders of Islamic states, through the continuous growth in the number of banks, branches, accounts and invested capital (Khan, 2010). Many of the leading international conventional banks such as ABN Amro, Bank of America, Barclays, Citigroup, Deutsche Bank, HSBC, JP Morgan, Lloydes TSB, Standard Chartered and others have started offering Islamic products and services through their Islamic windows. Consequently, due to the global financial liberalization, Islamic Financial Institutions (IFIs) made their existence as important players in the global financial system. Some recent statistics estimates the managed asset value of IFIs between US$ 1.816 to 2.1 trillion as at year end 2014, with the last five years compound annual growth rate (CAGR) of around 17%, to which Islamic banks hold more than 80 percent share with a CAGR of 14% from year 2009 to 2014 (ICD and REUTERS, 2015). There are more than 614 Islamic financial institutions including Islamic banks operating in almost 75 countries (Farahani and Dastan, 2013). Islamic banking and the associated financial institutions have transformed from an ambiguous experimentation project into a key player in the global finance market (Khan, 2010). For example, Standard and Poor's (2014) reports that the Islamic banks of Gulf Cooperation Council (GCC) countries outgrew their conventional peers between 2009 and 2012. They showed a compound average asset growth of 17.4% compared with conventional banks 8.1% during that period, while their net lending and customer deposits grew by an average of 18.2% and 19.9% compared with conventional banks 8.1% and 10%, respectively (Holmes and Kathpalia, 2014). Although, Islamic banks are concentrated more in Muslim majority regions such as the Middle East, Southeast Asia and Africa, their existence is gaining prominence in several parts of the US and Europe. For example, the UK is intending to become the global Islamic banking hub in the region (Kerr, 2007).

This exponential growth in the Islamic banking industry does not imply that Islamic banks are free from the risks associated to the global financial environment. Similar to their conventional counterparts, Islamic banks also face various types of risks that are evolved due to the contemporary changes and developments in the global financial market along with the recent financial crises generating financial distress and severe key challenges to the world's economy. According to El Tiby (2010), liquidity risk is among the most critical risk in Islamic banking system, and the main factors involved in this are:

i. Limited *Shari'ah* compliant financial instruments listed on secondary market, which calls for the institutions or regulators to increase participation in asset-based securities such as Sukuk (Ismal, 2008).
ii. The existing liquidity management options such as secondary market for debt instruments, interbank money market and lender of the last resort (LOLR) are based on interest rate (riba), which is prohibited by *Shari'ah* law (Islamic finance). This also possesses a huge challenge to Islamic banks in meeting their liquidity requirements.
iii. The unique specifications of the Islamic financial contracts such as cancellation risk in *murabaha* instruments, restriction to refinancing or contracts such as *bay salam* that can only be traded at par value, poses additional limitation to manage liquidity in Islamic banks.
iv. Absence of adequate depth in *Shari'ah* compliant money market also restricts the ability of Islamic banks in managing liquidity effectively.

The aim of this study is to analyse the impact of various internal and external factors on new regulatory liquidity requirements in the Islamic banking system. More specifically, we attempt to answer what bank-specific and macroeconomic factors influence the maturity transformation risk in Islamic Banking system. Our work contributes to the existing empirical literature in several ways. First, previous

studies that focus on the determinants of maturity transformation risk are mainly considering conventional banks from either the US or European countries, where the capital market structure is well developed and has much different dynamics than in developing countries. This may allow banks in the US and Europe with ease of external funding sources to manage their liquidity. Our study will contribute in the existing literature strand on maturity transformation risk by including a completely different banking system, i.e., Islamic banking system, and use a data set of banks from developing countries, where the banking system is the main source of financing to business in the private sector. This allows us to examine the impact of operational and market restrictions with regards to *Shari'ah* compliant financial instruments and refinancing options as well as the macroeconomic factors on liquidity transformation function of Islamic banks.

Second, the existing studies that examined the intermediation functions of Islamic banks and particularly the liquidity management requirements, theoretically or empirically, are either restricted to one country or descriptive in nature (Bacha, 2008; Brown, Hassan, and Skully, 2007; Iqbal and Molyneux, 2005; Khan and Ahmed, 2001; Rosly, Ayub, Toutounchian, Hasan, and Al-Zuhayli, 2005). This is the first study that focuses on the measurement of maturity transformation risk and its determinants in Islamic banks that operate in different countries, with regards to Basel III liquidity regulations.

Third, we divide the full sample into large and small banks based on asset size and also on the basis of their geographical location i.e., GCC and Non-GCC banks and estimate the same model. Further classification provides robustness tests which identify the suitability of new regulatory liquidity requirements among these groups.

Finally, to the best of our knowledge, this is the first study which utilizes dynamic panel technique to account for the lagged effects of explanatory variables on maturity transformation risk in Islamic banking system, to address the issues of potential endogeneity, heteroscedasticity and autocorrelation. This enables our study to quantify the most efficient estimates of the factors that affect maturity transformation risk in Islamic banks.

2. Literature Review

In the framework of risk and maturity transformation function of financial intermediaries, the later undertakes the tasks of liquidity creation and insurance for inter-temporal smoothing of income and consumption of economic agents (Diamond and Dybvig, 1983). The insurance function of intermediaries against liquidity shocks takes place through liquidity pooling of deposits in which certain proportion is liquidity reserves and the rest is used for profitable illiquid investments (Acharya, Hasan, and Saunders, 2006; Bhattacharya and Thakor, 1993; Bryant, 1980; Diamond and Dybvig, 1983; Diamond and Rajan, 1999; Holmström and Tirole, 1998; Kashyap, Rajan, and Stein, 2002). On the other hand, the liquidity creation function of the banks, through investing in long term illiquid assets, renders them intrinsically vulnerable to maturity transformation risk (Diamond and Dybvig, 1983). More generally, with increased liquidity creation, banks reduce their ability to meet the unexpected liquidity requirements of their borrowers and depositors, as illiquid assets are difficult to be monetized, especially when the economy is facing liquidity pressures or crises (Calomiris and Kahn, 1991; Diamond and Rajan, 2001).

