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PRIMARY RESEARCH

Liquidity Management by Islamic Banks in Pakistan: An Econometric Analysis

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Abstract. This paper investigates different liquidity management aspects of Islamic banking industry in Pakistan. Islamic banking liabilities (deposits) and assets models, with regard to liquidity management, have found the significant role of following variables: (a) returns on deposits, (b) returns on financing, (c) costs of banking operations, and (d) the Interbank rate, here Karachi Interbank Offer Rate (KIBOR). Islamic banking liquidity reserves model, however, recommends that Islamic banks need to consider following variables, while developing optimum liquidity reserves: (a) total Islamic financing, (b) returns on financing, and (c) KIBOR. Moreover, the resilience analysis of the Islamic banking industry carried out in the current study suggests that liquid instruments performed well historically in mitigating liquidity run conditions. Furthermore, forecasts made on the basis of Autoregressive Integrated Moving Average (ARIMA) models for the current study suggest that tier-2 liquid instruments would possibly be performing well in mitigating any future liquidity run conditions (up to 95% of deposits). However, in case of tier-1 liquid instruments, there is a possibility of liquidity mismatches when liquidity withdrawals exceed the limit of 55% of deposits. In conclusion, Islamic banking depositors, besides their religious motives of supporting Islamic banks, expect from their banks to earn profits and pay competitive returns on their deposits. Therefore, Islamic banks need to make prudent portfolio financing so as to pay competitive returns to their depositors.

KAUJIE Classification: H13, L31, L32
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INTRODUCTION

Liquidity management means strengthening a bank's ability to meet all its financial obligations on its liability side, as well as, seizing all the investment opportunities on its assets'

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side, without incurring any unexpected losses (Basel Committee, 2008). According to Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI's) Sharī'ah standard on liquidity management, liquidity refers to the money and other financial assets that are easily convertible into money; whereas, liquidity management, in case of a bank, refers to the realization of an appropriate and befitting balance between liquidity's acquisition, at the best price in the shortest possible time, and liquidity's investment and/or employment in the best possible manner (AAOIFI, 2014).

A bank requires liquidity to accommodate every fluctuation, expected as well as unexpected, of its balance sheet. That is, a bank is required to have ample liquid funds: (a) to fulfil depositors' withdrawal demands without any delay; (b) to pay maturing liabilities; (c) to fulfil financing demands by entrepreneurs; and (d) to rebalance the investment portfolio (Saiti, Hasan, & Engku-Ali, 2016). A bank will be experiencing the liquidity risk, which is the spectre haunting the banking industry, when it would not receive liquid funds in times of dire needs, except with difficulty and at high costs (Wahyudi, Rosmanita, Prasetyo, & Putri, 2015).

Despite impressive development of Islamic finance over last three decades, a complete Islamic financial system, with its distinctive financial instruments and financial markets, is still in early stages of evolution. It is pertinent to note that Islamic banking system is comparatively well-developed; while, Islamic capital and money markets are at their infancy stages and experiencing a shortage of Sharī'ah compliant tools used in both mobilization and utilization of funds (Ahmed, 2011; Zaher & Hassan, 2001). According to some recent estimates, total assets held by the Islamic financial institutions worldwide are about USD 1.8 trillion (Rizvi & Alam, 2016). Whereas, the total assets held by Pakistan-based Islamic financial institutions have reached to about PKR 1.7 trillion (SECP, 2015).

Roots of Islamic finance can be traced back to the early Islamic history and beyond. It is reported that trade and commerce in the Medieval Islam were carried out on the basis of partnership (*mushārakah*), commenda (*muḍārabah*), credit sale (*bai' al-mu'ajjal*), advance payment sale (*bai' al-salam*), and benevolent lending (*qarḍ al-ḥasan*) (Goitein, 1971; Udovitch, 1970). It is worth mentioning here that Islamic financial system is prohibition-driven. According to Ibn-e-Taymiyya (d. 728 A.H./1328 A.D.), two prohibitions, that of *ribā* (interest) and *gharar* (uncertainty with regard to the subject matter and the price in contracts), can distinguish between financial contracts that are valid or void (El-Gamal, 2006). The aforementioned prohibitions, along with the prohibition of *maysir* (gambling-like speculations) and regard for others' interests while pursuing material gains, are central to the Islamic economic teachings (Siddiqi, 2006; 2009).

It is advocated by Islamic economists that: since, Islamic finance is based on real economic activities, and devoid of excessive leverages and imprudent risk taking; therefore, it has the ability to correct the structural flaws of the conventional finance due to which financial crises have been occurring time and again (SBP, 2015). Quaid-e-Azam Muhammad Ali Jinnah, Muslims can fulfil their mission of giving humanity a message of peace only by the development of banking practices in the light of Islamic principle of socio-economic justice he rejected the western economic theory and finance system and emphasized Muslims to present an Islamic economic system promoting equality and socio-economic justice[1].

According to financial intermediation theory, the maturity transformation of short-term, liquid deposits into long-term, illiquid loans (financing in case of Islamic banks) is the fundamental role of banks, which inherently makes banks vulnerable to liquidity risk (Basel Committee, 2008; Berger & Bouwman, 2009). The primary aim of the research paper is to analyse econometrically different liquidity management aspects of Islamic banking industry in Pakistan. The aim is further broken down into the following two objectives: (i) to identify factors that influence Islamic banks in managing liquidity on liability as well as asset sides and in maintaining the optimum liquidity reserves; and (ii) to investigate the resilience of the Pakistan-based International Banking Facility (IBF) industry against certain liquidity pressures.

The rest of the paper is organised as follows: Section 2 provides a brief literature review on liquidity management by banking institutions, while section 3 explains the research methodology of the current study. Afterwards, section 4 analyses econometrically different liquidity management aspects of Pakistan-based IBF industry and develops econometric models, and finally, section 5 concludes the paper.

LIQUIDITY MANAGEMENT BY ISLAMIC BANKS

Islamic finance has a long history going back to the early days of Islam and its theories are derived from revealed texts. Islam encourages its believers to conduct trade and business being fair, honest and just towards others. It is pertinent to note that prohibitions of *ribā* and *gharar* most importantly differentiate Islamic business and commerce from western commercial transactions (Venardos, 2012).

It has been reported that the Prophet (S.A.W) himself participated in *muḍārabah* contracts as *muḍārib*, while capital providers (*rab al-māl*) were his wife and others. Moreover, his companions of such as Umar (R.A) and Usman (R.A), used to invest funds belonging to orphans on the basis of *muḍārabah*. It is also reported that Muslim traders were using financial instruments-*ṣukūk*-in order to mitigate risks involved (theft or loss of money) in carrying money on long commercial journeys between Islamic world and East Asia (Jamaldeen, 2012).

Financial intermediation in the medieval Islamic world was closely tied to commercial activities. It is pertinent to note that *ṣarrāf* (goldsmiths and money exchangers) of that time were supporting commercial activities by undertaking various traditional functions of a modern financial institution, such as, operating secure cross-border payment systems through *ṣukūk* issuance (Udovitch, 1981). Interestingly, *ṣarrāf* were operating through organized networks that established them as intermediaries of the medieval period (Chapra & Ahmed, 2002). It has also been reported that some of the contracts, concepts and institutions developed in the medieval Islamic world of late eighth century provided foundations for the

[1]For details, see the inaugural address of Quaid-e-Azam Muhammad Ali Jinnah available at: www.sbp.org.pk/about/history/h_moments.htm

development of similar contracts and instruments in the Western world several centuries later (Udovitch, 1970).

Islamic banks typically attract funds in the form of: (a) Current Accounts deposit holders; and (b) unrestricted Investment Account Holders (IAHs). It is pertinent to note that C/As and some demand deposits are in the form of *qard al-ḥasan* or *wadī‘ah* to Islamic banks, which can be withdrawn anytime. For the purpose, Islamic banks need to maintain a sound repayment capacity to meet fully the cash withdrawals by demand deposit holders. Unrestricted investment accounts, on the other hand, are investments made by IAHs on the basis of *bai‘ al-mu’ajjal*. Therefore, IAHs share in profits and losses (Al-Amine, 2013; Central Bank of Oman, 2012; Iqbal & Mirakhor, 2011; Vogel & Hayes, 1998).

Liquidity management is a shared responsibility of Islamic banks and their regulators, i.e., central banks. Islamic banks, like conventional banks, generally maintain their liquidity positions to such an extent that facilitate them in: (a) meeting their commitments; (b) maintaining required reserves; and (c) seizing all the investment opportunities-while remaining solvent and profitable. It is important here to realize that liquidity and solvency-in case of banks (whether Islamic or Conventional)-are interlinked: an illiquid bank may soon become insolvent, while, an insolvent bank is illiquid, and therefore, causes the financial instability. Central banks, on the other hand, are equally responsible for liquidity management of banks, in order to: (a) ensure an efficiently stable banking system; (b) ensure the smooth interbank payment settlements; and (c) maintain a level of liquidity in the banking system that is consistent with the central bank's monetary policy targets (Ganley, 2004; Kahf & Hamadi, 2014).

Islamic banks worldwide rely heavily on *ṣukūk*-an Islamic alternative to conventional bonds-for the liquidity management purposes. It is pertinent to note that the demand for *ṣukūk* is much greater than their availability. This demand-supply gap of *ṣukūk* has left no other choice for Islamic bankers to use Commodity *Murābaḥah*-as a liquidity management instrument. Commodity *Murābaḥah* (based on *tawarruq*) is controversial in terms of its Sharī‘ah permissibility. Some contemporary Sharī‘ah scholars have opined that Commodity *Murābaḥah* should only be used in extreme emergency only to avoid dealing in interest (Usmani, 2015). However, Kahf and Hamadi (2014) argued that the commodity *Murābaḥah* is not permissible since this transaction involves an organized banking *tawarruq*, which is not permitted in the Sharī‘ah perspective as resolved by the Organisation of Islamic Cooperation (OIC) *Fiqh* Academy.

Pakistan, with the world's 2nd largest Muslim population, is the first Muslim country where, during 1950s, an Islamic mutual savings bank was established by religious-minded landlords to provide agricultural finance to poor farmers (Asutay, Aysan, & Karahan, 2013; Siddiqi, 2006), while, the Islamisation process of the whole economy was initiated in late 1970s. But such a challenging task still remains incomplete due to lack of interest of different stakeholders, apart from some other reasons. In the meanwhile, Iran and Sudan got established their interest-free banking systems. As per the amended policy, in Pakistan, the first Islamic bank was given the license and became operational in 2002 (Beseiso, 2014; Khan & Bhatti, 2008; Farooq & Zaheer, 2015).

Presently, there exists a dual banking system in Pakistan, where conventional and Islamic banks coexist and compete with each other. It is worth mentioning here that, during the financial panic of 2008, Pakistan-based Islamic banks experienced fewer deposit withdrawals as compared to their conventional counterparts; even some Islamic banks recorded deposit increases, which lead to a net deposits' inflow into Islamic banks. Thus, Islamic banks have shown superior performance, greater resilience, and at the same time, ability to inject liquidity into the real economy during times of financial distress as well (Farooq & Zaheer, 2015).

In a recent study titled, "Knowledge, Attitude, and Practices of Islamic banking in Pakistan" (KAP-study), jointly conducted by State Bank of Pakistan (SBP) and Department for International Development (DFID), U. K., an overwhelming demand for Islamic banking has been identified in the Pakistan. The findings of the KAP-study further reveal that Islamic banking demand is higher amongst households (95%) as compared to businesses (73%). Moreover, 88.41% Banked and 93% Non-Banked respondents of the KAP-study considered that the interest charged and given by banks is the prohibited *ribā* (SBP, 2014).

After the re-launch since 2002 Islamic banking, with the full support of the government, has now become the fastest growing segment of the Pakistan-based banking industry. There is a widespread agreement among the academicians and practitioners of Islamic banking and finance in Pakistan that finding an innovative, Sharī'ah compliant solution to the liquidity management challenge of Islamic banks, together with increasing the awareness in the country regarding the Islamic banking model, are the two important tasks ahead (Russell-Walling, 2014).

