An Empirical Analysis of Bank-specific and Macroeconomic Determinants of Liquidity in Pakistan

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Abstract **-- The global financial crisis has had a profound impact on bank performace and has brought the issue of liquidity risk to the forefront. As a result, liquidity risk management has become a topic of considerable interest to financial economists, practitioners, and policymakers. This empirical study aims to examine the impact of bank-specific and macroeconomic variables on the liquidity of 20 commercial banks in Pakistan. The fixed-effects model was used to analyze panel data covering the period 2009-2018. The liquidity ratio approach was used to measure bank liquidity, which calculates bank liquidity based on liquid assets relative to total assets. Empirical results show that bank size, credit risk, and net interest margin have a negative impact on liquidity, while capital adequacy, profitability, management efficiency, and management quality have a positive impact on liquidity. In addition, the study found that the monetary policy rate and the exchange rate have a positive impact on the liquidity of Pakistani commercial banks. The study suggests that the State Bank of Pakistan should take stringent measures to recover funds and reduce liquidity constraints to improve the performance of banks. These findings provide valuable insights into the factors affecting bank liquidity and could inform future policymaking in the banking sector.**

Index Terms **-- Bank-specific factors, Commercial banks, Fixed-effects model, Liquidity, Macroeconomic variables, Pakistan**

JEL Classification **– C5, C33, E43, G21, G32**

I. INTRODUCTION

Commercial banks play a crucial role in a country's financial system by facilitating the transfer of surplus cash from developed to developing sectors, thereby balancing the surplus and deficit business units and improving commercial activities (Ahmad and Rasool, 2017). The Bank for International Settlements (BIS) (2008) defines liquidity as a bank's ability to meet its short-term depositor claims without incurring further losses[1]. Liquidity[2] is essential for banks to meet their obligations to depositors and their payment claims, as failure to do so may result in liquidity constraints and eventual bankruptcy. Diamond and Dybvig (1983) found that banks'roles in transferring maturity and ensuring timely payment of claims by short-term depositors are leading causes of banks'banktrupcy. The finding is supported by Rausch *et al.* (2009), who emphasize the importance of maintaining adequate liquidity levels in commercial banks to avoid cash sterility. Minh (2021) further advocates that banks maintain high levels of liquidity during recessionary periods to retain their customers. Large banks that lacked sufficient liquid assets collapsed during the credit crunch, despite receiving substaintial liquidity support (Ahmad and Rasool, 2017). Moreover, the low liquidity of banks during the financial crisis was highlighted by Munteanu (2012), while Bandt *et al.* (2021) demonstrated that French banks reduced loan liquidity during periods of the financial crisis, indicating that the regulation was not initially binding, with the transmission channel manifesting mainly on the liability side. However, due to liquidity mismanagement and extensive support from the central bank to scheduled banks, many banks[3] were declared bankrupt, although profitable banks (Ahmad and Rasool, 2017).

The topic of liquidity has gained increased attention among financial economists, policymakers, and academicians since the 2008 global financial crisis. Wang (2002) argued that maintaining high liquidity is critical for banks to fulfill their long-term payment obligations to investors. Nevertheless, short-term depositors' cash withdrawals from banks may lead to liquidity imbalances that reduce the bank's ability to meet its financial obligations. The risk of a bank's maturity transformation arises from the interaction of both risks, which suggests that banks may not be able to meet unexpected money withdrawals. In the literature, capital adequacy, bank size, and capitalization have been found to positively influence a bank's liquidity. Liquidity has also been found to moderate the relationship between capital adequacy, asset quality, and bank performance (Al-Matari, 2021). Efficient bank activities have been identified as the main driver of adequate liquidity. For

[1] https://www.bis.org/publ/bcbs144.htm
[2] The liquidity of a bank refers to its ability to meet financial commitments on time (Drehmann and Nikolaou, 2009).
[3] Lehman Brother in 2008

instance, Duan *et al.* (2021) found that banks with lower efficiency tend to generate less liquidity for the public. Therefore, reducing banks' cost burdens or increasing their profit efficiency levels could enhance banks' liquidity creation function. Mismanagement of liquidity can lead to lower profitability, insolvency, and destruction of shareholder value (Malik and Rafique, 2013). Moreover, Shah *et al.* (2018) found that bank-specific factors such as capital adequacy ratios, bank size, and funding costs are significant determinants of liquidity. Aldeen *et al.* (2020) also found that non-performing finance ratios (NPF) and bank size are critical predictors of liquidity risk management in Syrian Islamic banks. Additionally, macroeconomic variables such as real GDP and unemployment play significant roles in determining liquidity (Nguyen and VO, 2021). However, Vodova (2013) concluded that interest rates have a negative effect on liquidity.

The concept of 'too-big-to-fail' asserts that large banks hold lower liquidity because they rely on central banks for funding while also being able to access capital markets and monitor loan borrowers. Bordeleau and Graham (2010) suggest that banks with greater liquidity can take advantage of promising investment opportunities in financial institutions, leading to increased profitability and reduced financing costs. In the context of Bangladesh, Islam and Nasreen (2018) investigate the influence of bank-specific and macroeconomic factors on liquidity. The study finds that large and high-risk-taking banks maintain less liquidity than small banks, while bank profitability, bank age, and deposits positively affect liquid assets. Furthermore, higher GDP growth rates reduce liquidity due to increased credit provision to support output. Pakistan's banking sector faces liquidity constraints due to high demand from credit companies and borrowed capital, making it difficult for the State Bank of Pakistan (SBP) to manage liquidity effectively to meet all economic needs. Despite some studies highlighting bank-specific determinants of liquidity, the lack of empirical literature on effective liquidity management in Pakistani banks leaves the determinants influencing liquidity unclear.