Liquidity transformation has been extensively studied by many researchers in the past (Berger and Bouwman, 2009; Bhattacharya and Thakor, 1993; Bryant, 1980; Diamond and Dybvig, 1983; Holmström and Tirole, 1998; Kashyap et al., 2002; Von Thadden, 1999). However, these studies mainly focus on quantifying the extent of liquidity created by banks and their exposure to maturity transformation risk. Recently some development has been made in investigating the factors effecting liquidity creation function of the banks (Fungáčová, Weill, and Zhou, 2010; Shen, Chen, Kao, and Yeh, 2009; Vodová, 2011) and its effects on banks maturity transformation risk (Angora and Roulet, 2011). However, most of these studies are conducted on conventional banking model. Using the findings from previous literature, we aim to examine the relevant determinants of maturity transformation risk in the Islamic banking system. This section provides an insight of various bank-level and macroeconomic variables that are likely to influence bank exposure to maturity transformation risk in Islamic banks.

Very few studies have focused empirically on bank specific, industry specific and macroeconomic determinants of funding liquidity risk. Rauch, Steffen, Hackethal, and Tyrell (2009b) identify the determinants of liquidity risk and attempted to ascertain the elements of liquidity creation. The authors' study emphasizes monetary policy and macroeconomic variables as the most significant determinants.

Their results also illustrate that bank specific variables such as efficiency and size have no significant relationship with the liquidity creation.

Fungáčová et al. (2010) examine the relationship between bank capital and liquidity creation function and the impact of deposit insurance on this relationship. The authors take various measures of liquidity creation by Russian banks and find that bank capital and liquidity creation are negatively related. Also the introduction of the deposit insurance scheme has only a slight impact with no change in the negative sign of this relationship. Their results support the "financial fragility - crowding out" hypothesis that suggests better capitalized banks tend to create less liquidity.

Vodová (2011) used four liquidity ratios to determine various factors that influence liquidity of Czech commercial banks over a period from 2001 to 2009. The author's study finds a significant and positive relation between bank capital and liquidity. Further, non-performing loans and net interest income are positively linked to bank liquidity. Inflation, business cycle and financial crisis are significant but negatively related to liquidity. Moreover, the study was unable to establish any significant relationship between bank size and liquidity.

Following Saunders and Cornett (2007), Shen et al. (2009) employed funding gap ratio as a liquidity risk measure to investigate the factors causing bank liquidity risk. (Saunders and Cornett, 2007) indicated that banks can measure liquidity risk exposure by determining their financing gap. The financing gap is defined as the difference between a bank's average loans and average core deposits. They applied instrumental variable technique on unbalanced panel data of banks from 12 advanced economies for the period 1994 – 2006, and found components of liquid assets and dependence on external funding as the main causes of funding liquidity risk. The study also finds a non-linear relationship among liquidity and bank size. Additionally, macroeconomic variables such as GDP and inflation as well as supervisory and regulatory factors have shown significant effect on banks' liquidity risk.

Munteanu (2012) used country specific data and multiple regression model to identify the determinants that influence retail bank's liquidity in Romania. The author used two different liquidity measures i.e. L1- net loans/total assets and L2 – liquid assets/deposits and short term funding, and divided the dataset into pre-crisis and during crisis. Munteanu (2012) used the period 2008 – 2010 as the crisis period. The author's findings revealed these two measures have different policy implications in the pre-crisis and during crisis period. Further, macroeconomic factors such as unemployment and inflation are observed for *L2* measure, which calls for the need of continuous reporting for aggregate risk. Munteanu's study also reveals that the Z-score (bank's stability indicator) has a significant effect on bank liquidity during the crisis period.

Bonfim and Kim (2012) also explained that the relationship between liquidity and bank size, efficiency and loan to deposit ratio depends on the type of liquidity risk measure used. Their results also showed that the banks with greater lending to the customers tend to have higher loan to deposit ratios and usually maintain minimum liquidity ratios.

Horvath, Seidler, and Weill (2012) examined the potential impact of tighter capital requirements on banks' liquidity creation in Czech Republic and found Basel III capital requirements can reduce liquidity creation, as well as the increased liquidity creation can trigger bank's insolvency. Using the exhaustive data sample from year 2000 – 2010, the authors performed Granger – causality tests in a dynamic GMM panel estimator framework and revealed that capital is negatively associated with liquidity creation in their sample banks (mainly small banks). The study also highlighted that liquidity creation also Granger – causes a reduction in bank capital. The authors concluded that this reverse causality generates a trade-off between the benefits of financial stability induced by stronger capital requirements and the benefits of increased liquidity creation.

To the best of our knowledge, there is only one study by Alman and Oehler (2012), which focused on the liquidity transformation factors in Islamic banks. The authors used a cross-country data set of 82 Islamic and 55 conventional banks over the period 2000-2010 and revealed that liquidity transformation is negatively affected by the regulation of Islamic banks. However, the authors proxy liquidity transformation gap (LTG) to measure liquidity transformation as the dependant variable. One of the demerit of using LTG is that it does not classify assets and liabilities according to product category. In addition, such proxy does not indicate the extent of liquidity creation beyond which it offsets the advantage of performing this function. Our study will use net stable funding ratio as relevant proxy documented in the guidelines of Basel III (BIS, 2009) to examine the maturity transformation in Islamic banks.

2.1 Maturity Transformation Risk Measurement

Deep and Schaefer (2004) are the first to empirically measure the maturity transformation risk. They estimated liquidity transformation as the difference between liabilities due within one year (liquid liabilities) and near cash (liquid) assets scaled to gross assets. The authors used panel regression analysis on data of the 200 largest US banks from 1997 to 2001. Their result showed that the banks exhibited unexpectedly low liquidity transformation of about 20%. The study also revealed that deposit insurance provides less incentive to the banks in performing their liquidity transformation function as insured deposits generally replace uninsured liabilities instead of expanding the deposit base or encouraging banks to make more loans. Besides, it is the credit risk in loan portfolios that appears to discourage liquidity transformation.

Berger and Bouwman (2009) use a more generalized approach to measure liquidity creation, where they classified assets and liabilities according to product category and maturity and include off-balance sheet activities, which were not considered by Deep and Schaefer (2004). The main finding of their study shows a significant and positive relationship between bank capital and liquidity creation in large banks. The relationship was also significant in small banks but with opposite sign.