In Pakistan, Islamic banks are required to maintain the same Cash Reserve Requirement (CRR). However, the Statutory Liquidity Requirement (SLR) for Islamic banks has been set differet from that of conventional banks since 2017. Conventional banks have opportunities of investing in Pakistan Investment Bonds (PIBs) as well as treasury bills (T-bills). Islamic banks on the other hand, are lacking a Sharī'ah-compliant alternative of T-bills (Alam, 2014). Under such circumstances, Pakistan-based Islamic banks rely heavily on *ṣukūk* for investing their excess liquidity. *Ṣukūk* are also held by Islamic banks for SLR purposes. According to some recent estimates, total *ṣukūk* issued in Pakistan amount to nearly PKR 695 Billion (Saheed, 2014), which are not enough to meet the Islamic banks' demand.

Islamic banks in Pakistan generally use two interbank *mushārakah* and interbank *wakālah* for short-term liquidity placements. Some Islamic banks are also using Commodity *Murā bahah* for investing their excess liquidity.

RESEARCH METHODOLOGY

The research methodology of this paper is quantitative. The paper has developed econometric models that explain different liquidity management aspects of Pakistan-based IBF industry. For this purpose, secondary data has been collected from State Bank's website and Islamic banks' financial statements.

Quantitative research explains phenomena by collecting numerical data associated with the phenomena and analyse it using statistical methods (Aliaga & Gunderson, 2002). It typically involves: (i) formation of hypothesis from theory; (ii) collection of primary or secondary data associated with the social phenomenon under investigation; (iii) analysing the numerical data either statistically or econometrically in order to test the hypothesis; (iv) producing the research's output explaining the social phenomenon under investigation (Ismal, 2010).

ARDL Models

An ARDL model regresses a dependent variable over the present and past values of a set of independent variables along with the past values of the dependent variable (Fabozzi, Focardi, & Kolm, 2006). This paper uses ARDL approach to model Islamic banks' balance sheet, because of the following: (i) each variable of Islamic banks' balance sheet can possibly be functioning in an equation either as an independent variable or as a dependent variable; (ii) other than present values of independent variables, their time lags (past values) are also explaining the dependent variable in an ARDL model; and (iii) an ARDL model provides a vehicle for testing presence of long-run relationships among variables (Ismal, 2010)

ARDL models, estimated using Ordinary Least Squares (OLS), are most commonly used econometric tools for developing robust dynamic models. Other econometric tools, for the purpose of estimating robust dynamic models, require an extensive series of data that is not available in case of Islamic banks in Pakistan. It is mainly due to the reason that Pakistan-based Islamic banking industry is still in an evolutionary stage with limited data and information.

Time series data of Islamic banking variables, ranging between July 2006 and December 2016, is obtained from SBP's website and quarterly financial statements of Islamic banks in Pakistan. It is pertinent to note that the modelling process follows the following sequential steps in order to make robust dynamic models: (i) developing a theoretical model on the basis of literature review; (ii) selecting independent variables; (iii) selecting hypothetically signs of slope coefficients; (iv) collecting, inspecting and cleaning the data; (v) estimating the regression equation and evaluating it; and (vi) documenting regression results. (Studentmund, 2016).

ARIMA Models

ARIMA modelling techniques are being used in the current study to: (a) estimate models for variables related to Islamic bank's liquidity management by employing their historical data from July 2006 to December 2016; (b) to forecast expected values of aforesaid Islamic banking variables, by employing ARIMA models, from January 2017 to December 2019; and (c) to investigate the resilience of the Islamic banking industry under different liquidity withdrawal scenarios.

It is pertinent to note that ARIMA modelling approach combines two different processes, Autoregressive (AR) and Moving Average (MA), into a single equation. An AR process expresses a dependent variable Yt as a function of the dependent variable's past values, while, MA process expresses the dependent variable Yt as a function of the error term's past values (Studentmund, 2016).

An ARIMA (*p, d, q*) model can be expressed as follows:

$$Y_t = \beta_0 + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} \cdots + \theta_p Y_{t-p} + \varepsilon_t + \phi_1 \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2} \cdots + \phi_q \varepsilon_{t-q}$$

Where "*p*" refers to the number of AR terms, "*d*" denotes the number of times the time series is differenced before becoming stationary, and "*q*" refers to the number of MA terms.

According to the Box-Jenkin methodology, an ARIMA process consists of following four steps: (i) finding out the appropriate values of *p, d,* and *q*; (ii) estimating coefficients of AR and MA terms of the chosen model; (iii) checking whether the chosen model fits the data; and (iv) producing future forecasts on the basis of ARIMA models (Gujarati, 2004).

ECONOMETRIC ANALYSIS OF THE LIQUIDITY MANAGEMENT ASPECTS OF IBF INDUSTRY

Theoretical Construction of Models

Model of Banks' Behaviour in the Competitive Banking Sector

According to Ismal (2010), a bank's profit can be calculated by subtracting its asset side's revenues from its liability side's expenditures. That is:

$$\pi = r_L L + r_M - r_D D - C(D, L) \tag{1}$$

In the equation (1), "π" denotes bank's profit, "*rL*" denotes interest on loans, "*L*" denotes total outstanding loans, "*r*" is denoting the money market rate, "*rD*" denotes interest on deposits, "*D*" is denoting total deposits and "*C*" is the total costs in managing both deposits and loans. However, "*M*" is the bank's net money market position, which can be formulated as:

$$M = (1 - \alpha)D - L \tag{2}$$

In the equation (2), "α" is denoting the reserve coefficient set by a central bank as a cash reserve requirement.

When the two equations (1) and (2) are combined together, we get:

$$\pi(D, L) = (r_L - r)L + [r(1 - \alpha) - r_D]D - C(D, L) \tag{3}$$

A bank's maximum profit is the first order condition of equation (3). That is:

$$\frac{\partial \pi}{\partial L} = (r_L - r) - \frac{\partial C}{\partial L}(D, L) = 0 \text{ and } \frac{\partial \pi}{\partial D} = [r(1 - \alpha) - r_D] - \frac{\partial C}{\partial D}(D, L) = 0 \tag{4}$$

Aforementioned equations (3) and (4) are suggesting that any competitive banking institution will adjust the volume of loans and deposits in such a way that $(rL - r)$ and $[r(1 - \alpha) - rD]$ equals its marginal costs of banking operations. Consequently, an increase in "r_D" will entail a decrease in the bank's demand for deposits. Similarly, an increase in

"r_L" will entail an increase in the bank's supply of loans. In case, in an economy, there are N number of banks (*n = 1, 2, ..., N*). Each bank is characterised by a loan supply function $Ln(r_L, r_D, r)$ and deposit demand function $Dn(r_L, r_D, r)$. Let $S(r_D)$ is the savings function of households and $I(r_L)$ is the investment demand by firms. Let banking deposits and T-Bills are assumed to be the perfect substitutes for households. The competitive equilibrium of the banking sector will be characterised by the following three equations (Freixas & Rochet, 1999):

$$I(r_L) = \sum_{n=1}^{N} L^n(r_L, r_D, r) \quad \text{(loans market)} \quad (5)$$

$$S(r_D) = B + \sum_{n=1}^{N} D^n(r_L, r_D, r) \quad \text{(savings market)} \quad (6)$$

$$\sum_{n=1}^{N} L^n(r_L, r_D, r) = (1 - alpha) \sum_{n=1}^{N} D^n(r_L, r_D, r) \quad \text{(Interbank market)} \quad (7)$$

Where '*B*' is the net supply of T-bills. Equation (7) expresses the fact that aggregate position of all banks on the interbank market is zero ($M = 0$).

Let us assume that marginal costs of intermediation are constant ($C_L = \gamma_L$ and $C_D = \gamma_D$) then equations (5) and (6) can be replaced by a direct determination of 'r_L' and 'r_D', deduced from equation (4), such as: $r_L = r + \gamma_L$ and $r_D = r(1 - \alpha) - \gamma_D$.

Then the interest rate '*r*' on the interbank market is determined by equation (7), which can also be written as:

$$S(r(1 - \alpha)\gamma_D) - \frac{1 - (r + \gamma_L)}{1 - \alpha} = B \quad (8)$$

$$1(r + \gamma_L) = \sum_{n=1}^{N} L^n(r_L, r_D, r) = (1 - \alpha) \sum_{n=1}^{N} D^n(r_L, r_D, r) \quad (9)$$

Above mentioned equations fulfil the expected utility of investors. Equation (8), specifically, identifies that liquidity of a bank on its liability side is affected by reserve coefficient (α) and a change in the level of B through open market operations on the equilibrium level of interest rates 'r_L' and 'r_D'. On the other hand, investment demands from firms are influenced by money market rate and the costs of intermediation. Equation (9) identifies that liquidity of a bank on its asset side is influenced by a set of interest rates (r_L, r_D and, r), cost of intermediation, total deposits and the reserve coefficient.

Model of the Liquidity Reserves in Banks

Liquidity Reserves (R) of a bank include cash and its balances with the central bank as a CRR. A bank, therefore, advances credit to its customers equal to the difference between its deposits (*D*) and liquidity reserves (*R*), that is, DR. Referring to Ismal (2010), let the net amount of liquidity withdrawn by a bank is represented by the random variable '$\tilde{x}$'. When the realization '*x*' of '$\tilde{x}$' is greater than *R*, then the bank will experience shortage of liquidity and it has to pay a penalty $r_p(x - R)$ in proportion of the shortages.

In case, banking deposits are assumed as costless and risk free, then the expected profit of a bank can be calculated as under:

$$\pi(R) = r_L(D - R) + rR - r_p E[\max(0, \tilde{x} - R)] \tag{10}$$

Let expected costs of liquidity shortages are a convex function and the random variable '$\tilde{x}$' has a continuous density function f(x); then these liquidity shortages are differentiable. According to Freixas and Rochet (1999), C(R) denotes the expected cost of liquidity reserves, such that:

$$C(R) = r_p \int_R^{+\infty} (x - R) f(x) d(x) \tag{11}$$

$$C'(R) = -r_p \int_R^{+\infty} f(x) d(x) = -r_p \text{ Proba } [\tilde{x} > R] = 0 \tag{12}$$

$$C''(R) = r_p f(R) \geq 0 \tag{13}$$

(Note: $C(R)$ and $C(R)$ are the 1st and 2nd difference of $C(R)$).
According to Ismal (2010), a bank achieves the maximum profit, when:

$$\pi'(R) = -(r_l - r) + r_p \text{ Proba } [\tilde{x} \geq R] = 0 \tag{14}$$

Similarly, the optimum level of liquidity reserves ($R*$) can be found as follows:

$$\text{Proba } [\tilde{x} \geq R] = \frac{(r_L - r)}{r_p} \tag{15}$$

Equation (15) implies that the optimum level of liquidity reserves is that for which the marginal opportunity cost of holding reserves becomes equal to the expected cost of liquidity shortages (Freixas & Rochet, 1999).

Econometric Analysis

Liability, Asset, and Liquidity Reserves Models have been estimated econometrically on the basis of theoretical construction of these models by employing ARDL modelling approach. The aforementioned ARDL models will: (a) explain liquidity related behaviours of Islamic banking depositors as well as Islamic bankers; (b) identify those factors that can help in determining the asset-liability balance; and (c) identify factors that can help in determining the optimal liquidity reserves.

Definition of Variables and Model Specification

Liability Model: This ARDL regression model represents the liquidity behaviour of Islamic banking depositors. Total Islamic Deposits (TID) is the dependent variable of the model, which comprises demand, saving and term deposits of Islamic banking depositors. While, independent variables of the model, which are selected on the basis of equation (8), are given as under:

i. Total Return on Deposits (ROD) for Islamic banking depositors. It helps Islamic banking depositors in deciding either to add liquidity or withdraw it form Islamic banks.

ii. Total Return on Financing (ROF) earned by Islamic banks. It stands as an indicator of Islamic banks' performance and optimal portfolio management.

iii. Total Cost of Banking Operations (CBO). It stands as a performance indicator of robust Islamic bank.

iv. KIBOR used as a benchmark rate. If KIBOR is higher than ROD paid by Islamic banks, return-seeking Islamic banking depositors might transfer their funds from Islamic to conventional banks that could cause displaced commercial risk.

v. The lag of TID. This lag variable is representing the self-assessment of Islamic banking depositors regarding their prior investment decisions, and it also influences their liquidity behaviour as well.