This empirical study aims to explore the relationship between liquidity and various macroeconomic and bank-specific determinants to assist bank managers in adopting effective bank-oriented policies while minimizing losses. While existing literature in Pakistan emphasizes liquidity creation, few studies examine the impact of bank-specific factors[4] on liquidity (Melese, 2015; Khan *et al.*, 2021). This study considers bank-specific factors (bank size, credit risk, net interest margin, management efficiency, capital adequacy, profitability, and management quality) and macroeconomic variables (monetary policy rate and exchange rate) that affect liquidity in Pakistani banks. Thus, this study contributes to finance literature by designing . bank-oriented policies to help the banking sector deal with liquidity issues and avoid banktruptcy while formulating growth-oriented policies to boost investment opportunities and accelerate economic activities for smooth functioning of banks.

The rest of this paper is organized as follows: Section II presents a literature review, Section III outlines the variables and data sources, Section IV discusses the model specification and estimation techniques, Section V reports empirical findings, and Section VI concludes the study with policy recommendations.

II. LITERATURE REVIEW

The *Liquidity Management Theory*, proposed by Prochanow in 1944, has been recognized as a significant theory that focuses on loans and their interactions with commercial banks in the United States. According to this theory, banks plan the liquidation of the term loans based on the expected income of borrowers, irrespective of their business nature and features. The theory emphasizes the importance of interest rates and credit risk in maintaining bank liquidity, while companies are responsible for managing their principle and interest amount. Through this theory, banks can avoid liquidation and effectively manage their credit risk. Another important theory related to the banking sector is the *Credit Creation Theory*, which suggests that banks can create money and do not solely lend out deposits provided to them. This theory is concerned with credit risk and bank size, as banks lend money to deficit units based on their size and total assets As the size of the bank grows, it creates more credit, and vice versa. The significance of liquidity for the smooth functioning of the financial system was not widely recognized by financial economists, economic policymakers and academics until the global financial crisis of 2008. Since then, research on liquidity has gained increased attention. Scholars such as Diamond and Dybrig (1983), Vodova (2011), Adrian and Shin (2010), and the Basel Committee (2010) have emphasized the importance of effective liquidity management in preventing losses and ensuring profitability.

Empirical studies by Alger and Alger (1999), Bonfimm and Kim (2012), and Delechat *et al.* (2012) have identified bank size as a crucial factor affecting bank liquidity. The findings of these studies highlight the need to examine the factors that contribute to liquidity in the financial network and to consider effective liquidity management to preserve the inner role of banks in maintaining cash flow. In contrast to the findings of some studies, Dinger (2009) and Singh and Sharma (2016) have demonstrated that there is a negative correlation between the level of liquidity and bank size. Similarly, Alzoubi's (2017) study on liquidity risk determinants in Islamic banks across 15 countries from 2007 to 2014 indicated that bank size, capital, and return on equity (ROE) are negatively correlated with liquidity risk, while return on assets (ROA) and bad financing (PBL) are positively correlated with liquidity risk. However, Aspachs *et al.* (2005) found no significant impact of bank size on liquidity. Additionally, numerous empirical studies have confirmed a significant positive relationship between profitability and liquidity of commercial banks, as reported by Lartey *et al.* (2013), Vodova (2013), and Singh and Sharma (2016), while Delechat *et al.* (2012) found a negative correlation between profitability and liquidity. Minh's (2021) study on selected

[4] Several factors that majorly affected the liquidity of Pakistani banks have been ignored by existing studies. This study fills the research gap by taking into account those ignored factors to better understand Pakistan's current liquidity situation.

Nigerian deposit money banks revealed a significant association between liquidity and profitability but not between credit risk and profitability. Moreover, Aspachs *et al.* (2005) found no significant association between profitability and liquidity.

Distinguin *et al.* (2013) explored the relationship between bank regulatory capital and liquidity in banks across Europe and the United States from 2000 to 2006, discovering that these banks reduce their capital to increase liquidity. Similarly, Sharma and Singh (2016) found a positive correlation between banks' capital and commercial banks' liquidity. Berger and Bouwman (2009) agreed that larger capital and liquidity secure institutions reduce risk absorption during periods of solid liquidity demand, and risk absorption and liquidity generation capability increase with capital, as reported by Munteanu (2012), Distinguin *et al.* (2013), and Vodova (2013). However, some studies have shown that bank capital sufficiency negatively influences liquidity, such as Bunda and Desquilbet (2008), Delechat *et al.* (2012), Bhati and De Zoysa (2012), and Moussa (2015). Furthermore, several studies have examined the impact of the cost of funds on a firm's liquidity, revealing a significant correlation between the cost of capital and liquidity in some studies, as reported by Bunda and Desquilbet (2008), Munteanu (2012), Singh and Sharma (2016), and Shah *et al.* (2018). However, Singh and Sharma (2016) did not find any significant correlation between these variables. Moreover, Waemustafa and Sukri (2016) found a positive correlation between equity to total assets and liquidity, while Nguyen (2019) reported the opposite. This suggests that higher equity ratios may help banks build trust and attract customers in all aspects of their operations. Alger and Alger (1999) and Munteanu (2012) emphasized the importance of liquid assets for depositors to accommodate rapid withdrawals from banks, highlighting the need for businesses to maintain a sufficient level of liquid assets to survive the liquidity storm. Corporations must diversify their portfolios and include highly liquid assets to reduce their dependence on other banks for funding and avoid borrowing money from the country's central bank as a last resort when depositors unexpectedly withdraw their funds.