Although liquidity creation increases banks illiquidity and maturity transformation risk, the measure for liquidity creation proposed by Berger and Bouwman (2009) does not indicate to what extent liquidity creation may become damaging for a bank in terms of excessive liquidity creation and exposure to transformation risk. To overcome this issue, Angora and Roulet (2011) use the guidelines of Basel III accord and determine the inverse of net stable funding ratio (*I*_NSFR) as a measure of "how much is too much" for liquidity creation in the US and European banks and assessed various factors involved in determining maturity transformation risk in these banks. *I*_NSFR is the ratio of required amount of stable funding to available amount of stable funding. Our study also used the net stable funding ratio NSFR, as proposed in the guidelines of Basel III accord (BIS, 2009) to measure the maturity transformation risk of Islamic banks.

2.2 Net Stable Funding Ratio

In the aftermath of the US 2007 subprime crisis, the need of improved bank liquidity management practices has drawn substantial attention of the regulators. To address these requirements, the Basel Committee on Banking Regulation and Supervision has proposed several international guidelines for banks to assess their liquidity position (BIS, 2009). Among them, the Basel III accords include the implementation of the *net stable funding ratio* (NSFR). It is a ratio of available amount of stable funding to the required amount of stable funding. This ratio is proposed to manage the banks liquidity position for more than one-year time horizon by introducing continuous structural changes in the bank's balance sheet, to fund their activities with more stable funding sources. The available amount of stable funding constitutes of bank capital, liabilities with residual maturities of one year or more and stable deposits. A portion of non-maturity deposits and term deposits with effective maturities of less than one year that are expected to stay within the institution. The required amount of stable funding is the value of bank assets that is difficult to be liquidated or utilized as collateral in a secured borrowing during liquidity stress conditions, over one-year period. Each component of the balance sheet is assigned with specific weights recommended in the Basel III framework, in order to calculate the net stable funding ratio.

The net stable funding ratio is calculated as:

$$NSFR = \frac{Available\ amount\ of\ stable\ funding}{Required\ amount\ of\ stable\ funding}$$

Equation (1) shows the simplified version of the NSFR (BCBS, 2014)

$$= \frac{\begin{array}{c} 0.9 * (demand\ deposits + savingdeposits) \\ +0 * (short - term\ market\ debt + other\ short - term\ liabilities) \\ +1 * (long - term\ libilities + equity) \end{array}}{\begin{array}{c} 0 * (cash + interbank\ assets + short - term\ marketable\ assets) \\ +0.5 * (long - term\ marketable\ assets + customer\ acceptances) \\ +0.85 * (constant\ loans) \\ +1 * (commercial\ loans + other\ loans + other\ assets + fixed\ assets) \end{array}} \quad (1)$$

A higher value of Basel III *net stable funding ratio* corresponds to more amount of stable funds available than required amount of stable funds, in which case the banks find less difficulty in meeting their current liquidity obligations. On the other hand, the lesser value of this ratio refers to the extent of a bank's inability to meet unexpected withdrawal requirements from customers without borrowing money from external sources or fire selling its assets at a discount, consequently exposed to an increased maturity transformation risk (Roulet, 2011).

3. Methodology

3.1 Model Specifications

Previous studies have documented that various determinants (for example, bank capital, fee income, non-performing loans, size, inflation and gross domestic product) have significant influence on liquidity transformation function and risk of conventional banks. These factors are classified into bank specific, industry specific, macroeconomic and supervisory or regulatory factors (Shen et al., 2009). Based on the existing literature, we developed the following general model to analyze the influence of internal and external factors on maturity transformation risk in Islamic banks.

$$y_{ijt} = \sum_{b=1}^{B} \vartheta_b \prod_{it}^{b} + \sum_{m=1}^{M} \mu_m \prod_{it}^{m} + \varepsilon_{it} \quad (2)$$

Where:

$\varepsilon_{it} = \mu_i + v_{it}$

(y_{ijt}) = dependent variable for bank 'i' of country 'j' at time 't', with '$i = 1 \ldots N$ and $t = 1 \ldots T$'.

N is the number of cross-sectional observations and the length of the sample period represented by T.

$(\prod_{it}^{b}, \prod_{it}^{m})$ = a vector of bank-specific and macroeconomic variables, respectively.

(ε_{it}) = disturbance error.

(μ_i) = unobserved heterogeneity (the fixed effect).

(v_{it}) = idiosyncratic error.

Equation (2) is a one-way error component regression, where (μ_i) is ~IIN $(0, \sigma_{\mu_i}^2)$ and independent of (v_{it}) which is ~IIN $(0, \sigma_{v_{it}}^2)$.

3.2 Explanatory Variables

In this study we included the following banks-specific and macroeconomic explanatory variables to determine their effect on maturity transformation risk in the Islamic banking system. Among bank-specific variables, Bank capital signifies the degree of cushion maintained by the bank to absorb losses from ongoing operations when exposed to risk and uncertainty. Previous literature revealed a two-way relationship between liquidity and bank capital. Under the risk absorption theory, Allen and Gale (2004) ascertained that higher capital requirements increase liquidity creation of the financial institutions. The authors' study revealed that increased liquidity creation exposes banks to higher degree of risk as the losses increase with the level of illiquid assets to satisfy the liquidity demands of customers. This activity is directly related to the risk transformation role of the financial intermediaries (Al-Khouri, 2012). The increased liquidity needs attract the banks to incur higher losses due to the disposal of illiquid assets at available market prices rather than the desired prices, to meet their customers' obligations. However,

higher bank capital absorbs these losses and expands the risk-bearing capacity of the financial intermediaries (Bhattacharya and Thakor, 1993; Coval and Thakor, 2005).

On the contrary, Diamond and Rajan (2011) argue that a nominal intermediary service levy will be charged to the depositors to lend their respective deposits. However, the mismatch of this fee with the repayment capability of risky borrowers, will provoke the depositors to withdraw their funds, promoting financial fragility, which, in extreme cases, may lead to bank runs causing severe liquidity problems to the banks and the financial sector as a whole. Similar findings revealed by Gorton and Winton (2000) who argued the "crowding out effect" where the banks' preference to meet higher capital requirements by shifting investors' funds to their capital accounts. Nevertheless, these investments are susceptible to financial uncertainty and cyclical variations which are not insured and difficult to be withdrawn when required, ensuing a decrease in liquidity creation. Based on the above discussion, *we hypothesise that maturity transformation risk decreases with increased level of bank capital*.