TABLE 1
Descriptive statistics of the liability, asset & liquidity reserves models' variables

Variables	Mean	Median	St. Dev	Min	Max
TID*	613,290	492,000	456,548	66,011	1,573,000
Total Islamic Financing (TIF)*	266,861	195,250	195,255	52,621	821,000
Total Liquidity Reserves (TLR)*	53,100	39,473	35,678	12,165	133,460
ROD*	17,426	11,220	13,605	2,375	52,392
ROF*	33,203	22,405	26,108	4,560	99,766
CBO*	13,244	9,201	10,461	1,805	43,760
KIBOR**	10.53	10.18	2.52	6.04	15.52

*Million rupees; ** per cent

Asset Model

This ARDL regression model represents the Islamic banks' liquidity behaviour while dealing with entrepreneurs on their asset side. TIF is the dependent variable of the model. While, independent variables of the model, which are selected on the basis of equation (9), are given as under:

i. ROD received by Islamic banking depositors. This variable is considered by Islamic banks while making their portfolio financing decisions in order to retain the existing Islamic banking depositors as well as attracting new ones.

ii. ROF earned by Islamic banks. It stands as an indicator of Islamic banks' performance and a measure of the robustness of its portfolio financing decisions.

iii. CBO. This variable determines the profitability of Islamic banks.

iv. KIBOR used as a money market rate.

v. The lag of TIF. This lag variable is representing the assessment of Islamic banks' prior portfolio financing decisions, and it also influences their liquidity behaviour as well.

Liquidity Reserves Model

This ARDL regression model represents the optimal level of liquidity reserves of an Islamic bank and those variables that affect the optimum liquidity reserves. TLR is the dependent variable of the model, while, independent variables of the model, which are selected on the basis of equation (15), are given as under:

i. TIF, which influences the optimal level of liquidity reserves of an Islamic bank.

ii. ROF earned by Islamic banks. This variable is an indicator of Islamic banks robust portfolio financing and how attractive and competitive will be the profit sharing to Islamic banking depositors. This variable further explains liquidity behaviours of Islamic banks and their depositors.

iii. KIBOR used as a money market rate. This variable influences investment decisions of Islamic banking depositors.

iv. The lag of TLR. This lag variable influences Islamic banks' reserves. It contains the effect of penalty rate (r_p) in case of liquidity shortage below the required level of reserves and the opportunity cost of holding cash reserves.

Construction of the Liability, Asset and Liquidity Reserves Models

Stationarity Test: Since ARDL regression models are estimated using OLS estimation techniques, therefore, unit root tests are first of all applied to check the stationarity of each dependent and independent time series variable. For the purpose, Augmented Dickey and Fuller (1979) test is applied. It is interesting to note that Augmented Dickey and Fuller (1979) test investigates the unit root, and thus non-stationarity in time series variable. The basic idea of the unit root test is explained as follows with the help of a first-order autoregressive model AR (1):

$$Y_t = \mu + \rho y_{t-1} + \varepsilon_t \tag{16}$$

Where 'μ' and 'ρ'[2] are parameters and 'ε_t' is the white noise. Y_t is considered as stationary series, if ($-1 < \rho < 1$); similarly, If $\rho = 1$, Y_t is a non-stationary series. The null hypothesis of the Augmented Dickey and Fuller (1979) test is taken as (Ho: $\rho = 1$), which is tested against the alternate hypothesis (H1: $\rho < 1$).

Augmented Dickey and Fuller (1979) test is carried out by estimating an equation with Y_{t-1} subtracted from both sides of the equation (19):

$$Y_t - Y_{t-1} = \mu + \rho Y_{t-1} - Y_{t-1} + \varepsilon_t$$

$$\Delta Y_t = \mu + (\rho - 1)Y_{t-1} + \varepsilon_t$$

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \varepsilon_t \tag{17}$$

Where, ΔY_t is representing changes in the each dependent and independent variable of the Asset, Liability, and Liquidity Reserves models; and $\gamma = \rho 1$. Whereas, corresponding null and alternative hypotheses are, Ho: $\gamma = 0$ and H1: $\gamma < 0$.

[2]The parameter 'ρ' is the first-order serial correlation coefficient.

The test statistic of the Augmented Dickey and Fuller (1979) test is the *t*-statistic. The null hypothesis of a unit root can be rejected against the alternative, if the *t*-statistic is less than the MacKinnon (1991) critical values for rejection of the aforesaid null hypothesis; the time series under examination will then be stationary. Alternatively, the time series will be non-stationary, if the *t*-statistic is greater than the MacKinnon critical values. Akaike Information Criterion (AIC) is used for selecting the optimal lag length.

TABLE 2
ADF test statistics of liability, asset & liquidity reserves models' variables

$N = 42$	Level			1st Difference			2nd Difference		
	t-Stat.	Prob.*	Test Critical Values**	*t*-Stat.	Prob.*	Test Critical Values**	*t*-Stat.	Prob.*	Test Critical Values**
TID	2.322939	1.0000	-4.273277	-2.18822	0.4792	-4.284580	-4.84745	0.0027	-4.296729
			-3.557759			-3.562882			-3.568379
			-3.212361			-3.215267			-3.218382
TIF	0.429480	0.9985	-4.262735	0.736817	0.9995	-4.262735	-8.51669	0.0000	-4.262735
			-3.552973			-3.552973			-3.552973
			-3.209642			-3.209642			-3.209642
TLR	-3.56692	0.0454	-4.198503	-7.414310	0.0000	-4.211868	-5.31753	0.0007	-4.252879
			-3.523623			-3.529758			-3.548490
			-3.192902			-3.196411			-3.207094
ROD	-2.20056	0.4753	-4.226815	-3.692845	0.0354	-4.226815	-43.4265	0.0000	-4.226815
			-3.536601			-3.536601			-3.536601
			-3.200320			-3.200320			-3.200320
ROF	-2.08868	0.5349	-4.226815	-3.323780	0.0782	-4.226815	-47.6156	0.0000	-4.226815
			-3.536601			-3.536601			-3.536601
			-3.200320			-3.200320			-3.200320
CBO	-0.17284	0.9914	-4.219126	-3.105372	0.1200	-4.226815	-53.1206	0.0000	-4.226815
			-3.533083			-3.536601			-3.536601
			-3.198312			-3.200320			-3.200320
KIBOR	-1.88652	0.6433	-4.198503	-5.389357	0.0004	-4.205004	-5.503944	0.0003	-4.219126
			-3.523623			-3.526609			-3.533083
			-3.192902			-3.194611			-3.198312

* MacKinnon (1991) one-sided *p*-values
**Test Critical Values are basically MacKinnon (1991) critical values for rejection of null hypothesis, which are calculated at 1% level, 5% level, and 10% level respectively.

Augmented Dickey and Fuller (1979) test (with an intercept and trend model) statistics reveal dependent variables of Asset, Liability, and Liquidity Reserves models: (1) TID is non-stationary at level and 1st difference but stationary at 2nd difference; (2) TIF is non-stationary at level and 1st difference, but stationary at 2nd difference; and (3) TLR is non-stationary at level (1% statistical significance) but stationary at 1st difference. Moreover, independent variables of Asset, Liability, and Liquidity Reserves models: (1) ROD is non-stationary at level and 1st difference (1% statistical significance) but stationary at 2st difference; (2) ROF is non-stationary at level and 1st difference (1% & 5% statistical significances) but are stationary at 2nd difference; (3) CBO is non-stationary at level and 1st difference but are stationary at 2nd difference; and (4) KIBOR is non-stationary at level but stationary at 1st difference.

Since an ARDL model may include I (1) and I (0) variables (but not I (2) variables), therefore, the current study integrates all variables in order 1 (1st difference) to find the robust Asset, Liability and Liquidity Reserves models.

Estimation of ARDL Models Using Bounds Testing Approach to Cointegration: This thesis estimate ARDL models by using bounds testing approach to cointegration developed by Pesaran, Shin, and Smith (2001). ARDL bounds testing approach involves the following two steps (Pesaran & Pesaran, 2009). Firstly, a conditional Error Correction Model (ECM) is developed to examine the cointegration among time series variables of interest through an F-test, as follows:

$$\Delta Y_t = C + \pi_y Y_{t-1} + \pi_x Y_{t-1} + \sum_{i=1}^{p-1} \Psi \Delta Z_{t-i} + w \Delta X_t + \varepsilon_t \tag{18}$$

Where $Z_t(Y_t, X_t)$ Presence of the cointegration between the two time series variables X_t and Y_t can be checked by calculating the F-statistic for the null hypothesis ($H_0 : \pi_y = \pi_x = 0$). If F-statistic is greater than the upper bound I (1), then null hypothesis H0 can be rejected, and the alternative hypothesis of long run relationship in levels or cointegration between variables is accepted. If, however, F-statistic is less than the lower bound I (0), then null hypothesis H0 cannot be rejected. In case, the value of F-statistic falls between the lower and upper bounds, then results are inconclusive.

If the two time series variables X_t and Y_t are cointegrated, then ARDL model can be determined with optimal lags selected on the basis of Akaike Information Criterion (AIC) in the second step, as follows:

$$\Phi(L, p_0)Y = C_0 + \beta(L, q_1)X + \mu_t \tag{19}$$

Where

$$\Phi(L, p_0) = 1 - \Phi_1 L + \Phi_2 L^2 - \cdots - +\Phi_{p0} L^{p0}$$

And

$$\beta(L, q_1) = \beta_0 + \beta_1 L + \beta_2 L^2 + \cdots + \beta_{q1} L^{q1}$$

Here, L is the lag operator, such that: $L^i X = X_t - i$.

In the long run, we have $Y_t - Y_{t-1} = \cdots = Y_{t-p0}$ and $X_t - X_{t-1} = \cdots = X_{t-q1}$. Thus, we can derive the long run cointegration equation as follows:

$$Y = \alpha_0 + \beta^* X + v_t \tag{20}$$

Where

$$\alpha_0 = C_0/\Phi(1, p_0);\ \beta^* \beta(1, q_0);\ \text{and}\ v_t = \mu_t/\Phi(1, p_0)$$

Next, following Banerjee, Dolado, Galbraith, and Hendry (1993) a dynamic ECM for the short term relationship can be obtained by linearly transforming the ARDL model. This ECM model explains short run dynamics with the long run equilibrium without losing the long run information. Thus, equation (19) can be rearranged as follows to get the short term dynamics of the ARDL:

$$\Delta Y_t = \Delta\alpha_0 + \sum_{i=1}^{p0-1} \beta_{pi}\Delta Y_{t-i} + \sum_{i=1}^{q1-1} \beta_{qi}\Delta X_{t-i} + \gamma ECT_{t-1} + \mu_t \tag{21}$$

Here, the Error Correction Term (ECT_t) denotes the OLS residuals series from the long run cointegrating regression, which is given as follows:

$$ECT_t = Y_t - \alpha_0 - \beta^* X_t \tag{22}$$

In the equation (21), γ the coefficient of ECT_{t-1}, denotes the speed of adjustment, which suggests how quickly variables return to equilibrium. Importantly, 'γ' should be statistically significant and negative (Pak & Ku, 2017).