The empirical literature on the relationship between monetary policy rates and liquidity in the context of macroeconomic variables has generated mixed evidence. While some studies have found a positive association between monetary policy rates and liquidity (Vodova, 2011; Malik and Rafique, 2013; Sheefeni and Nyambe, 2016; Khan, 2021), others have concluded that the relationship is negative (Vodova, 2012, 2013). This underscores the importance of banks being equipped to adapt to changing interest rates. In addition to monetary policy rates, other macroeconomic variables have also been shown to affect liquidity. For example, Al-Homaidi *et al.* (2019) found that exchange rates significantly influence the liquidity of Indian commercial banks. Suleiman and Hakim (2021) investigated the determinants of liquidity risk behavior in Saudi Arabian Islamic and conventional banks, and found that bank size was positively related to liquidity risk among Islamic banks, while inflation was negatively related. In conventional banks, return on assets, bank size, return on equity, earning assets, and inflation were significant determinants of liquidity risk, but liquidity risk was negatively related to bank size. Studies have also examined the effects of bank-specific variables on liquidity risk. Effendi and Disman (2017) used fixed-effects and pooled OLS models to investigate the impact of bank-specific variables on liquidity risk, and found that non-performing loans and return on assets significantly affected liquidity risk in conventional banks, but not in Islamic banks. Refique *et al.* (2020) investigated the effect of management quality and capital adequacy on banks' liquidity, and found that management quality and capital adequacy ratios were strongly associated with banks' liquidity decisions. However, funding cost ratios and non-performing loans were found to significantly reduce the level of liquidity of Pakistan's commercial banks. Khan *et al.* (2021) examined the impact of bank-specific profitability factors on the default risk of 20 Pakistani commercial banks, and found that net interest margin, non-interest income to total assets, and spread ratios were significant determinants of default risk.

A recent study conducted by Mdaghri and Oubdi (2022) aimed to investigate the impact of bank-specific and macroeconomic determinants on liquidity creation in 153 banks operating in 12 MENA countries between 2008 and 2017. The study employed the Fixed-effects model and the Method of Moments Quantile Regression to analyze the data. The empirical findings reveal that capital, bank size, bank risk, deposits, and profitability significantly impact bank liquidity creation. However, market concentration does not affect credit creation. Furthermore, macroeconomic variables such as inflation, unemployment, savings, and monetary policy were found to explain changes in bank liquidity creation. From a cultural perspective, Lee *et al.* (2022) utilized a sample of 26,539 banks from 58 countries to investigate the impact of power distance, individualism, uncertainty avoidance, and masculinity on liquidity creation. The study found that power distance, uncertainty avoidance, and masculinity increase liability-side liquidity, while individualism decreases liability-side liquidity. The research highlights that the national culture is a significant determinant of bank liquidity creation. Similarly, Aqel (2022) examined the impact of bank-specific and macroeconomic variables on liquidity for 110 Palestinian commercial banks over the period 2010-2019. The empirical results show that bank size, capital, and inflation rate have a significant relationship with bank liquidity. Conversely, profitability, Z-score, funding costs, GDP growth rate, and unemployment rate have an insignificant relationship with bank liquidity.

The present study aims to investigate the impact of bank-specific and macroeconomic factors on the liquidity of banks in Pakistan. Prior research conducted in Pakistan has primarily focused on examining the effect of internal and external factors on the liquidity creation of commercial banks. While existing literature has identified several internal factors affecting liquidity in Pakistan, other critical determinants that influence bank liquidity have been overlooked. Notably, limited research has been conducted to explore the relationship between macroeconomic factors and bank-specific variables and their impact on the liquidity of Pakistani banks. In the current research, both bank-specific and macroeconomic factors are investigated to assess the effect of global financial shocks on the liquidity of banks operating in Pakistan.

III. VARIABLES DESCRIPTION

A. Data Source

This study investigates the impact of bank-specific and macroeconomic determinants on the liquidity of Pakistani banks, especially those listed on the Pakistan Stock Exchange (PSX). Pakistan has a total of 46 financial institutions, comprising 36 commercial and Islamic banks and 10 microfinance banks. Of these, 25 are local commercial banks, including 18 private and 7 public sector banks, while 3 are Islamic and 8 are foreign banks[5] (State Bank of Pakistan, 2020). The study employs a sample of 20 commercial banks in Pakistan, selected based on data availability. Panel data covering the period 2009-2018 is analyzed empirically. Bank-specific data is sourced from publications[6] by the State Bank of Pakistan, while macroeconomic data is obtained from the World Development Indicators (WDI, 2021) database and Business Recorder[7].

B. Definitions of Variables

The aim of this research is to investigate the impact of both macroeconomic and bank-specific variables on the liquidity of Pakistani banks. The internal factors considered in this study are bank size, credit risk, net interest margin, management efficiency, capital adequacy, profitability, and management quality. External factors include the SBP policy and exchange rates. There are two common methods used to describe banks' liquidity determinants: the liquidity gap approach and the liquidity ratio approach. However, this study utilizes the liquidity ratio approach due to several benefits. Firstly, it is useful for determining creditworthiness, which is crucial for the banking industry to assess their ability to repay loans. Secondly, it is beneficial in evaluating investment worthiness, which is valuable for investors. Thirdly, the liquidity ratio approach is widely used to measure liquidity due to its standardized method. Therefore, this study uses this approach to provide reliable and accurate results. Other studies, such as Praet and Herzberg (2008), Rychtarik (2009), Moore (2009), Ahmad and Rasool (2017), and Khan (2021), have also employed this approach to measure liquidity. Ahmad and Rasool (2017) state that the liquidity gap approach is not a classical method for determining liquidity. Equation 1 demonstrates how the liquidity of banks is calculated:

$$Bank\ Liquidity = \frac{Total\ liquid\ assets}{Total\ assets} \quad (1)$$

In addition, this study uses the equity to total assets ratio to measure capital adequacy, a method used by previous studies such as Berger and Bouwman (2009), Gorton and Winton (2000), and Moussa (2015). It is hypothesized that there is a negative relationship between firm capital structure and liquidity.