In addition, to check the effect of bank diversification on maturity transformation risk, we utilize non-interest income. The seminal article by Boyd, Hanweck, and Pithyachariyakul (1981), laid the foundation for the relationship between non-interest income and risk. They argued that increased non-interest income can help banks to improve risk diversification leading to higher degree of stability. However, DeYoung and Roland (2001) highlighted the large volatility of non-interest income and commented that creditors find it even difficult to shift their financing relationship because of information costs. Furthermore, Busch and Kick (2009) found that although banks' risk-adjusted returns increase with the increase in portion of fee income activities, retail banks that are heavily involved in non-interest income activities have shown significantly more volatile returns leading to increased banks risk.

Similar findings were obtained by Altunbas, Manganelli, and Marques-Ibanez (2011) and Demirgüç-Kunt and Huizinga (2010b) using a data of listed investment-oriented banks. Likewise, Brunnermeier, Dong, and Palia (2012) find evidence that banks involved more in non-core banking activities like trading and investment and venture capital activities to earn higher non-interest income which contribute more towards systemic risk than those following the traditional banking function of deposit taking and lending. Their findings remain consistent even after categorizing non-interest income into trading income and investment banking and venture capital income, where both components are found as approximately equal contributors to systemic risk. Considering the infancy stage of Islamic banking and using the previous literature support, *we hypothesise that banks involved in diversified activities are more exposed to maturity transformation risk*.

We are also interested to capture the effect of financial soundness of banks on risk taking behaviour. Bank profitability in general explains the influence of increased financial soundness on banks' risk bearing capacity and on their ability to create liquidity (Rauch, Steffen, Hackethal, and Tyrell, 2008; Shen et al., 2009). As a result, this increased financial strength may enhance the banks' ability to take risk, which yields a positive relationship between bank profitability and transformation risk. Moreover, profitability can also account for the "too big to fail" philosophy of large banks (Demirgüç-Kunt and Huizinga, 2010a; Zhou, 2010). Large banks may expose to increased maturity transformation risk as they can create more liquidity even in stress conditions in order to increase their profitability. Based on the above discussion, *we hypothesise that financial soundness attracts the banks to increase their liquidity creation function which can lead to increased maturity transformation risk*.

Many researchers have studied the impact of credit risk in the determination of transformation risk (Berger and Bouwman, 2009; Deep and Schaefer, 2004; Fungáčová et al., 2010; Rauch et al., 2008). The lower the credit risk, the more aggressive a bank can extend its lending activities. Consequently, better asset quality encourages the banks to create more liquidity which in turn leads to increase exposure to transformation risk. Based on the above arguments, an inverse relationship between credit risk and maturity transformation risk is assumed.

Bank market power may influence the availability of funding (Petersen and Rajan, 1995) and the split of loan portfolio (Berger, Miller, Petersen, Rajan, and Stein, 2005). The influence of bank market power in relation to liquidity creation and transformation risk is analysed by Berger and Bouwman (2009). Their findings reveal that banks with greater market power may enhance their liquidity creation by making more loans and attracting more funds either from the depositors or from the wholesale market. Thus, the higher the bank market power, the higher its liquidity creation and exposure to transformation risk.

Bank size is generally described in terms of net total asset. In line with the argument of 'too big to fail' philosophy, the implicit guarantee by the regulators decreases banks' funding cost which enable them to

invest in more risky assets (Iannotta, Nocera, and Sironi, 2007). Tesfaye (2012) highlighted the regulators' protection to large banks as the cause of moral hazard problem. This also reduces the incentive to hold more liquid assets for larger banks. This allows difference in liquidity creation among the banks relative to their size. As revealed by Delechat, Arbelaez, Muthoora, and Vtyurina (2012), liquidity increases with bank size, however, after a certain level in bank size, their study showed a negative relationship between liquidity and bank size. During stress conditions, larger banks perform more liquidity creation, hence exposed to higher risks of losses which may incur due to the sale of illiquid assets. Further, Rauch et al. (2009b) and Berger and Bouwman (2009) highlighted that smaller bank are less involved in liquidity creation as they focused on transformation activities and intermediation processes. These findings are in line with some of the previous studies where Audretsch and Elston (2002) found that smaller banks possess relatively more liquid assets and less liquidity constraints. Similarly, Kashyap et al. (2002) also revealed a strong influence of bank size on liquidity creation and concluded that as smaller banks face constraints in accessing capital markets, they tend to maintain higher levels of liquidity. Hence, *a positive effect of bank size on risk exposure is hypothesized*.

Many studies in the past have established the impact of macroeconomic factors on bank liquidity. For example, Gavin and Hausmann (1996) determined macroeconomic instability as one of the major cause of bank failures. The authors revealed that the impact of such negative shocks increases the inability of borrowers to repay their obligations, giving rise to NPLs, which hampers the banks performance and ultimately causes financial instability. Determining the impact of economic downturn, Bordo, Eichengreen, Klingebiel, and Martinez-Peria (2001) argue that the degree of loan defaults is even higher during recession. This stimulates the depositors to perceive high solvency risk triggering unexpected large deposit withdrawals. This leads to the bank run causing liquidity risk and ultimately bank insolvency. Similar findings have been revealed by Shen et al. (2009).

Analysing the cyclical effect on bank liquidity preferences, Aspachs, Nier, and Tiesset (2005) propose that banks prioritize liquidity during economic uncertainties when banks find less opportunity to increase their lending assets. Painceira (2010) suggests that banks' incentive of holding more liquid assets decreases during the economic booms, however, banks are likely to maintain high levels of liquidity during stress conditions. Based on these arguments we can expect the banks to increase their liquidity creation and their exposure to transformation risk during economic booms.

In our study, inflation is also accounted for as another macroeconomic factor effecting maturity transformation risk. As mentioned by Vodová (2013), banks vulnerability in terms of nominal values of loans issued to borrowers, increases with an increase in rate of inflation. This hampers the liquidity creation function of the banks as they are more likely to maintain their liquidity when the economy is under high inflationary pressure, thus reducing their exposure to maturity transformation risk. Based on this argument, we can expect an inverse relationship between inflation and risk. Table 1 defines the variables used in our model.