TABLE 3
ADF test statistics of liability, asset & liquidity reserves models' variables

ARDL Models	*F*-Bounds Test				*t*-Bounds Test			
	F-statistic	Sig.	Lower I(0)	Upper I(1)	*t*-Statistic	Sig.	Lower I(0)	Upper I(1)
Liability Model	10.97449	10%	3.03	4.06	-4.85291	10%	-3.13	-4.04
		5%	3.47	4.57		5%	-3.41	-4.36
		2.5%	3.89	5.07		2.5%	-3.65	-4.62
		1%	4.4	5.72		1%	-3.96	-4.96
Asset Model	35.80920	10%	3.03	4.06	-2.53123	10%	-3.13	-4.04
		5%	3.47	4.57		5%	-3.41	-4.36
		2.5%	3.89	5.07		2.5%	-3.65	-4.62
		1%	4.4	5.72		1%	-3.96	-4.96
Liquidity Reserves Model	16.51229	10%	3.47	4.45	-8.07883	10%	-3.13	-3.84
		5%	4.01	5.07		5%	-3.41	-4.16
		2.5%	4.52	5.62		2.5%	-3.65	-4.42
		1%	5.17	6.36		1%	-3.96	-4.73

Source: I (0) and I (1) asymptotic critical values are obtained from Pesaran et al. (2001)
Case 5: Unrestricted Constant and Unrestricted Trend.

Table 3 reveals: (a) In case of liability model, F-bounds test statistic is greater than the 1% critical value for the upper bound. Therefore, the hypothesis of "No Long-Run Relationship" is strongly rejected. This means that the dependent variable and the four regressors are cointegrated. Furthermore, the absolute value of t-bounds test statistic is greater than the 2.5% critical value for the upper bound. Therefore, the null hypothesis of the t-bounds test is rejected. Hence, the cointegration is not "Nonsensical". This means that the cointegrating relationship is either "usual" or it is "degenerate cointegration". (b) In case of asset model, F-bounds test statistic is greater than the 1% critical value for the upper bound. Therefore, the hypothesis of "No Long-Run Relationship" is strongly rejected. This means that the dependent variable and the four regressors are cointegrated. Furthermore, the absolute value of t-bounds test statistic is less than the 10% critical value for the lower bound. Therefore, the null hypothesis of the t-bounds test cannot be rejected. This means that the cointegrating relationship is "Nonsensical". (c) In case of liquidity reserves model, F-bounds test statistic is greater than the 1% critical value for the upper bound. Therefore, the hypothesis of "No Long-Run Relationship" is strongly rejected. This shows that the dependent variable and the three regressors are cointegrated. Furthermore, the absolute value of t-bounds test statistic is greater than the 1% critical value for the upper bound. Therefore, the null hypothesis of the t-bounds test is rejected. Hence, the cointegration is not "Nonsensical". This means that the cointegrating relationship is either "usual" or it is "degenerate cointegration".

In conclusion, cointegration between the dependent variables and regressors in the liability, asset, and liquidity reserves models have been identified. Therefore, the underlying ARDL models can now be established to investigate the long run slope-estimated coefficients and the short-run dynamic-estimated coefficients (Pak & Ku, 2017).

TABLE 4
ADF test statistics of liability, asset & liquidity reserves models' variables

ARDL Models	Variable	Coefficient Std.	Error	t-Statistic	p-value
Liability Model	D(ROD)	-1.235118	8.739515	-0.141326	0.8911
	D(ROF)	0.045116	4.935543	0.009141	0.9929
	D(CBO)	7.136819	9.343495	0.763828	0.4669
	D(KIBOR)	8949.219	7862.807	1.138171	0.2880
Asset Model	D(ROD)	-10.37344	13.05325	-0.794702	0.4343
	D(ROF)	1.758696	8.589283	0.204755	0.8394
	D(CBO)	24.62332	11.95876	2.059020	0.0501
	D(KIBOR)	-10961.52	7611.455	-1.440134	0.1622
Liquidity Reserves Model	D(TIF)	-0.036908	0.037291	-0.989730	0.3380
	D(ROF)	-1.600123	0.291504	-5.489192	0.0001
	D(KIBOR)	3831.974	1270.014	3.017269	0.0087

Source: I (0) and I (1) asymptotic critical values are obtained from Pesaran et al. (2001) for Case 5: Unrestricted Constant and Unrestricted Trend.

TABLE 5
Short run error correction estimates of ARDL (3, 4, 5, 5, 5) model

Dependent Variable: D(TID) (Case 5: Unrestricted Constant and Unrestricted Trend)			
Independent Variable	Coefficient	*t*-statistic	*p*-value
Constant	-4975.916	-1.255131	0.2449
Trend	2438.827	7.661414	0.0001
D(TID(-1))	0.657200	4.329086	0.0025
D(TID(-2))	0.969765	5.061428	0.0010
D(ROD)	1.996523	0.993472	0.3496
D(ROD(-1))	-8.638917	-3.233833	0.0120
D(ROD(-2))	-12.78015	-3.249548	0.0117
D(ROD(-3))	-7.475340	-2.106261	0.0683
D(ROF)	-1.120193	-0.985833	0.3531
D(ROF(-1))	5.018159	2.995356	0.0172
D(ROF(-2))	5.950740	2.340946	0.0473
D(ROF(-3))	2.125687	0.960049	0.3651
D(ROF(-4))	-1.970427	-4.190991	0.0030
D(CBO)	0.080961	0.036407	0.9718
D(CBO(-1))	-7.137212	-2.237163	0.0557
D(CBO(-2))	-1.526826	-0.448123	0.6660
D(CBO(-3))	3.598946	1.268418	0.2403
D(CBO(-4))	6.130394	3.518699	0.0079
D(KIBOR)	-85.32015	-0.040346	0.9688
D(KIBOR(-1))	-12975.22	-5.115744	0.0009
D(KIBOR(-2))	-11252.34	-4.185489	0.0031
D(KIBOR(-3))	-13539.56	-4.226890	0.0029
D(KIBOR(-4))	-6900.661	-2.925284	0.0191
ECTt-1	-1.506994	-9.072412	0.0000
Diagnostic Analysis	Value	*p*-value	
R-squared	0.995245		
Residual Sum of Square	1.00E+09		
AIC	21.31379		
F-Statistics	109.2109	0.0000	
Jarque-Bera Test	14.10160	0.0009	
Breusch-Godfrey Serial Correlation LM Test	0.067103	0.9358	
Heteroscedasticity Test: Breusch-Pagan-Godfrey	0.236394	0.9978	
Ramsey RESET Test	3.260103	0.1140	

TABLE 6
Short run error correction estimates of ARDL (1, 2, 2, 2, 1) model

Dependent Variable: D(TIF) (Case 5: Unrestricted Constant and Unrestricted Trend)			
Independent Variable	Coefficient	*t*-statistic	*p*-value
Constant	-1032.693	-0.281749	0.7805
Trend	188.6381	1.243207	0.2253
D(ROD)	0.092500	0.058182	0.9541
D(ROD(-1))	8.095180	5.004351	0.0000
D(ROF)	-0.732756	-0.792951	0.4353
D(ROF(-1))	-3.918659	-4.290403	0.0002
D(CBO)	4.995538	6.790088	0.0000
D(CBO(-1))	-3.704249	-5.264724	0.0000
D(KIBOR)	-2559.633	-1.789674	0.0856
ECTt-1	-0.457431	-14.41157	0.0000
Diagnostic Analysis	Value	*p*-value	
R-squared	0.953782		
Residual Sum of Square	3.05E+09		
AIC	21.52415		
F-Statistics	66.49630	0.0000	
Jarque-Bera Test	1.643627	0.4396	
Breusch-Godfrey Serial Correlation LM Test	0.695579	0.5090	
Heteroscedasticity Test: Breusch-Pagan-Godfrey	1.917215	0.0787	
Ramsey RESET Test	5.809881	0.0240	

TABLE 7
Short run error correction estimates of ARDL (4, 4, 3, 5) model

Dependent Variable: D(TLR) (Case 5: Unrestricted Constant and Unrestricted Trend)			
Independent Variable	Coefficient	*t*-statistic	*p*-value
Constant	-12559.48	-2.958447	0.0098
Trend	1906.409	7.148486	0.0000
D(TLR(-1))	3.175308	6.443039	0.0000
D(TLR (-2))	1.985704	5.709212	0.0000
D(TLR (-3))	0.966628	5.392487	0.0001
D(TIF)	-0.339112	-2.524189	0.0234
D(TIF(-1))	-0.021172	-0.127632	0.9001
D(TIF(-2))	0.635507	3.877317	0.0015
D(TIF(-3))	0.396665	2.186007	0.0451
D(ROF)	-1.789084	-7.914087	0.0000
D(ROF(-1))	4.812320	9.019295	0.0000
D(ROF(-2))	2.500677	8.646634	0.0000
D(KIBOR)	5409.922	3.206298	0.0059
D(KIBOR(-1))	-10802.37	-5.293423	0.0001
D(KIBOR(-2))	-4956.414	-2.784185	0.0139
D(KIBOR(-3))	-9229.545	-4.683715	0.0003
D(KIBOR(-4))	-6212.491	-3.543796	0.0029
ECT_{t-1}	-5.337371	-8.902752	0.0000
Diagnostic Analysis	Value	*p*-value	
R-squared	0.937858		
Residual Sum of Square	1.64E+09		
AIC	21.47066		
F-Statistics	15.98005	0.0000	
Jarque-Bera Test	9.961281	0.0069	
Breusch-Godfrey Serial Correlation LM Test	0.291616	0.7518	
Heteroscedasticity Test: Breusch-Pagan-Godfrey	0.819465	0.6668	
Ramsey RESET Test	1.433827	0.2510	

Diagnostic Analysis: In order to assess the validity of the assumptions that underlie the liability, asset, and liquidity reserves models, different diagnostic tests have been conducted, whose results are shown in Tables 5, 6, and 7 respectively. Breusch-Godfrey serial correlation LM test statistic confirms that residuals in the liability, asset and liquidity reserves models are serially uncorrelated. Moreover, Breusch-Pagan-Godfrey heteroscedasticity test statistic reveals that residuals in the aforementioned ARDL models are homoscedastic. Interestingly, functional form of the aforesaid three ARDL models is checked by applying Ramsey RESET test. Results of the said test confirm that there is no misspecification with respect to the functional form of the three ARDL models. In order to examine the stability of the estimated parameters of the said ARDL models, CUSUM tests are applied. Figures 1, 2, and 3 respectively show that all the three estimated ARDL models are valid with robust recursive residuals.