$$Capital\ adequacy\ ratio = \frac{Equity}{Total\ assets} \quad (2)$$

Profitability, as a critical indicator of financial performance in banks, is often measured by the return on asset as a proxy variable (Molyneux and Thornton, 1992; Naceur, 2003; Khrawish and Al-Sa'd, 2011; Moussa, 2015). As per the theory, we expect a negative relationship between profitability and liquidity.

$$Profitability = \frac{Net\ income}{Total\ assets} \quad (3)$$

Accordingly, the null hypothesis can be formulated as follows:

H_O: *There is no significant relationship between bank size and liquidity.*

In line with prior literature (Poorman and Blake, 2005; Al Khouri, 2012; Tseganesh, 2012; Vodová, 2013; Khan *et al.*, 2023), bank size was operationalized as the natural logarithms of a firm's total assets. It is hypothesized that there exists a positive relationship between bank size and liquidity.

$$Bank\ size = ln\ (total\ assets) \quad (4)$$

Accordingly, the null hypothesis can be formulated as follows:

H_O: *There is no significant relationship between bank size and liquidity.*

In the context of commercial banks, the net interest margin serves as a ratio for evaluating the efficacy of a bank's investment of its liquid assets in its expenditures. According to Hamadi and Awdeh (2012), this ratio serves as an indicator of financial institutions' efficiency. Based on this premise, we postulate a negative relationship between the net interest margin and liquidity.

$$\text{NIM} = \frac{\text{Interest receivable} - \text{Interest incurred}}{\text{Total assets}} \quad (5)$$

Accordingly, the null hypothesis can be formulated as follows:

H_O: *Net interest margin has a negative and significant effect on bank liquidity.*

Rashid and Jabeen (2016) defined management efficiency as the ratio of total expenditures to total assets in a bank, which provides an indication of the bank ability to effectively utilize its assets. Other studies have measured this measured this determinant by using a proxy of operating expenses to total assets (Lartey *et al.*, 2013; Moussa, 2015). Based on the theoretical relationship between management efficiency and liquidity, it is hypothesized that there exists a positive relationship between management efficiency and liquidity.

$$\text{Bank efficiency} = \frac{\text{Operating expense}}{\text{Total Assets}} \quad (6)$$

Accordingly, the null hypothesis can be formulated as follows:

[5] https://www.export.gov/article?id=Pakistan-US-Banks

[6] The data on bank-specific factors have been compiled from the 2009-2013 financial report until 2012, and the rest have been updated from the 2014-2018 financial report published by the SBP.

[7] https://markets.brecorder.com/company-information/financial-highlights.html

H_O: *Management efficiency has a positive and significant effect on bank liquidity.*

According to Brown and Moles (2011), credit risk represennts the likelihood of a party to default on its payment obligations as per the agreed terms. Typically, this ratio is computed using the proxy of "non-performing loans to total loans" (Vodová, 2011, 2012; Tseganesh, 2013). The hypothesis posits that there exists a negative relationship between credit risk and liquidity.

$$\text{Credit risk} = \frac{\text{Non-performing loan}}{\text{Total loan}} \quad (7)$$

Therefore, the null hypothesis can be formulated as follows:

H_O: *Credit risk has a negative and significant effect on bank liquidity.*

In the financial industry, the quality of assets held by a bank is often considered an important indicator of the managerial quality of the institution. This determinant is widely used to measure the extent to which banks have invested their deposits in a prudent and effective manner. As outlined by Lartey *et al.* (2013), the asset quality of a bank is commonly calculated as the ratio of bank advances to total deposits. By comparing the amount of loans granted by the bank to its overall deposit base, this ratio offers a useful proxy for evaluating the quality of a bank's asset portfolio.

$$\text{Managerial quality} = \frac{\text{Advances}}{\text{Total Deposits}} \quad (8)$$

The exchange rate, defined as the price of one currency relative to another (Khalid, 2017), is an important determinant that affect liquidity. Deléchat *et al.* (2012), Issah and Antwi (2017), Al-Homaidi *et al.* (2019) have all used the exchange rate as a proxy to measure this determinant. The exchange rate has been found to have a positive impact on liquidity. To measure the exchange rate, we used the Pakistani Rupee against the USD, as suggested by Khalid and Khan (2017), and calculated the average rate in a year (PKR/$).

$$Exchange\ rate = Average\ rate\ in\ a\ year(\text{Rs/\$}) \quad (9)$$

Thus, the null hypothesis can be formulated as follows:

H_O: *Exchange rate has a positive and significant effect on bank liquidity.*

The SBP's policy rate is often measured captured using the interest rate of the 6-month Treasury bill as a proxy (Rauch *et al.*, 2009; Ongore and Kusa, 2013; Vodova, 2013; Al-Homaidi *et al.*, 2019). These studies suggest a negative relationship between the interest rate and liquidity.

$$\text{SBP policy rate} = \text{Interest rate} \quad (10)$$

Thus, the null hypothesis can be formulated as follows:

H_O: *Interest rate has a negative and significant effect on bank liquidity.*

IV. MODEL SPECIFICATION AND METHODOLOGY

A. Econometric Specification

This study aims to investigate the impact of bank-specific and macroeconomic factors on the liquidity of Pakistani banks. The factors under examination include bank size, credit risk, net interest margin, management efficiency, capital adequacy, profitability, management quality, interest rate, and exchange rate. These factors have been extensively studied in the literature on bank liquidity (Malik and Rafique, 2013; Roman and Sargu, 2015; Zaghdoudi and Hakimi, 2017; Shah *et al.*, 2018; Khan, 2021). The econometric model for panel data estimation in the context of Pakistani commercial banks can be expressed using Equation 11.

$$Y_{it} = \alpha_0 + \beta_1 X_{it} + \varepsilon_{it} \quad (11)$$

In Equation 11, Y_{it} is the dependent variable where *i* and *t* represent the cross-sectional and time-series units, respectively. Similarly, α_0 denotes the intercept and β_1 denotes the slope of the regression line, which needs to be estimated. X_{it} represents the set of independent variables (i.e., i = 1, 2, …, N and t = 1, 2, …, T). We assume that: $E(u_{it}) \sim N(0, \sigma^2)$. Previous literature suggested a linear multivariate regression model to examine the bank-specific and macroeconomic factors of liquidity. Equation 12 shows the specific econometric model for liquidity.

$$LIQ_{it} = \beta_0 + \beta_1 ROA_{it} + \beta_2 NIM_{it} + \beta_3 CAP_{it} + \beta_4 Size_{it} + \beta_5 CR_{it} + \beta_6 MQ_{it} + \beta_7 ME_{it} + \beta_8 MIR_{it} + \beta_9 EXCH_{it} + \varepsilon_{it} \quad (12)$$

In Equation 12, LIQ_{it} represents the liquidity of commercial banks, β_0 is the intercept term, and $\beta_i' s$ are the slope coefficients of explanatory variables. The explanatory variables include profitability (*ROA*), net interest margin (*NIM*), capital adequacy ratio (*CAP*), bank size (*Size*), credit risk (*CR*), managerial quality (*MQ*), management efficiency (*ME*), interest rate (*MIR*), and exchange rate (*EX*) for all cross-sectional units (i = 20 commercial banks) and time (t = 2009-2018).

B. Methodology

This study employs panel data[8] analysis to examine the effect of bank-specific and macroeconomic factors on the liquidity of Pakistani banks. In econometrics, fixed-effects models (FEM) and random-effects models (REM) are the two commonly used approaches to estimate panel data. The FEM assumes that the intercept varies across time but the slope coefficient remains constant (Gujarati, 2004). Equation 13 presents the general form of the FEM used in this study:

$$Y_{it} = \alpha_i + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} \ldots + \beta_k X_{kit} + \varepsilon_{it} \quad (13)$$

[8] Panel data combines the time-series and cross-section data (Asteriou & Hall, 2011; Wooldridge, 2012).

In panel data estimation, the choice between fixed-effects and random-effects models depend on the variability of the observed events and the intercepts of each bank. When the intercepts differ, the FEM is preferred (Asteriou and Hall, 2011). This model is also appropriate when there is autocorrelation between the error term and the explanatory variables (Shah *et al.*, 2018). In contrast, REM assume that the intercepts of all banks are not fixed but random parameters. Thus, the variation in the constant terms of all banks can be represented as follows:

$$\alpha_i = \alpha + v_i \quad (14)$$

In Equation 14, v_i denotes the standard random variable having zero mean and standard deviation 1. The extended form of the REM can be represented as follows:

$$Y_{it} = (\alpha + v_i) + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \cdots + \beta_k X_{kit} + \varepsilon_{it} \quad (15)$$

$$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \cdots + \beta_k X_{kit} + (v_i + \varepsilon_{it}) \quad (16)$$

In the context of panel data estimation, the selection between REM and FEM depends on the presence of multicollinearity between the dependent variable and error term. If such multicollinearity exists, FEM is preferred over REM. The choice between these two models can be determined through the Hausman test, which examines the correlation between the individual unobserved effects and the coefficients in the two models. The econometric literature suggests that FEM is more suitable for balanced panel data estimation, whereas REM is more appropriate for a sample with a limited number of cross-sectional observations. The Hausman test, proposed by Ahn and Moon (2001), formulates two hypotheses: the null hypothesis assumes that random effects are consistent and efficient, while the alternative hypothesis posits that random effects are inconsistent. The test statistic for the Hausman test is expressed as follows:

$$H = \left(\beta^{\widehat{FE}} - \beta^{\widehat{RE}}\right)' \left[Var\left(\beta^{\widehat{FE}}\right) - Var\left(\beta^{\widehat{RE}}\right)\right]^{-1} \left(\beta^{\widehat{FE}} - \beta^{\widehat{RE}}\right) \sim X^2(k) \quad (17)$$

The Hausman test is employed to determine whether the REM or the FEM is more appropriate for estimating panel data. The test formulates two hypotheses: the null hypothesis suggests that the random-effects are consistent and efficient, while the alternative hypothesis asserts that the random-effects are inconsistent. If the Hausman's test statistic value is large, the difference between the two models' estimates is significant, leading to rejection of the null hypothesis. Conversely, if the Hausman's test statistic value is low, we conclude that the random-effects estimators are more appropriate than the fixed-effects estimators. In Table 6, the Hausman test indicates that the FEM is more appropriate than the REM. Therefore, we employ the fixed-effects model for panel data estimation in this study.