Table 1: Variables Definition

Variables	Definitions	Explanation	Source	Expected Sign
Dependent variable				
NSFR (%)	Net stable funding ratio	Maturity transformation risk	Authors' calculations based on banks annual reports	+
Explanatory variables				
CAR (%)	Capital adequacy ratio	Bank capitalization	SNL Financials and banks annual reports	+
NII (%)	Ratio of Non-Interest income to operating income	Bank diversification	SNL Financials and banks annual reports	-
SPEC (%)	Ratio of bank loans to total assets	Bank specialization	SNL Financials and banks annual reports	+
ROAA (%)	Return on average assets	Bank performance	SNL Financials and banks annual reports	+
RWATA (%)	Ratio of risk weighted assets to total assets	Bank credit risk	Authors' calculation using definition of SNL Financials	-
MP (%)	Ratio of bank assets to industry total assets of a country	Bank market power	Authors' calculations based on bank annual report	+
Size	Natural log of total assets	Bank size	SNL Financials and banks annual reports	+
CIR (%)	Cost to income ratio	Bank efficiency	SNL Financials and banks annual reports	-
GDP (%)	Annual change in GDP/capita	Economic growth	World bank database	+
CPI (%)	Year-on-year change in consumer price index	Inflation	World bank database	-

Equation (2) identifies the factors effecting maturity transformation risk with respect to the restrictions specified to the products and activities of Islamic banking:

$$NSFR_{it} = \delta_1 NSFR_{it-1} + \vartheta_2 CAR_{it} + \vartheta_3 NII_{it} + \vartheta_4 SPEC_{it} + \vartheta_5 ROAA_{it} + \vartheta_6 RWATA_{it} + \vartheta_7 MP_{it} + \vartheta_8 SIZE_{it} + \vartheta_9 CIR_{it} + \mu_1 GDP_t + \mu_2 GDP_{t-1} + \mu_3 CPI_t + \mu_4 CPI_{t-1} + \varepsilon_{it} \quad (3)$$

3.3 Selection of Estimation Technique

To incorporate the temporal effects of the dependent variable, this study applies the dynamic panel data model, which uses lags of the dependent variable as explanatory variables. The introduction of these lags is crucial to control for the dynamics of the process.

Consider the following general equation for dynamic panel data model

$$y_{it} = \gamma y_{it-1} + \beta x_{it} + \alpha_i + \nu_{it} \quad (4)$$

where;
$i = 1, \ldots, N$ (individuals), $t = 1, \ldots, T$ (time), x_{it} are the regressors, α_i is fixed individual effects and ν_{it} has zero mean, constant variance and is uncorrelated across time and individual.

One of the basic assumptions for regression analysis is that all the explanatory variables must be uncorrelated with the disturbance error term. As y_{it-1} is correlated with α_i because y_{it-1} is a function of α_i, Generalized Least Squares (GLS) and Ordinary Least Squares (OLS) estimators are biased and inconsistent. Similarly, within Group (WG) estimators are also biased and inconsistent, because in the transformed model, when using variable deviations from mean $[y_{it} - \bar{y}_i = \gamma(y_{it-1} - \bar{y}_i) + \beta(x_{it} - \bar{x}_i) + (\nu_{it} - \bar{\nu}_i)]$, the independent variable will be endogenous ($\bar{y}_i$ is correlated with $\bar{\nu}_i$).

An alternative transformation to remove individual effects α_i is the "first difference" transformation:

$$\Delta y_{it} = \gamma \Delta y_{it-1} + \beta \Delta x_{it} + \Delta v_{it} \quad (5)$$

Again WG and GLS estimators are inappropriate as the model suffers from an endogeneity problem. Due to the dynamic structure of equation (4), Δy_{it-1} is correlated with Δv_{it}. To solve this problem, Anderson and Hsiao (1982) proposed to control endogeneity using Δy_{it-2} or y_{it-2} as instruments for Δy_{it-1}. Arellano and Bond (1991), proposed a method that exploits all possible instruments. Using the Generalized Method of Moments (GMM), they obtained estimators using the moment conditions generated by lagged levels of the dependent variable $(y_{it-2}, y_{it-3}, \cdots)$ with Δv_{it}. These estimators are called differenced GMM estimators. Similar to all instrumental variables regressions, GMM estimators are unbiased. By using Monte Carlo simulations to compare the performance of difference GMM, OLS, and WG estimators, they found that GMM estimators exhibit the smallest bias and variance.

However, there are two situations where the difference GMM model does not provide good estimators. First when model errors are heteroskedastic, we do need a modified tool i.e., two-step GMM estimators. These estimates are robust under heteroscedasticity, but their standard errors are severely downward biased. Our study applied Windmiejer's finite-sample correction to report standard errors for two-step GMM estimators (Windmeijer, 2005). Secondly, when a given independent variable does not change across time (e.g. religious preferences), the variable is eliminated in equation (4), making this method inappropriate to estimate its associated parameter. Arellano and Bover (1995) as well as Blundell and Bond (1998) proposed an alternative method. In addition to differencing the model (equation (4)) and using lagged levels of y_{it-1} as instruments of Δy_{it-1}, they worked with the "original" model (equation (4)) and used the difference Δy_{it-1} as instruments of y_{it-1}. The estimators obtained are called system GMM estimators.

We utilize two-step system GMM technique for dynamic panel specification to overcome the issues of heteroscedasticity, potential endogeneity and autocorrelation between error component and the regressors (Roodman, 2009). Originally, system GMM method was developed to improve the behaviour of difference GMM estimators when the autoregressive parameter $'\gamma'$ approaches unity, in which case, lagged levels of dependent variable are weak instruments. Another advantage of this method is that time-invariant variables can be included as regressors (Roodman, 2006).

3.4 Data Sources

This study applies an unbalanced panel dataset comprising of 68 full-fledged Islamic banks from 11 Islamic states of Asia and MENA region for a period of 10 years from 2005 - 2014. The selection of sample countries is based on the common religious belief as majority of the population is Muslim. Following (Lee and Hsieh, 2013), we dropped a bank from the sample if the data is available for three years only or less. Further the banks selected for this study are listed banks with publically available annual reports from their web sites. All the bank specific data is retrieved from SNL financials and cross-validated with annual reports of the sample banks and the macroeconomic data is retrieved from the World Bank database (Please refer to http://data.worldbank.org/indicator for data on macroeconomic variables of each country). Table 2 shows the name of the countries and the number of Islamic banks selected from each country.

Table 2: Complete sample of banks and observations

No.	Country	Bank number	Observations
1	Bahrain	7	66
2	Bangladesh	6	57
3	Indonesia	9	57
4	Kuwait	5	38
5	Malaysia	17	128
6	Pakistan	4	36
7	Qatar	4	32
8	Saudi Arabia	4	34
9	Sudan	3	16
10	Turkey	4	33
11	UAE	5	40
Total		68	537

Source: Authors' own illustrations based on SNL financial database and banks annual reports.