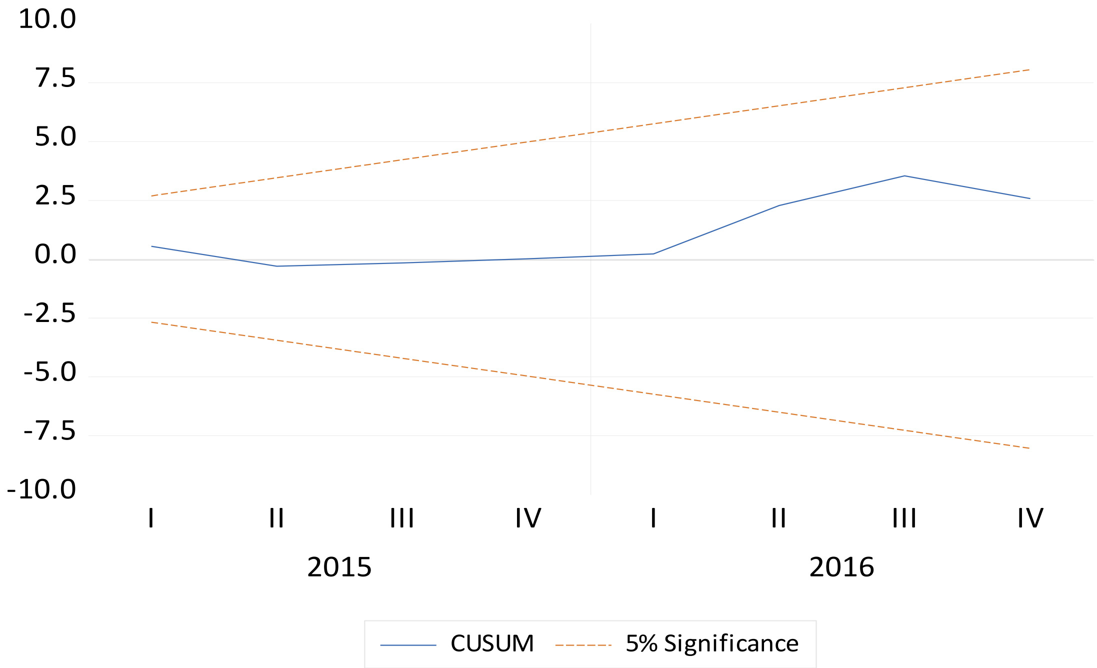

FIGURE 1. CUSUM of recursive residuals of liability model

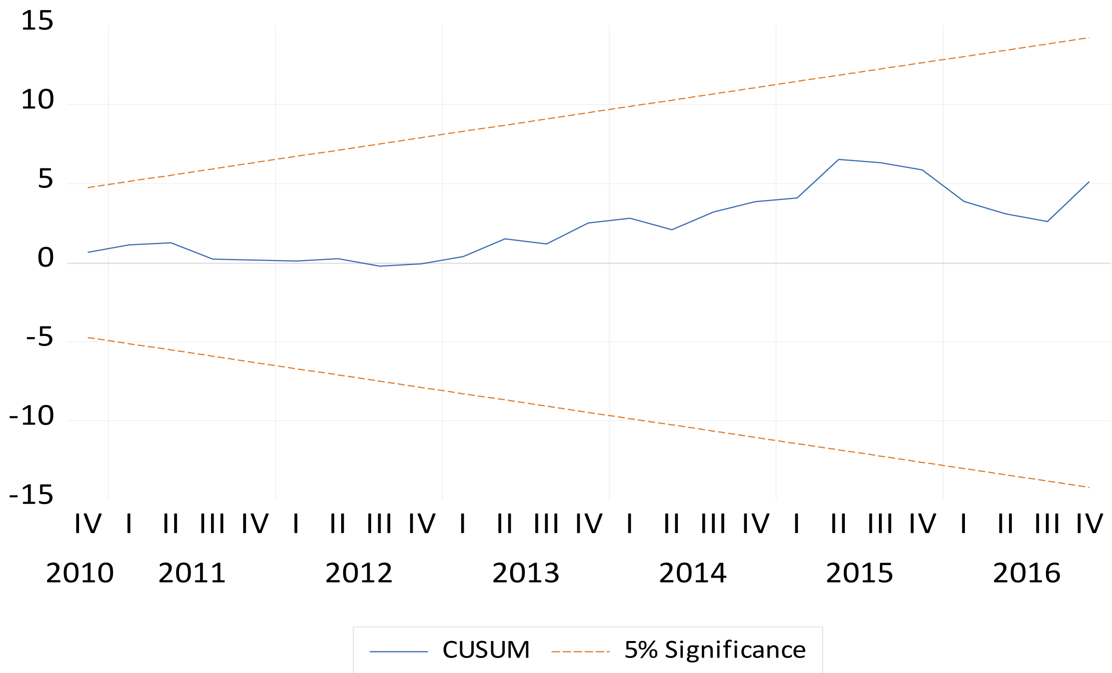

FIGURE 2. CUSUM of recursive residuals of asset model

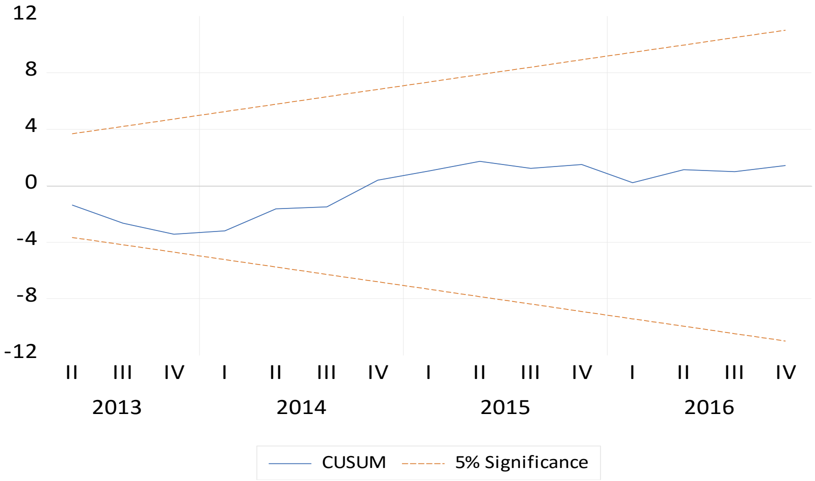

FIGURE 3. CUSUM of recursive residuals of liquidity reserves model

Interpretations of the Models

Liability Model

Islamic banks' liability side has a specific liquidity behaviour that represents Islamic banking depositors' liquidity behaviour. Firstly, the most important factor that determines the liquidity behaviour of Islamic banking depositors is the amount of returns paid to them in a short-term period. It is interesting to note that higher the Islamic banks' profit (return on financing), better the Islamic banking depositors' perception of their banks that will ultimately lead them to deposit more funds.

Secondly, after returns on deposits, the amount and level of benefits received by Islamic banking depositors by depositing money stimulate their investment decision. Besides monetary benefits (returns, bonuses, etc.), other non-monetary benefits, for instance, standard banking facilities, use of innovative technologies, branch network, etc., improve Islamic banking depositors satisfaction and loyalty. Interestingly, more satisfied and loyal Islamic banking depositors will add more funds in their banking deposits.

Thirdly, KIBOR-a benchmark rate-is an important factor explaining Islamic banking depositors' behaviour. Therefore, for being competitive so as to convince depositors to add more funds, returns on deposits must be competitive and matching the expected return of Islamic banking depositors (KIBOR).

Fourthly, costs of banking operations also predict Islamic banking depositors' behaviour. Higher the costs of banking operations, lower will be the cost efficiency and lesser will be the amount available for distributing among Islamic banking depositors. This will provoke Islamic banking depositors not to add funds into their existing deposits, may be causing withdrawal of funds.

Asset Model

The asset side of Islamic banks also has a specific liquidity behaviour explaining the liquidity behaviour of Islamic banks. Firstly, one of the Islamic banks' purposes in managing liquidity is optimizing returns on financing. If such returns tend to be more prospective, Islamic banks will advance more financing.

Secondly, returns on deposits paid to Islamic banking depositors is the factor affecting Islamic financing. This factor is important because it is related to the Islamic banks' competitiveness, attractiveness and their ability to match depositors' expectations. In this way, Islamic banks will attract more deposits and, therefore, more funds will be available to finance the projects.

The third variable that affects Islamic financing is the KIBOR, as a benchmark rate. If such rate is high, Islamic banks tend to advance more financing. Whereas, Islamic banks total financing in the previous periods is the fourth variable that influences their liquidity behaviour, that also guides their future financing policy. This variable estimates the success or failure of Islamic banks' portfolio financing policy and suggests future policy regarding portfolio financing.

Finally, the fifth variable affecting Islamic banks' financing is the cost of banking operations, which is associated with the Islamic banks' efforts in evaluating the performance of their business partners and in finding the prospective projects to be financed. Sustainable and higher profits can be made by: (a) selecting financially stable entrepreneurs as business partners; (b) analysing critically their business proposals, and (c) building amicable working relations with business partners.

When Islamic banks expand financing, associated cost might also increase accordingly. However, if returns on financing are as expected, Islamic banks may achieve more returns by expanding financing and increasing associated costs. Indeed, these additional costs of banking operations will benefit Islamic banks in competing conventional banks in a dual banking system, attracting more deposits, and fulfilling expectations of existing Islamic banking depositors.

Liquidity Reserves Model

This ARDL regression model discovers the factors, as indicated here, that determine the optimal level of liquidity reserves. Firstly, the current liquidity reserves position depends on returns on financing. If returns on financing fall then the liquidity reserves model suggest that Islamic banks will need more liquidity since the returns on deposits paid to Islamic banking depositors might as well fall and, therefore, return-seeking depositors might withdraw their deposits. Secondly, liquidity reserves depend on KIBOR. If the return paid to Islamic banking depositors fall short of KIBOR, then Islamic banks will need more liquid funds in anticipation of displaced commercial risk.

The third factor that affects the liquidity reserves position is the Islamic banks' financing. If it goes up, Islamic banks need to raise the liquidity reserves level. It is interesting to note that expansion in financing is basically possible when Islamic banking depositors add more funds. These high deposits require Islamic banks to hold higher liquidity reserves (Cash Reserve Requirement of the central bank). Finally, the previous liquidity reserves' position explains the pattern of liquidity demands by Islamic banking depositors and entrepreneurs.

Resilience of the Industry against Liquidity Pressures

The current study tries to investigate the resilience of the Islamic banking industry by analysing: (a) the ability of liquidity suppliers to meet liquidity demands; and (b) the level of Islamic banking depositors' liquidity withdrawals, which could possibly make an Islamic bank fail to meet its financial obligations. For the purpose, ARIMA modelling approach is employed: (a) to estimate models for variables related to Islamic bank's liquidity management by employing historical data from July 2006 to December 2016; (b) to forecast expected values of aforesaid Islamic banking variables, by employing ARIMA models, from January 2017 to December 2019; and (c) to investigate the Islamic banking industry's resilience under different liquidity withdrawal scenarios.

ARIMA Process

ARIMA modelling process involves eight variables, which are sorted into following two groups: (1) Liquidity-demanders-Demand Deposits (DD), Saving Deposits (SD), Term Deposits (TD); and (2) Liquidity-suppliers TLR that include cash and balances with treasury banks, Interbank Placements (IP), Sharīʻah-Compliant Investments (SI), Equity Participation (EP), and Funds Borrowed (FB) from IFIs. Variables of liquidity-supplier group will be subdivided into: (a) 1st Tier Liquid Instrument-that serve the liquidity demands from Demand Deposits and Saving Deposits; and (b) 2nd Tier Liquid Instrument-that serve all liquidity demands from Demand, Saving and Term Deposits. The current study considers TLR and FB as 1st tier liquid instruments, while, TLR, FB, IP, SI, and EP collectively are considered as 2nd tier liquid instruments.

Identification of Variables: Firstly, descriptive statistics of liquidity-demanders and liquidity-suppliers group of variables are given in the table 8. Next, each variable of liquidity-demanders (DD, SD, TD) and liquidity-suppliers (TLR, IP, SI, EP, and FB) are tested for stationarity. Table 9 provides the Augmented Dickey and Fuller (1979) test statistics of each variable of liquidity-demanders and -suppliers.