V. EMPIRICAL RESULTS

A. *Descriptive Statistics*

The primary objective of descriptive statistics is to provide an understanding of the characteristics and overall patterns of the data within the sampling period. As shown in Table 2, Pakistani banks exhibit an average liquidity buffer of 8.10% and an average capital adequacy ratio of 8.70%. The maximum liquidity buffers observed were 0.183 and 0.298, while the minimum values were between 0.003 and 0.016. It is imperative for financial institutions to maintain profitability, with return on assets (ROA) serving as a measure of profitability throughout the sample years. The average ROI is 0.007, with the highest and lowest values at 0.035 and -0.054, respectively. Notably, the negative ROA values may be attributed to significant losses experienced by commercial banks due to mergers and acquisitions between 2007 and 2012, such as HBC Mergers and Acquisitions with Meezan Bank, Barclay Bank Mergers, and Acquisitions with Habib Bank. Moreover, the capital adequacy ratio of Pakistani banks stands at 8.7%, which is slightly above the State Bank of Pakistan's (SBP) minimum requirement of 8%. Management efficiency (ME) analysis reveals that Pakistani banks have an ME of approximately 31%, ranging between 0.807 and 0.145. During the sampling period, Pakistani firms amassed substantial deposits, with an average bank size of 19.65%. The average interest rate is around 9.9%, while the average exchange rate is 0.062%. It is worth noting that Pakistan's policy rate was approximately 14% throughout the sample period, which is reflected in the highest interest rate observed. Similarly, the highest exchange rate figure of 0.268 is reflective of Pakistan's nominal exchange rate reaching as high as 0.268 during the analysis period. Furthermore, the interest and exchange rates remained at 6.2% and -0.041%, respectively.

Table 2: Descriptive Statistics (*n=200*)

Variable	Mean	Std. Dev.	Min.	Max.
LIQ	0.081	0.026	0.003	0.183
ROA	0.007	0.013	-0.054	0.035
NI	0.033	0.02	-0.016	0.191
CAP	0.087	0.044	0.016	0.298
Size	19.65	1.08	16.99	21.83
CR	0.115	0.079	0.00[9]	0.516
MQ	0.006	0.001	0.00	0.014
ME	0.309	0.106	0.145	0.807
MIR	0.099	0.028	0.062	0.139
EXCH	0.062	0.078	-0.041	0.268

Note: Descriptive statistics are calculated for each variable from 2009 to 2018.
Source: Data processed by the author

B. *Correlation Analysis*

The correlation matrix is an essential tool for evaluating the relationship between variables in an econometric model. However, the presence of severe multicollinearity may lead to biased estimates, violating the classical assumption of Ordinary Least Squares (OLS). According to Kennedy (2008) and Malhotra (2007), severe multicollinearity arises when the correlation coefficient between two independent variables exceeds 0.70 or 0.75, respectively. Table 3 illustrates that bank liquidity (LIQ) is positively correlated with profitability (ROA), net interest margin (NIM), capital adequacy ratio (CAP), bank

[9] The Standard Chartered Bank and Bank Al Habib Limited have 0 credit risk values in 2016 and 2018, respectively.

size (Size), managerial quality (MQ), management efficiency (ME), interest rate (MIR), and exchange rate (EX). In contrast, bank liquidity exhibits a negative correlation with credit risk (CR). Notably, the correlation coefficient between the net interest margin (NIM) and credit risk (CR) is the highest, measuring -0.415. Nevertheless, as all pairwise correlations are less than 0.70, the results indicate that problematic multicollinearity is not present among the examined variables.

Table 3: Pairwise correlations

Variable	*LIQ*	*ROA*	*NIM*	*CAP*	*SIZE*	*CR*	*MQ*	*ME*	*MIR*	*EXCH*
LIQ	1.000									
ROA	0.127	1.000								
NIM	0.127	0.054	1.000							
CAP	0.036	0.060	0.185*	1.000						
SIZE	0.239*	0.048	0.148*	-0.334*	1.000					
CR	-0.077	-0.193*	-0.415*	-0.024	-0.231*	1.000				
MQ	0.079	-0.288*	0.138	0.131	-0.180*	-0.068	1.000			
ME	0.042	-0.044	-0.148*	0.234*	-0.320*	0.007	0.156*	1.000		
MIR	0.217*	0.078	0.244*	0.234*	-0.385*	0.276*	0.132	-0.111	1.000	
EXCH	0.022	0.017	-0.111	-0.135	0.131	-0.130	0.007	-0.027	-0.169*	1.000

Note: '' shows significance at the 0.05 significance level.*
Source: Data processed by the author

In order to confirm the absence of induced multicollinearity in the data, the study additionally conducted a Variance Inflation Factor (VIF) analysis. Table 4 presents the VIF values for each explanatory variable, all of which are found to be less than 10. This indicates that there is no severe multicollinearity issue present in the data. Moreover, the study conducted pre-diagnostic tests such as White's test and the Jarque-Bera test, which further confirmed that the error terms are homoscedastic and normally distributed. These tests help to ensure the validity of the econometric model and strengthen the reliability of the results.

Table 4: Variance inflation factor

Variable	VIF	1/VIF
Size	1.736	0.576
MI	1.728	0.579
NI	1.709	0.585
CR	1.652	0.605
ME	1.470	0.680
MQ	1.291	0.774
ROA	1.288	0.776
CAP	1.281	0.781
EXCH	1.041	0.961
Mean VIF	1.466	---

Source: Data processed by the author

C. *Likelihood Test*

In this study, the suitability of panel estimation approaches, namely the common constant and fixed-effects models, was evaluated using the likelihood test. The test result was presented in Table 5, and it was found that the FEM was more appropriate for the panel data analysis. This conclusion was drawn based on the computed *p*-value of 0.00, which was less than the associated significance level of 0.05. As a result, the null hypothesis (H_0) was accepted, and the alternative hypothesis (H_1) was rejected.