4. Empirical Analysis

This section is divided into two parts. In the first part reports descriptive statistics of the variables. The second section discusses the results obtained from 2-step system GMM estimation technique.

4.1 Descriptive Statistics

Table 3 shows the descriptive statistics of the variables used in our model.

Table 3: Descriptive statistics of the Variables

Variable	Mean	Std. Dev	Minimum	Maximum
NSFR	136.0445	58.79097	65.64	854.39
CAR	20.41041	16.41996	-2.84	204.41
NII	34.34773	25.60241	-207.69	159.74
ROAA	1.259106	1.791923	-7.42	11.5
CIR	55.46497	32.6982	10.1	467.49
SPEC	58.17557	15.36993	3.87	91.41
MP	2.903073	4.37021	0.01	31.16
SIZE	14.85754	1.384819	10.84	18.22
RWATA	70.21516	19.10673	24.83	156.09
CPI	5.478305	5.480114	-4.89	37.39
GDP	5.105829	3.689343	-7.1	26.17

Source: Authors' calculation

According to the table, NSFR variable shows the highest mean value of 136.0445 while ROAA variable has recorded the minimum average value of 1.259106. The mean value of CAR (i.e., 20.41041) shows that Islamic banks exceeded their capital regulatory requirements. Moreover, the cost efficiency in Islamic banks is quite low with a reported average CIR value of 55.46497. A low average value of NII also suggests that Islamic banks are not actively involved in diversified activities which is supported by the average value of SPEC variable (i.e., 58.17557) whereby these banks are more involved in lending activities. The macroeconomic indicators show that the average economic growth (i.e., 5.105829) in the sample countries is close to the average increase in their inflation rate (i.e., 5.478305).

With regards to the standard deviation, NSFR variable recorded the highest value of 58.79097. This shows that the sample banks are not consistent in maintaining their stable funding ratio. Small data dispersion exists for the SIZE variable. Among the macroeconomic variables, CPI variable shows more variation with a value of 5.480114 as compared to the GDP variable with a standard deviation of 3.689343.

4.2 Econometric Analysis

This study applies Fisher-type Augmented Dickey-Fuller test for dynamic heterogeneous unbalanced panel dataset to test whether the variables of concern are stationary as suggested by Choi (2001). The following stochastic process y_{it} is produced by the first order autoregressive process below:

$$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{k} \beta_{ij} \Delta y_{it-j} + X_{it}\delta + \varepsilon_{it} \quad (6)$$

$H_0: \beta_i = 0$; for all i

$H_1: \beta_i < 0;\ i = 1,2,\ldots\ldots,N$

We assumed '$\alpha = \rho - 1$', however the lag order for the difference term allows ρ_i to have different values across the units. The null hypothesis of a unit root is rejected if $\beta_i = 0$ in favour of the alternative that the variable is stationary. The test results provide no evidence of unit root in any of the variables. Hence, all the variables are stationary. Test statistics of unit root test for all the variables are shown in Appendix 1. We further examined whether individual effects are fixed or random. To choose between the fixed or random effect models, we applied Hausman test. The null hypothesis of the difference in coefficients between fixed and random is systematically rejected at 10% significance level, providing support for fixed effects model (see Appendix 2 for the Hausman Test). However, as discussed earlier, in a dynamic arrangement where lagged dependent variable is present among explanatory variables, the least squares (within) estimator of the fixed effects model is both biased and inconsistent (Judson and Owen, 1999). To get the unbiased and more consistent estimators, our study applied 2-step system GMM estimation technique.

4.3 Estimation Results

Table 4 reports the estimation results of equations (3) using 2-step system GMM dynamic panel data estimation technique. The diagnostic tests indicate that the model is appropriate for our analysis. Hansen J-statistics for identifying restrictions tests the null hypothesis of valid instruments. The statistically insignificant J-statistics shows no evidence of over-identifying restrictions and confirms the validity of instruments. Moreover, insignificant AR (2) errors indicates the absence of second order correlation which implies that the estimates are consistent (Arellano and Bond, 1991).

Table 4: Estimation results of complete sample based on Net Stable Funding Ratio ($NSFR_{it}$) as dependent variable using two-step System GMM Model

Variables	**Full Sample**
$NSFR_{it-1}$	0.2530016 *** (.0956262)
CAR_{it}	1.466887 *** (.5511233)
$SPEC_{it}$	-1.578258 * (.9377068)
$RWATA_{it}$	-.5270011* (.2767585)
NII_{it}	-.1033712 (.0949015)
$ROAA_{it}$	6.209884 (5.156127)
$SIZE_{it}$	11.82572 *** (3.537805)
CIR_{it}	.2983415 (.2974039)
MP_{it}	-1.711521 ** (.7245081)
GDP_t	1.205907 * (.6783894)
GDP_{t-1}	-1.249424 * (.6482575)
CPI_t	-1.743159** (.7608099)
CPI_{t-1}	3.129818** (0.5401461)
Model fit	
F-Statistics	F(13,68)=262.98 (p-value = 0.000)
AR(2) test stat	-0.18 (p-value = 0.856)
Hansen *J*-stat	37.75 (p-value = 0.616)
Observations	465
No. of Banks	68

***, ** and * indicates significance level at 1%, 5% and 10%, respectively.
Robust standard errors are in parenthesis.
Source: Authors' calculations

In our complete sample, the estimation results are mostly in line with our expectations. The high value of net stable funding ratio means low maturity transformation risk, but these results have to be interpreted in reverse: positive sign of the coefficient shows negative impact on the exposure to maturity transformation risk. The coefficient of the lagged dependent variable at one percent significance level, confirms the dynamic specification of the model, which implies that banks' current exposure to maturity transformation risk is moderately effected by its available stable funding from previous years. Among the explanatory

variables, the coefficients of mostly bank-specific factors including bank capital, credit risk, specialization and market power show the expected signs and confirm our hypotheses. Bank capital (CAR) shows a highly significant and inverse relationship with maturity transformation risk in Islamic banks. The results are in line with the financial fragility hypothesis (Diamond and Rajan, 1999) and crowding out effect (Gorton and Winton, 2000). Due to the restrictions in refinancing and limited access to interbank market, Islamic banks require to maintain additional capital to buffer against defaults, which lower their liquidity creation function resulting in a decreased exposure to maturity transformation risk. The findings are also consistent with the theoretical notion that banks with higher equity capital are involved in less risky investments. The results show that a 1% increase in bank capital reduces the maturity transformation risk exposure by 1.46% in Islamic banks.