TABLE 8
Descriptive statistics of liquidity-demanders & liquidity-suppliers

Liquidity-Demanders					
Variables	Mean	Median	St. Dev	Min	Max
DD*	157,857	110,356	137,573	13,379	483,434
SD*	222,512	160,302	183,844	18,684	633,664
TD*	179,410	175,762	106,277	24,399	362,530
Liquidity-Suppliers					
Variables	Mean	Median	St. Dev	Min	Max
TLR*	58,410	43,420	39,246	13,382	146,806
Interbank Placements (IP)*	27,558	26,042	10,847	13,113	61,362
SI*	234,495	228,323	192,252	3,437	661,787
EP*	52,626	53,029	26,380	13,542	112,223
FB from IFIs *	189,387	143,356	137,885	36,456	579,128

* Million rupees

TABLE 9
ADF test statistics of liquidity-demanders and liquiditysSuppliers

	Liquidity-Demanders								
N=42	Level			1st Difference			2nd Difference		
	t-Stat.	Prob.*	Test Critical Values**	*t*-Stat.	Prob.*	Test Critical Values**	*t*-Stat.	Prob.*	Test Critical Values**
DD	-0.44445	0.9819	-4.226815	-1.84723	0.6611	-4.226815	-8.53478	0.0000	-4.226815
			-3.536601			-3.536601			-3.536601
			-3.200320			-3.200320			-3.200320
SD	-0.02391	0.9946	-4.198503	-7.19718	0.0000	-4.205004	-8.06577	0.0000	-4.219126
			-3.523623			-3.526609			-3.533083
			-3.192902			-3.194611			-3.198312
TD	-3.74343	0.0310	-4.211868	-4.56087	0.0047	-4.252879	-4.31058	0.0097	-4.296729
			-3.529758			-3.548490			-3.568379
			-3.196411			-3.207094			-3.218382
	Liquidity-Suppliers								
N=42	Level			1st Difference			2nd Difference		
	t-Stat.	Prob.*	Test Critical Values**	*t*-Stat.	Prob.*	Test Critical Values**	*t*-Stat.	Prob.*	Test Critical Values**
TLR	4.283972	1.0000	-4.198503	-2.83658	0.1934	-4.205004	-8.67464	0.0000	-4.211868
			-3.523623			-3.526609			-3.529758
			-3.192902			-3.194611			-3.196411
IP	-1.71747	0.7253	-4.198503	-5.23074	0.0006	-4.205004	-9.36107	0.0000	-4.211868
			-3.523623			-3.526609			-3.529758
			-3.192902			-3.194611			-3.196411
SI	-2.50215	0.3255	-4.205004	-3.48416	0.0548	-4.205004	-7.36613	0.0000	-4.211868
			-3.526609			-3.526609			-3.529758
			-3.194611			-3.194611			-3.196411
EP	-4.46470	0.0059	-4.252879	-4.93262	0.0014	-4.205004	-7.23344	0.0000	-4.219126
			-3.548490			-3.526609			-3.533083
			-3.207094			-3.194611			-3.198312
FB	-0.94640	0.9404	-4.198503	-4.75274	0.0024	-4.211868	-6.82530	0.0000	-4.219126
			-3.523623			-3.529758			-3.533083
			-3.192902			-3.196411			-3.198312

* MacKinnon (1991) one-sided *p*-values.
**Test Critical Values are basically MacKinnon (1991) critical values for rejection of null hypothesis, which are calculated at 1% level, 5% level, and 10% level respectively.

Table 8 reveals that all variables under investigation are non-stationary at level but stationary at 1st difference, except DD, TLR and SI that are stationary at 2nd difference.

The next identification process in the ARIMA modelling is to examine the Autoregressive and Moving Average patterns using a correlogram test for behaviour patterns of Autocorrelation Function (ACF) and Partial Correlation Function (PACF) patterns. The three commonly found patterns in the ARIMA models are as follows:

a. All ACF values are zero;
b. ACF values show a cut off pattern between 1st and the 2nd or 3rd periods of ACF; and
c. ACF values are showing a dying down pattern.

In ARIMA modelling, if ACF is dying down and PACF cuts off, then following pure AR model should be employed:

$$Z_t = \delta + \theta_1 Z_{t-1} + \theta_2 Z_{t-2} + \dot{+}\theta_p Z_{t-p} + \varepsilon_t \quad (23)$$

In case, ACF cuts off and PACF is dying down, then following pure Moving Average (MA) model should be employed:

$$Z_t = \mu + \varepsilon_t - \Phi_1 \varepsilon t - 1 - \Phi_2 \varepsilon t - 2 - \cdots - \Phi_q \varepsilon t - q \quad (24)$$

In case, ACF and PACF both are dying down, then following model, which is a combination of AR and MA models, should be employed:

$$Z_t = \mu + \theta_1 Z_{t-1} + \theta_2 Z_{t-2} + \cdots + \theta_p Z_{t-p} + \varepsilon_t - \Phi_1 \varepsilon t - 1 - \Phi_2 \varepsilon t - 2 - \cdots - \Phi_q \varepsilon t - q \quad (25)$$

Table 10 reveals that: (a) for DD, ACF is dying down, while, PACF cuts off; (b) for SD, ACF and PACF both are dying down; (c) for TD, ACF cuts off, while, PACF is dying down; (d) for TLR, ACF cuts off, while, PACF is dying down; (e) for IP, ACF cuts off, while, PACF is dying down; (f) for SI, ACF is dying down, while, PACF cuts off; (g) for EP, ACF and PACF both are dying down; and (h) for FB, ACF and PACF both are dying down.

TABLE 10
ACF & PACF correlograms

	DD		SD		TD		TLR		IP		SI		EP		FB	
Lags	ACF	PACF	ACF	PACF	ACF	PACF	ACF	PACF	ACF	PACF	ACF	PACF	ACF	PACF	ACF	PACF
1	0.91	0.91	0.92	0.92	0.94	0.94	0.90	0.90	0.84	0.84	0.91	0.91	0.90	0.90	0.89	0.89
2	0.82	-0.05	0.84	-0.01	0.88	-0.07	0.80	-0.03	0.62	-0.26	0.81	-0.10	0.78	-0.11	0.76	-0.20
3	0.74	-0.02	0.77	-0.02	0.81	-0.06	0.70	-0.03	0.37	-0.22	0.71	-0.01	0.66	-0.10	0.64	0.07
4	0.66	-0.05	0.68	-0.10	0.74	-0.12	0.61	-0.04	0.22	0.20	0.65	0.12	0.53	-0.08	0.56	0.03
5	0.58	-0.03	0.61	-0.01	0.66	-0.02	0.53	-0.01	0.18	0.22	0.59	-0.03	0.42	-0.02	0.48	-0.05
6	0.50	-0.04	0.53	-0.03	0.58	-0.10	0.45	-0.02	0.18	-0.11	0.54	-0.02	0.32	-0.00	0.42	0.06
7	0.43	-0.01	0.46	0.00	0.51	0.01	0.38	-0.01	0.20	-0.01	0.48	0.00	0.24	-0.01	0.37	-0.00
8	0.36	-0.04	0.40	-0.06	0.44	0.05	0.32	-0.02	0.21	0.13	0.43	-0.02	0.18	0.00	0.31	-0.05
9	0.30	-0.03	0.34	0.01	0.38	-0.01	0.26	-0.02	0.18	-0.11	0.38	-0.01	0.16	0.17	0.28	0.10
10	0.23	-0.04	0.28	-0.02	0.33	-0.02	0.21	-0.02	0.11	-0.11	0.34	-0.01	0.14	-0.03	0.25	-0.03
11	0.18	0.00	0.22	-0.09	0.27	-0.12	0.16	-0.01	0.07	0.16	0.29	-0.03	0.13	-0.04	0.22	-0.02
12	0.12	-0.04	0.16	-0.03	0.20	-0.13	0.12	0.01	0.02	-0.04	0.24	-0.10	0.12	-0.00	0.18	-0.06
13	0.07	-0.02	0.10	-0.04	0.14	-0.01	0.09	-0.02	0.03	-0.03	0.17	-0.11	0.11	0.01	0.13	-0.03
14	0.02	-0.03	0.04	-0.06	0.07	-0.05	0.05	-0.03	0.01	-0.12	0.09	-0.06	0.10	-0.01	0.08	-0.06
15	-0.02	-0.01	-0.01	-0.03	0.01	-0.01	0.02	-0.03	-0.01	0.06	0.02	-0.10	0.08	-0.03	0.03	-0.04

* MacKinnon (1991) one-sided *p*-values.
**Test Critical Values are basically MacKinnon (1991) critical values for rejection of null hypothesis, which are calculated at 1% level, 5% level, and 10% level respectively.

Estimation of Models: All the eight estimated ARIMA models are presented below along with the values of coefficients, *t*-statistics (in brackets), *R*-squared, AIC and *F*-statistics with the *p*-value in brackets.

$$\Delta DD_t = \mu + \theta_1 DD_{t-1} + \theta_2 DD_{t-2} + \theta_3 DD_{t-3} + \varepsilon_t \quad (26)$$

588.5730	-0.799092	-0.459417	-0.598620		
[3.193323]	[-6.496046]	[-2.867596]	[-4.927881]		
R-squared	0.778280	AIC	19.30991	*F*-stat	30.71422 [0.0000]

$$\Delta SD_t = \mu + \theta SD_{t-1} + \varepsilon_t - \Phi_1\varepsilon_{t-1} - \Phi_2\varepsilon_{t-2} \tag{27}$$

778.1852	0.561544	-1.999983	0.999983		
[15.12540]	[3.589414]	[-903.6047]	[644.4647]		
R-squared	0.670432	AIC	21.95819	*F*-stat	17.79988 [0.0000]

$$\Delta TD_t = \mu + \varepsilon_t - \Phi_1\varepsilon_{t-1} - \Phi_2\varepsilon_{t-2} - \Phi_3\varepsilon_{t-3} - \Phi_4\varepsilon_{t-4} \tag{28}$$

8324.090	0.254683	-0.275776	-0.344774	-0.634128	
[18.66156]	[7.310027]	[-7.525896]	[-7.482580]	[-5.898475]	
R-squared	0.368723	AIC	21.62881	*F*-stat	4.088637 [0.0049]

$$\Delta TLR_t = \mu + \varepsilon_t - \Phi_1\varepsilon_{t-1} \tag{29}$$

161.0087	-0.421087				
[1.147623]	[-2.793731]				
R-squared	0.143750	AIC	17.62521	*F*-stat	3.105842 [0.0566]

$$\Delta IP_t = \mu + \varepsilon_t - \Phi_1\varepsilon_{t-1} - \Phi_2\varepsilon_{t-2} - \Phi_3\varepsilon_{t-3} - \Phi_4\varepsilon_{t-4} \tag{30}$$

653.0106	0.070301	0.215291	-0.722382	-0.563196	
[2.329949]	[0.000366]	[0.001449]	[-0.006175]	[-0.002402]	
R-squared	0.349521	AIC	19.64460	*F*-stat	3.761294 [0.0078]

$$\Delta SI_t = \mu\theta_1 SI_{t-1} + \varepsilon_t \tag{31}$$

16192.19	0.538062				
[2.068020]	[4.192150]				
R-squared	0.301028	AIC	23.14805	*F*-stat	8.182768 [0.0011]

$$\Delta EP_t = \mu + \theta_1 EP_{t-1} + \theta_2 EP_{t-2} + \varepsilon_t - \Phi_1\varepsilon_{t-1} - \Phi_2\varepsilon_{t-2} \tag{32}$$

2191.220	1.669098	-0.877750	-1.640258	0.999993	
[2.369016]	[13.85902]	[-8.314473]	[-12.23886]	[6.947091]	
R-squared	0.297128	AIC	19.53089	*F*-stat	2.959141 [0.0249]

$$\Delta FB_t = \mu + \theta_1 FB_{t-1} + \varepsilon_t - \Phi_1\varepsilon_{t-1} - \Phi_2\varepsilon_{t-2} - \Phi_3\varepsilon_{t-3} - \Phi_4\varepsilon_{t-4} \tag{33}$$

8955.475	-0.985477	1.556908	0.367426	-0.036826	0.193013
[2.339270]	[-11.70936]	[0.007043]	[0.005455]	[-0.001147]	[0.000966]
R-squared	0.341640	AIC	21.88614	*F*-stat	2.940583 [0.0202]

Forecasting on the Basis of Estimated ARIMA Models: In order to forecast the future liquidity demands and its supply and assess the Islamic banking industry's resilience against an unanticipated liquidity demands, the eight estimated ARIMA models are utilized to generate estimated values from January 2017 to December 2019.

The current study anticipates the first scenario of regular liquidity withdrawals by Islamic banking depositors. The second scenario is of irregular liquidity withdrawals-liquidity demands rise than the former scenario. This scenario can arise when Islamic banking depositors withdraw their deposits due to unfavourable economic conditions and hold more cash.

The last scenario is that of liquidity run, which might possibly be occurring due to any financial sector's crisis or due to certain circumstances when Islamic banking depositors' confidence over their banks is shattered.

Resilience of the 1st Tier Liquid Instruments

In order to investigate the 1st tier liquid instruments' resilience, the aforementioned three liquidity withdrawal scenarios are examined. The first scenario is assumed to be of regular liquidity withdrawals by Islamic banking depositors. The current study assumes regular liquidity withdrawals equal to the 10% of each quarterly balance of demand and saving deposits. 1st tier liquid instruments' resilience in case of regular liquidity withdrawals is drawn as a thick line in the Figure 4.