H_0: The fixed-effects model is appropriate.
H_1: The common constant effects model is appropriate.

Table 5: Likelihood test

Effects Test	Stat.	*d.f*	Prob.
Cross.-section. *F*.	7.819	-19171.00	0.000
Cross.-section Chi-square.	125.052	19.000	0.000

Source: Data processed by the author

D. *The Hausman Test*

In econometric analysis, the selection of the appropriate panel data estimation approach between fixed-effects model and random-effects model is a critical decision. To assist in this process, researchers often utilize the Hausman test, which compares the two models' estimates and evaluates which one is more appropriate for a particular dataset. In the current study, Table 6 displays the results of the Hausman test, which indicates that the calculated test value (11.134) exceeds its critical value. Hence, the null hypothesis (H_0) is rejected in favor of the alternative hypothesis (H_1), indicating that the FEM is more suitable for estimating the model parameters. This result supports the utilization of the FEM in the current study.

H_0: The REM is suitable for the data.

H_1: The FEM is suitable for the data.

Table 6: The Hausman test

Test. cross-section. Random. Effects.			
Summary.	*Chi-sq. statistic*	*Chi-sq. d.f.*	*P-value*
Cross-section. random	11.133800	9	0.0000

Source: Data processed by the author

E. Results of Regression Analysis

The present study employs the fixed-effects model (FEM) to estimate a multivariate econometric specification for the sample period. The FEM is preferred by researchers due to its ability to provide consistent and robust estimation results. The results of the FEM estimation are presented in Table 7, which shows that although statistically insignificant, the capital adequacy ratio positively influences the liquidity of commercial banks in Pakistan. Banks with high liquidity are better equipped to facilitate firms in carrying adequate capital to support their transactions. Conversely, banks that rely heavily on substantial loans to the government against bank deposits may find it difficult to meet their capital requirements. Our results align with previous studies (Munteanu, 2012; Vodova, 2013; Shah *et al.*, 2018). Moreover, the analysis reveals that bank size has a statistically significant negative impact on bank liquidity in Pakistan at the 1% significance level. This finding supports the "too-big-to-fail" hypothesis proposed by Lannotta *et al.* (2007) and other empirical studies (Alger and Alger, 1999; Kashyap *et al.*, 2002; Vento and Ganga, 2009; Hackothal *et al.*, 2010; Vodova, 2011). Shah *et al.* (2018) also observed that the effect of bank size on bank liquidity varies with the measure of liquidity employed. Finally, the results indicate that firms' profitability has a positive but statistically insignificant impact on bank liquidity. This finding suggests that banks with higher profitability may find it easier to maintain higher levels of liquidity. This result is consistent with prior studies (Aspachs *et al.*, 2005; Shah *et al.*, 2018). Overall, the FEM estimation results provide valuable insights into the determinants of bank liquidity in Pakistan.

According to Khidmat and Rehman (2014), banks' profitability is beneficial during times of liquidity shortages but does not support solvency. This is because liquidity is required for day-to-day operations, whereas bank profitability pertains to a more extended period (Aspachs *et al.*, 2005; Olarewaju and Adeyemi, 2015; Shah *et al.*, 2018). Our findings indicate that the net interest margin (NIM) negatively impacts bank liquidity in Pakistan, and this correlation is statistically significant at the 10% level of significance. The rise in NIM prompts banks to focus more on lending activities, causing the proportion of liquid assets to decline (Vodova, 2013). This outcome aligns with Moussa's (2015) discovery. Furthermore, our empirical results reveal that credit risk has a negative and significant effect on the liquidity of Pakistani banks. A 1% increase in non-performing loans causes the bank's average liquidity to decrease by 4.6%. Consequently, borrowers are unable to repay their loans, resulting in a loss of bank liquidity that should be returned to firms to fulfill loans, including interest rates and commissions. This scenario exposes banks to liquidity risk, and during financial shocks, borrowers may not be able to repay their loans, leading to a substantial drop in liquidity rates and bank bankruptcy. This tragic situation disrupts the smooth functioning of banks in the economy, a finding that is supported by other studies (Gautam, 2016; Ojha, 2018; Shahms *et al.*, 2018; Khanal, 2019). Moreover, our results demonstrate a significant correlation between management efficiency and liquidity. Specifically, a 1% increase in management efficiency results in a 0.1% increase in bank liquidity. This outcome is consistent with Malik and Rafique's (2013) finding that a significant increase in operating expenses has a substantial impact on liquidity.

The findings also shed light on the relationship between the SBP policy rate and banks' liquidity, which is found to be positive and statistically significant. However, the underlying connection is negative, as observed in previous research by Vodova (2013). Moreover, Malik and Rafique (2013) found that the interest rate positively influenced bank liquidity in Pakistan, while Laurine (2013) demonstrated a similar positive relationship between the interest rate and banks' liquidity risk in Zimbabwe. Additionally, the estimation findings reveal that the exchange rate positively determines bank liquidity in Pakistan, which is consistent with Al-Homaidi *et al.*'s (2019) results, which focused on banks in India. The statistical diagnostic tests conducted in the present study suggest that the proposed econometric model is suitable since it explains 44% of the total variation in bank liquidity by all explanatory factors, as measured by the R^2. Other key statistical tests, including the adjusted R^2, standard deviation, and F-statistic, also indicate that the proposed econometric specification is reasonable and well-fitted.