Our results also show a negative relationship between bank size (ln_TA) and maturity transformation risk at 1% significance level. This is consistent with the previous literature that shows liquidity increases with bank size (Bunda and Desquilbet, 2008; Delechat et al., 2012; Rauch, Steffen, Hackethal, and Tyrell, 2009a). This suggests large Islamic banks are more prudent in managing their liquidity position. Another possible explanation could be that as Islamic banking is showing exponential growth through continuous increase in the number of branches, accounts and invested capital (Khan, 2010) banks tend to hold enough liquidity to meet additional operational costs and are not aggressively involved in lending activities.

Among other explanatory variables, credit risk, specialization and market power show significant and positive impact on maturity transformation risk. The negative coefficient of credit risk (RWATA) implies that banks with higher risk weighted assets tend to reduce their liquidity creation and hold more liquidity to meet any unexpected claims from their customers. A 1% increase in credit risk will increase maturity transformation risk by approximately 0.52%. This finding is consistent with the risk aversion characteristic of highly capitalized banks.

The specialization (SPEC) variable also presents a significant and positive impact on maturity transformation risk. Islamic banking is mainly involved in basic banking function of intermediation and banks with larger financing portfolio are more exposed to maturity transformation risk. Our result also supports the findings of Berger and Bouwman (2009) where the authors contested that banks are exposed to intrinsic risk while performing their primary role of liquidity creation.

Our results also show a statistically significant and positive impact of bank market power (MP) on maturity transformation risk in Islamic banking. In consistent to the findings of Petersen and Rajan (1995), Islamic banks with greater market power enjoy more ease of access to external funding sources which enables them to earn more profits through accelerated liquidity creation function. However, while doing so, they are exposed to higher level of maturity transformation risk.

Our study also finds significant effects of both the macroeconomic factors i.e., economic growth (GDP/capita) and inflation (CPI). The sign on the coefficient of current period GDP/capita is surprisingly positive which is contradictory to the theoretical notion of increased lending activities of financial intermediaries during economic booms. However, the one-year lagged economic growth variable shows that banks' exposure to maturity transformation risk increases by approximately 1.25% with a 1% change in economic growth. The results are consistent with the fact that most of the Islamic banks are operating in developing countries with not much advanced capital markets. Banks are also not efficient enough to capture the increased lending opportunities during times of economic boom. Further the current CPI shows a significant and negative impact on maturity transformation risk at 5% significance level. This implies that with increased inflation, overall customers borrowing demand decreases that reduces banks' lending opportunities effectively reducing their exposure to maturity transformation risk. Whereas the significant and positive influence of one-year lagged inflation seems to be because of deteriorated economic condition which can increase borrowing demand, hence providing incentive for the banks to increase their liquidity creation function, thereby increasing their exposure to maturity transformation risk.

Our estimation results show no significant effect of non-interest income on maturity transformation risk in Islamic banking. However, the negative sign of the coefficient follows the view of Busch and Kick (2009) who found that banks which are heavily involved in non-interest income activities have shown significantly more volatile returns that leads to increased banks risk. We also find no significant evidence of the impact of banks profitability (ROAA) and efficiency (CIR) on maturity transformation risk in Islamic banks.

4.4 Robustness analysis

The sample is further divided based on size and geography to check the consistency of our findings for the complete sample. We use the median to split the sample banks into large and small banks to capture the effectiveness of our model with respect to size, in determining various factors influencing maturity transformation risk in Islamic banking. We also split the sample into Gulf Cooperation Council (GCC) and Non-GCC countries to control for the heterogeneity in macroeconomic state in these countries. Appendix 3 provides the details on the size and geographic distribution of our sample.

Table 5: Estimation results of sample banks based size distribution with Net Stable Funding Ratio ($NSFR_{it}$) as dependent variable using two-step System GMM Model

Variables	**Large Banks**	**Small Banks**
$NSFR_{it-1}$	.3809089** (.1766316)	.2971108* (.1682822)
CAR_{it}	1.190735** (.5529575)	1.020346** (.4393712)
$SPEC_{it}$	-.9523759** (.4226482)	-1.915168*** (.6676048)
$RWATA_{it}$	-.3774155** (.1826505)	-.1703714 (.5042639)
NII_{it}	.1061902 (.1529943)	.2352416 (.7387831)
$ROAA_{it}$	1.811503 (2.406254)	7.716051* (3.977215)
$SIZE_{it}$	8.637472*** (2.893073)	13.6287*** (3.965445)
CIR_{it}	-.1253263 (.1459242)	.058192 (.209757)
MP_{it}	-.850238* (.4626868)	-5.267119 (4.692247)
GDP_{t}	1.070313** (.5370787)	-.3233111 (1.30959)
GDP_{t-1}	-1.218315** (.5369439)	.3672133 (3.166804)
CPI_{t}	-1.245204** (.5414392)	-.18461 (1.557341)
CPI_{t-1}	3.226988*** (1.017579)	-1.196693 (2.299515)
Model fit		
F-Statistics	F(13, 40) = 762.32 (p-value = 0.000)	F(13, 42) = 131.36 (p-value = 0.000)
AR(2) test stat	0.27 (p-value = 0.783)	-0.41 (p-value = 0.683)
Hansen *J*-stat	25.94 (p-value = 0.522)	21.35 (p-value = 0.770)
Observations	224	215
No. of Banks	40	42

***, ** and * indicates significance level at 1%, 5% and 10%, respectively.
Robust standard errors are in parenthesis.
Source: Authors' calculation

Table 6: Estimation results of sample banks based geographical distribution with Net Stable Funding Ratio ($NSFR_{it}$) as dependent variable using two-step System GMM Model