The second scenario is considered as of irregular liquidity withdrawals, which is assumed to be equal to 25% of each quarterly balance of demand and saving deposits. 1st tier liquid instruments' resilience in case of any irregular liquidity withdrawals is drawn as a dotted line in the Figure 4.

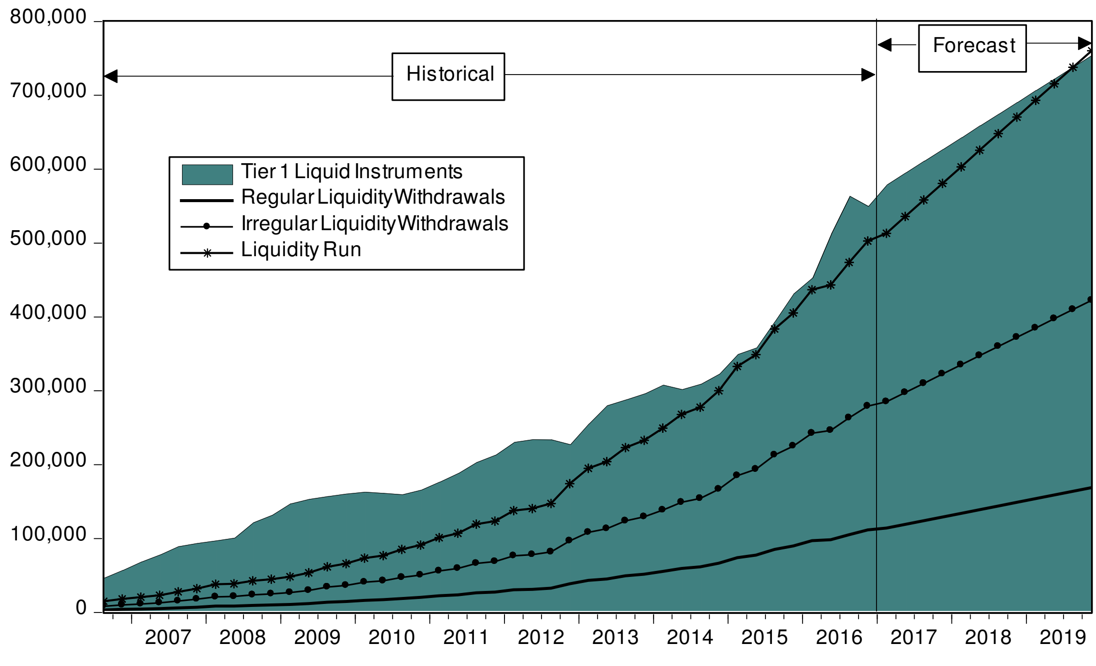

FIGURE 4. Tier-1 liquid instruments' resilience

The last scenario of liquidity run is assumed with 45% of each quarterly balance of demand and saving deposits. A more severe scenario (more than 45%) of liquidity run is not taken into consideration because 45% liquidity withdrawals would be giving strong signals to Islamic banks to take necessary actions in order to avoid further worsening of the scenario. 1st tier liquid instruments' resilience in case of a liquidity run is drawn as a starred line in the Figure 4.

Resilience of the 2nd Tier Liquid Instruments

2nd tier liquid instruments improve the liquidity supply for tackling the liquidity demands from term deposits in addition to the liquidity demands from demand and saving deposits. The first scenario is of regular liquidity withdrawals. The current study assumes that 10% term deposits of each quarterly balance are terminated in addition to the regular liquidity withdrawals equal to the 10% of each quarterly balance of demand and saving deposits. 2nd tier liquid instruments' resilience in case of regular liquidity withdrawals is drawn as a thick line in the Figure 5.

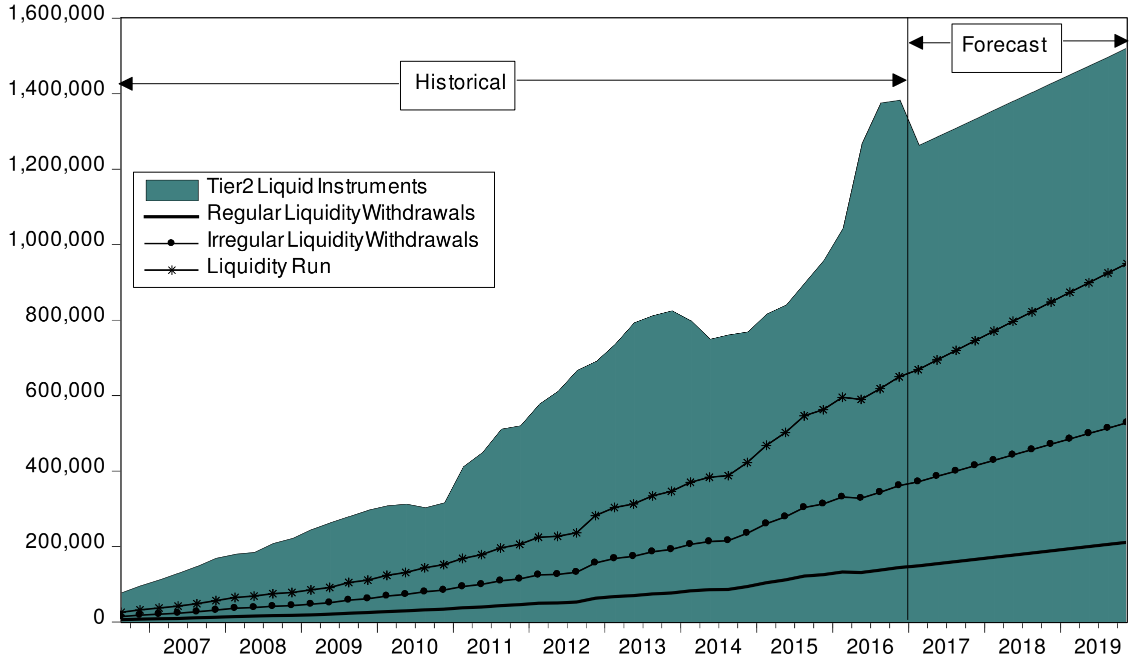

FIGURE 5. Tier-2 liquid instruments' resilience

The second scenario is of the irregular liquidity withdrawals that are assumed to be the termination of 25% term deposits of each quarterly balance in addition to the liquidity withdrawals from demand and saving deposits equal to the 25% of each quarterly balance. 2nd tier liquid instruments' resilience in case of any irregular liquidity withdrawals is drawn as a dotted line in the Figure 5.

The last scenario of liquidity run is assumed with termination of 45% term deposits of each quarterly balance in addition to the liquidity withdrawals equal to the 45% of each quarterly balance of demand and saving deposits. 2nd tier liquid instruments' resilience in case of liquidity run is drawn as a starred line in the Figure 5.

Findings of the Resilience Analysis

Islamic banking industry's resilience analysis lads to the the following findings that are important with regard to the Islamic banks' liquidity management:

a) Islamic banking industry performed historically well in managing the liquidity.

b) Tier-2 liquid instruments performed well historically in mitigating liquidity run conditions; moreover, it is forecasted that tier-2 liquid instruments would possibly be performing well in mitigating any future liquidity run conditions (see Figure 6). Likewise, tier-1 liquid instruments performed historically well in mitigating liquidity run conditions, however, tier-1 liquid instruments would apparently be facing a liquidity mismatch in the last quarter of 2019 (see Figure 7).

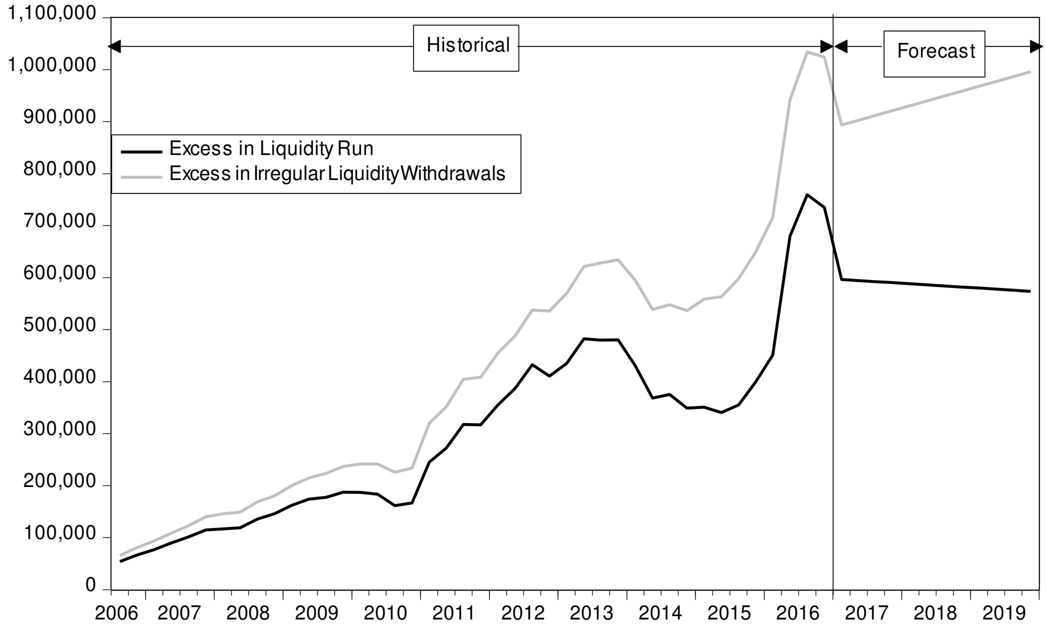

FIGURE 6. Performance of tier-2 liquid instruments

c) Based on the severe liquidity run scenarios, tier-1 liquid instruments have absorbed the liquidity pressure of up to 55% of withdrawals till 2013. Afterwards, 1st tier fails to handle liquidity run. However, tier-2 liquid instrument have managed to handle liquidity pressure of up to 95% of withdrawals till 2013 (see Figure 8).