Variables	**GCC Banks**	**Non-GCC Banks**
$NSFR_{it-1}$	-.4238097** (.1762076)	.5055221***
		(.0869493)
CAR_{it}	2.937245** (1.209715)	1.721522**
		(.6782753)
$SPEC_{it}$	-1.584424** (.6899258)	-1.004441*
		(.5315519)
$RWATA_{it}$	.1664815	.054764
	(.2785285)	(.6720141)
NII_{it}	.4623922	.2887484
	(.283069)	(.756142)
$ROAA_{it}$	.2093823	-.5785841
	(2.834131)	(5.145433)
$SIZE_{it}$	13.35134*** (3.572459)	5.445471***
		(1.610611)
CIR_{it}	-.1606043	.2522561
	(.1393556)	(.3393645)
MP_{it}	-3.237078*** (.6093322)	3.36147
		(2.901461)
GDP_{t}	-1.207131 (.8186946)	-.9753639
		(.9936247)
GDP_{t-1}	1.669466*** (.5452818)	-.7541958
		(1.96494)
CPI_{t}	-.8001429	-1.641371*
	(.8460803)	(.9299568)
CPI_{t-1}	2.995186***	.8348789
	(.8638574)	(2.077464)
Model fit		
F-Statistics	F(13, 25) = 262.98	F(13, 43) = 197.91
	(p-value = 0.000)	(p-value = 0.000)
AR(2) test stat	-0.18	-0.84
	(p-value = 0.856)	(p-value = 0.400)
Hansen *J*-stat	5.12	3.59
	(p-value = 0.954)	(p-value = 0.609)
Observations	184	281
No. of Banks	25	43

***, ** and * indicates significance level at 1%, 5% and 10%, respectively.
Robust standard errors are in parenthesis.
Source: Authors' calculation

Majority of the results in Table 5 and 6 are consistent with our findings of the complete sample estimates. Among bank characteristics, capitalization, specialization and size show significant impact on maturity transformation risk in all split banks. The signs are also consistent with those of our complete sample results, further strengthening our findings. The opposite sign on lagged dependent variable in GCC sample confirms the heterogeneity in the overall economic conditions in the sample countries. It seems that GCC countries have much better access to external sources of funding than others. Because of this funding availability, GCC banks with higher amount of stable funding in previous years, are aggressively involved in their liquidity creation function, which leads to an increased exposure to their maturity transformation risk. For the full sample banks we are unable to establish any evidence for the effect of return on assets, cost to income ratio and non-interest income on maturity transformation risk in the Islamic banking system. Among the macroeconomic variables, current and lagged value of both GDP/capita and inflation shows significant effect in large banks, but neither of these factors provides any evidence of their impact on maturity transformation risk in the small banks sample.

5. Conclusions

The aim of this study is to analyze the effect of various factors on maturity transformation risk in Islamic banking system. Following Basel III guidelines to measure the maturity transformation risk, we applied dynamic panel data technique on sample of 68 full-fledged Islamic banks. We draw the following conclusion based on the results found by utilizing 2-step system GMM technique.

Bank capital and size have a significant and negative impact on maturity transformation risk. The results are consistent even after the sample is split into large and small banks as well as on geographical distribution. On the other hand, bank specialization also shows significant impact on maturity transformation risk in the full sample banks, but in inverse direction.

Among the macroeconomic variables, both GDP/capita and inflation significantly affect the maturity transformation risk in Islamic banks in GCC and large banks samples. However, we could not find any evidence for the influence of bank diversification, cost efficiency and profitability in determining maturity transformation risk.

This study presents some important policy implications. First, does increased regulatory capital requirements reduce banks' exposure to maturity transformation risk? Our results show that higher capital adequacy ratio helps in minimizing banks' transformation risk at all levels. This validates the new improved capital requirements of Basel III accord for better management of Islamic banks' liquidity. Furthermore, the positive impact of bank specialization on maturity transformation risk suggests that regulators and practitioners should closely monitor the financing activities and implement more prudent practices while issuing loans to customer in consistent with their financing policies. Moreover, the significant effect of both the macroeconomic factors also provide insight to the authorities to better adapt to the economic cycles and implement relevant policy changes to maximize their benefits.

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APPENDIX 1. Fisher-type Augmented Dicky-Fuller Test for Stationarity

Table 1.A. Test statistics of unit root analysis

	χ^2	p- value
NSFR	39.3027	0.0000
NII	35.3311	0.0000
CAR	28.2978	0.0000
ROAA	22.7046	0.0000
CIR	30.5659	0.0000
SPEC	24.4514	0.0000
SIZE	26.8853	0.0000
RWATA	23.8312	0.0000
MP	6.2941	0.0000
CPI	32.9373	0.0000
GDP	14.0817	0.0000

Source: Authors' calculation

APPENDIX 2. Choice of Fixed or Random Effects Model

Table 2.A.: Hausman Test

hausman Fixed Random

	-------- Coefficients --------			
	(b) Fixed	(B) Random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
car	1.890979	1.7505	.1404795	.0702162
spec	-2.110512	-1.939519	-.1709923	.101733
nii_oi	.1392868	.1202912	.0189957	.0345102
rwata	-.1228469	-.1742789	.051432	.0512819
marketshare	1.076752	-.9389296	2.015681	1.682279
ln_ta	5.686423	5.025029	.6613939	2.48578
roaa	-1.366264	-1.209237	-.1570273	.3329429
cir	-.1008442	-.1140873	.0132431	.0199984
cpi	.2831698	.018463	.2647068	.2559707
gdp	-1.310957	-1.060725	-.2502316	.1324375

χ^2 (11) = 17.95
Prob >χ^2 = 0.0829

APPENDIX 3. Geographical and size distribution of sample

Table 3. A.: Geographic distribution of the sample and observations

No.	Country	Bank number	Observations
GCC countries			
1	Bahrain	7	66
2	Kuwait	5	38
3	Qatar	4	32
4	Saudi Arabia	4	34
5	UAE	5	40
Sub- total		25	210
Non-GCC countries			
1	Indonesia	9	57
2	Bangladesh	6	57
3	Malaysia	17	128
4	Pakistan	4	36
5	Sudan	3	16
6	Turkey	4	33
Sub- total		43	327

Table 3. B: Size distribution of the sample and observations

No.	Country	Bank number	Observations
Large Banks			
1	Bahrain	3	17
2	Bangladesh	2	8
3	Indonesia	2	9
4	Kuwait	4	31
5	Malaysia	13	73
6	Pakistan	1	2
7	Qatar	4	27
8	Saudi Arabia	4	33
9	Turkey	4	30
10	UAE	5	38
Sub – total		42	268
Small Banks			
1	Bahrain	7	49
2	Bangladesh	6	49
3	Indonesia	9	48
4	Kuwait	2	7
5	Malaysia	12	55
6	Pakistan	4	34
7	Qatar	3	5
8	Saudi Arabia	1	1
9	Sudan	3	16
10	Turkey	3	3
11	UAE	1	2
Sub – total		51	269