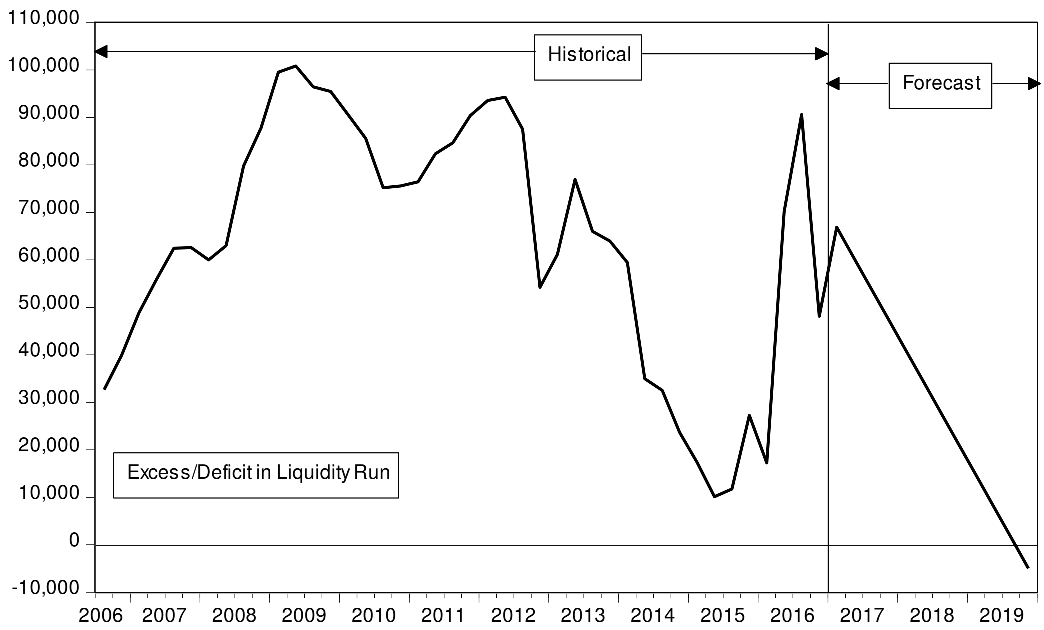

FIGURE 7. Performance of tier-1 liquid instruments

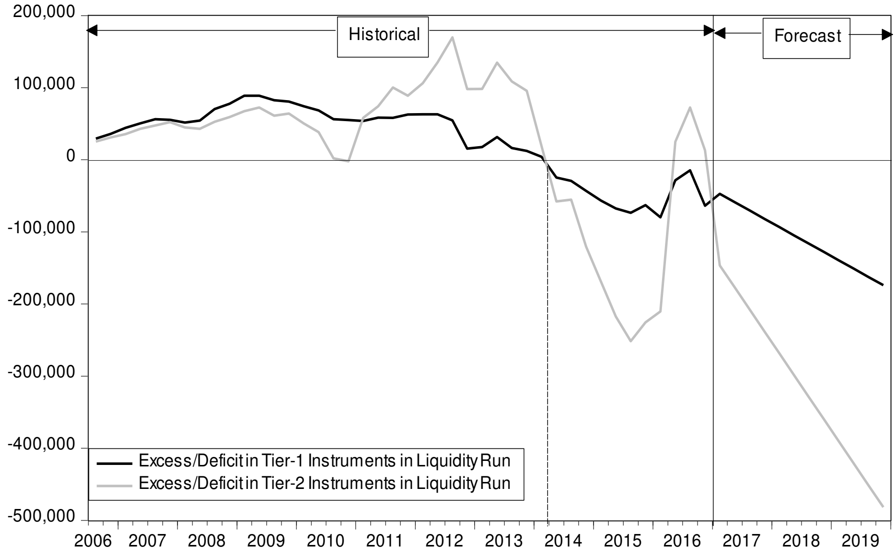

FIGURE 8. Performance of liquid instruments in severe liquidity run scenarios

d) The percentage assumptions of liquidity run delivers the important message that Islamic banks' failure in liquidity management begins with this percentage of liquidity withdrawals. Following are some of the steps that can be taken to maintain the sound conditions of Islamic banking industry and prevent any liquidity runs: (i) educating the Islamic banking depositors and general public about the contract mechanics of Islamic banking transactions; (ii) improving the asset-liability management; and (iii) optimizing portfolio financing in order to realize better returns on financing and paying competitive returns to Islamic banking depositors.

e) There is another tier (tier-3) of liquid instruments available to Islamic banks in case of any emergency. Tier-3 liquid instruments mainly include liquidity provided by State Bank of Pakistan as a Lender of Last Resort. However, using tier-3 liquid instruments may have certain negative implications for Islamic banks.

CONCLUSION

This empirical study was designed to analyse different liquidity management aspects of Islamic banking industry of Pakistan. For this purpose, econometric models identifying factors that influence Islamic banks in balancing liquidity on liability as well as asset sides and in maintaining the optimum liquidity reserves have been developed. Furthermore, the study has also endeavoured to investigate the resilience of the Islamic banking industry against anticipated and unanticipated liquidity pressures.

It is pertinent to note that Islamic banking liability and asset models, with regard to liquidity management, have identified the significant role of following variables: (a) returns on deposits, (b) returns on financing, (c) costs of banking operations, and (d) KIBOR. Islamic banking liquidity reserves model recommends Islamic banks to consider following variables, while developing optimum liquidity reserves: (a) total Islamic financing, (b) returns on financing, and (c) KIBOR.

Resilience analysis of Islamic banking industry has found that liquid instruments performed well historically in mitigating liquidity run conditions. Furthermore, it is forecasted that tier-2 liquid instruments would possibly be performing well in mitigating any future liquidity run conditions (up to 95% of deposits). However, in case of tier-1 liquid instruments, there is a possibility of liquidity mismatches when liquidity withdrawals exceed the limit of 55% of deposits.

Findings of the current study suggest that Islamic banking depositors, besides their religious motives of supporting Islamic banks, expect from their banks to produce profits and pay competitive returns on their deposits. Therefore, Islamic banks need to make prudent portfolio financing so as to pay competitive returns to their depositors.

It is pertinent to note that major banking business is that of maturity transformation of short-term deposits into long-term project financing. Inability of Islamic banks to meet depositors' liquidity withdrawal demands exposes them to liquidity risk. Consequently, liquidity management becomes a critical issue that calls for prompt responsiveness by Islamic banks and prudential supervision by banking regulators. In this regard, econometric models developed in the current study will help Islamic banks in managing deposits, financing portfolios, and liquidity reserves, and enable them for forecasting the future liquidity demands and supply.

REFERENCES

AAOIFI. (2014). Sharīʿah *standards book 2014 (Arabic).* Bahrain: Accounting and Auditing Organization of Islamic Financial Institutions.

Ahmed, A. M. E. T. (2011). *Islamic banking: How to manage risk and improve profitability.* Hoboken, New Jersey: John Wiley & Sons.

Ahmed, H. (2015). Basel III liquidity requirement ratios and Islamic banking. *Journal of Banking Regulation, 16*(4), 251-264. doi: https://doi.org/10.1057/jbr.2014.20

Alam, K. (2014). *Progress: Helping Islamic banks park liquidity.* Express Tribune. Retrieved from https://bit.ly/2L6e1Id

Al-Amine, M. A. (2013). Managing liquidity risk in Islamic finance. In K. Hunt-Ahmed, *Contemporary Islamic Finance: Innovations, Applications, and Best Practices* (pp. 121-146). New Jersey, NJ: John Wiley & Sons, Inc.

Aliaga, M., & Gunderson, B. (2002). *Interactive statistics* (2nd Edition). Upper Saddle River, NJ: Prentice Hall.

Asutay, M., Aysan, A. F., & Karahan, C. C. (2013). Reflecting on the trajectory of Islamic finance: From Mit Ghamr to the Globalisation of Islamic Finance. *Afro Eurasian Studies, 2*(1-2), 5-14.

Banerjee, A., Dolado, J. J., Galbraith, J. W., & Hendry, D. (1993). *Co-integration, error correction, and the econometric analysis of non-stationary data.* Oxford, UK: Oxford University Press.

Basel Committee. (2008). *Principles for sound liquidity risk management and supervision.* Basel, Switzerland: Bank for International Settlements.

Berger, A. N., & Bouwman, C. H. (2009). Bank liquidity creation. *The Review of Financial Studies, 22*(9), 3779-3837. doi: https://doi.org/10.1093/rfs/hhn104

Beseiso, F. H. (2014). Central banks' role in shaping the future of Islamic banking. In *The Developing role of Islamic banking and finance: From local to global perspectives* (pp. 3-30). Bingley, UK: Emerald Group Publishing Limited.

Central Bank of Oman. (2012). *Islamic banking regulatory framework.* Central Bank of Oman, Oman.

Chapra, U., & Ahmed, H. (2002). *Corporate governance in Islamic financial institutions* (Occasional paper no. 6). Islamic Development Bank, Jeddah, Saudi Arabia.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association, 74*(366a), 427-431. doi: https://doi.org/10.2307/2286348

El-Gamal, M. A. (2006). *Islamic finance: Law, economics, and practice.* Cambridge, MA: Cambridge University Press.

Fabozzi, F. J., Focardi, S. M., & Kolm, P. N. (2006). *Financial modeling of the equity market: From CAPM to cointegration.* Hoboken, New Jersey: John Wiley & Sons.

Farooq, M., & Zaheer, S. (2015). Are Islamic banks more resilient during financial panics? *Pacific Economic Review, 20*(1), 101-124. doi: https://doi.org/10.1111/1468-0106.12096

Freixas, X., & Rochet, J. C. (1999). *Microeconomics of banking.* London, UK: The MIT Press.

Ganley, J. (2004). *Surplus liquidity: Implications for central banks* (Lectures). Centre for Central Banking Studies, Bank of England, London, UK.

Gujarati, D. N. (2009). *Basic econometrics.* New York, NY: Tata McGraw-Hill Education.

Iqbal, Z., & Mirakhor, A. (2011). *An introduction to Islamic finance: Theory and practice.* Singapore: John Wiley & Sons.

Ismal, R. (2010). Strengthening and improving the liquidity management in Islamic banking. *Humanomics, 26*(1), 18-35. doi: https://doi.org/10.1108/08288661011024977

Jamaldeen, F. (2012). *Islamic finance for dummies.* Hoboken, NJ: John Wiley & Sons.

Kahf, M., & Hamadi, C. (2014). An attempt to develop Sharīʻah compliant liquidity management instruments for the financier of last resort: With reference to Qatar development plan. *Islamic Economic Studies, 22*(1), 109-138.
doi: https://doi.org/10.12816/0004132

Khan, M., & Bhatti, M. (2008). *Developments in Islamic banking: The case of Pakistan.* New York, NY: Palgrave Macmillan UK.

MacKinnon, J. G. (1991). Critical values for co-integration tests. In R. F. Engle, & C. W. Granger, *Long-run economic relationships: Readinds in co-integration* (pp. 267-276). London, UK: Oxford University Press.

Pak, C., & Ku, B. (2017). The impact of technology imports on technology balance of payments in Korea: An ARDL bounds testing approach. *Applied Economics Letters, 24*(14), 1041-1045. doi: https://doi.org/10.1080/13504851.2016.1248352

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*(3), 289-326. doi: https://doi.org/10.1002/jae.616

Rizvi, S. A., & Alam, N. (2016). Islamic capital market research: Past trends and future considerations. In N. Alam, & S. A. Rizvi, *Islamic capital markets: Volatility, performance and stability* (pp. 1-14). Switzerland: Springer International Publishing.

Saheed, A. (2014). *Supervisory consideration in determining the right approach for liquidity management of the Islamic financial institutions.* Global Islamic Financial Forum, Kuala Lumpur, Malaysia.

Saiti, B., Hasan, A., & Engku-Ali, E. R. (2016). Islamic interbank money market: Contracts, instruments and their pricing. In N. Alam, & S. A. Rizvi, *Islamic capital markets: Volatility, performance and stability* (pp. 67-100). Switzerland: Springer International Publishing.

SBP. (2014). *Knowledge, atitude and practices of Islamic banking in Pakistan.* State Bank of Pakistan, Karachi, Pakistan.

SBP. (2015). *Islamic banking bulletin (March-2015).* Islamic Banking Department, State Bank of Pakistan, Karachi, Pakistan.

SECP. (2015). *Securities and exchange commission of Pakistan's news letter (Spring Edition-2015).* Securities and Exchange Commission of Pakistan, Islamabad, Pakistan.

Siddiqi, M. N. (2006). Islamic banking and finance in theory and practice: A survey of state of the art. *Islamic Economic Studies, 13*(2), 1-48.

Siddiqi, M. N. (2009). Current financial crisis and Islamic economics. *Insights, 1*(3), 141-151.

Studentmund, A. H. (2016). *Using econometrics: A pratical guide.* New York, NY: Pearson Education, Inc.

Udovitch, A. L. (1970). *Partnership and profit in medieval Islam.* Princeton, NJ: Princeton University Press.

Udovitch, A. L. (1981). *Bankers without banks: Commerce, banking, and society in the Islamic world of the Middle Ages.* Princeton, NJ: Program in Near Eastern Studies, Princeton University.

Usmani, I. A. (2015). *Islamic finance: Revised & updated edition of Meezan mank's guide to Islamic banking.* Karachi, Pakistan: Maktaba Ma'ariful Qur'ān.

Venardos, A. M. (2012). *Islamic banking & finance in South-East Asia: Its development & future.* Singapore: World Scientific.

Vogel, F. E., & Hayes, S. L. (1998). *Islamic law and finance: Religion, risk, and return.* London, UK: Kluwer Law International.

Wahyudi, I., Rosmanita, F., Prasetyo, M. B., & Putri, N. I. S. (2015). *Risk management for Islamic banks: Recent developments from Asia and the Middle East.* Singapore: John Wiley & Sons.

Zaher, T. S., & Kabir Hassan, M. (2001). A comparative literature survey of Islamic finance and banking. *Financial Markets, Institutions & Instruments, 10*(4), 155-199. doi: https://doi.org/10.1111/1468-0416.00044

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