Table 7: Regression Results

Variable	*Coefficient*	*S. E*	*P-value*	*Significance*
Constant	-0.265	0.047	0.000	***
NIM	-0.178	0.105	0.092	*
CAP	0.027	0.041	0.518	
Size	-0.014	0.002	0.000	***
CR	-0.046	0.026	0.081	*
MQ	2.366	1.343	0.080	*
ME	0.001	0.000	0.005	***
ROA	0.208	0.148	0.162	
EXCH	0.138	0.042	0.001	***
MIR	0.412	0.076	0.000	***
R^2: 0.4412 *Adjusted R^2: 0.3281* *F- statistic: 3.42* *Probability: 0.0035*				

Note: **P<0.1, weak significant; **P<0.05, semi-strong significant; ***P<0.01, strong significant*
Source: Data processed by the author

VI. CONCLUSION AND POLICY RECOMMENDATIONS

This study presents an empirical investigation into the factors affecting bank liquidity in Pakistan, focusing on both bank-specific and macroeconomic variables. The bank-specific factors studied include profitability, net interest margin, capital adequacy ratio, bank size, credit risk, managerial quality, and management efficiency. The macroeconomic variables analyzed include the monetary policy rate and exchange rate. The study employs the fixed-effects model to

analyze panel data from 20 commercial banks operating in Pakistan over the period of 2009-2018. Bank liquidity is measured using the liquidity ratio approach, a widely used method in the literature. The study's main findings reveal that managerial quality, management efficiency, exchange rate, and interest rate are positively and significantly associated with bank liquidity. However, net interest margin, bank size, and credit risk are negatively related to bank liquidity. Bank capital and profitability have a small but significant impact on banks' liquidity. The economic impact of exchange rate on banks' liquidity is relatively low (0.138). The study's results contribute to the existing literature by providing preliminary insights into the factors influencing liquidity in the commercial banks of Pakistan, which can aid banks in managing liquidity risk and determining appropriate liquidity situations. The negative relationship between profitability and liquidity suggests that commercial banks are encouraged to invest liquid cash to increase profits. The empirical findings are expected to serve as a reference and guide for the central bank in developing policies related to bank liquidity management to ensure effective regulation of Pakistan's banking sector. For example, the accumulation of bad loans negatively affects banks' risk profile and liquidity, reducing their ability to meet their liabilities and increasing the likelihood of default. Therefore, the central bank must monitor bank loan policies and take appropriate actions to address non-performing loans.

The study's empirical findings have important implications for various stakeholders, including scheduled banks, the State Bank of Pakistan (SBP), and the overall economy. Given the potential for bank runs and the subsequent decline in liquidity, the SBP should closely monitor key determinants that significantly impact banks' liquidity in Pakistan. Failure to address these issues in a timely manner could result in liquidity stress and financial turmoil. Given that a lack of liquidity is typically the primary cause of bank failure, bank capital serves as a safeguard against liquidity shortfalls. Therefore, the SBP should routinely evaluate the capital strength of all banks. As per SBP policy regulations (2013), banks are required to maintain a minimum of 8% bank capital to function effectively. However, the study highlights that this minimum bank capital requirement is relatively low, which could create liquidity risk issues for banks. A strict recovery policy should be in place, particularly given that the maximum non-performing loans are around 40%. Finally, the SBP should consider implementing other monetary policy tools, such as open market operations, bank rates, and required reserve ratios, to enable it to weather liquidity crises. By taking these steps, the SBP can ensure that Pakistan's banking sector is resilient and that the economy remains stable.

Despite its significant contribution, this study has several limitations that need to be acknowledged. Firstly, due to the unavailability of complete data sets, some banks were excluded from the empirical investigation, which could have impacted the results. Secondly, it is important to investigate whether maintaining liquid cash has produced additional costs for Pakistani banks in the short-term and medium-term. Furthermore, extending the analysis to examine the impact of bank-specific factors on the liquidity of small, medium, and large banks in Pakistan would provide additional insights. Additionally, researchers can broaden the analysis to include non-financial entities, such as microfinance banks, investment banks, mutual fund companies, insurance companies, or leasing companies. Finally, further studies could consider other bank-specific factors (e.g., total deposits, cost of funds, interest rate margin, loan growth, asset quality, etc.) and macroeconomic variables (e.g., real GDP, inflation, unemployment, trade balance, etc.) to provide a more comprehensive understanding of liquidity.

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On behalf of all authors, the corresponding author states that there is no conflict of interest. The authors, however, alone are responsible for the content and writing of the paper.

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APPENDIX

Table 1: List of Variables

Variable	Formula	Reference
Liquidity	$\text{Bank Liquidity} = \frac{\text{Total liquid assets.}}{\text{Total assets.}}$	Moussa (2015)
Bank Size	$\text{Bank Size} = \ln(\text{total assets})$	Al Khouri (2012)
Capital adequacy ratio	$\text{Capital adequacy ratio} = \frac{\text{Total Equity.}}{\text{Overall assets}}$	Berger and Bouwman. (2009)
Profitability	$\text{Bank's profitability} = \frac{\text{Net income}}{\text{Total assets}}$	Khrawish (2011)
Net interest margin	$\text{NIM} = \frac{\text{Interest receivable} - \text{Interest incurred}}{\text{Total assets}}$	Moussa (2015)
Credit risk	$\text{Credit risk of Banks} = \frac{\text{Non} - \text{performing loan}}{\text{Total loan}}$	Tseganesh (2012)
Managerial quality	$\text{Managerial quality of Banks} = \frac{\text{Advances}}{\text{Total deposits}}$	Lartey *et al.* (2013)
Management efficiency	$\text{Bank efficiency} = \frac{\text{Operating expense}}{\text{Total assets}}$	Al-Homaidi *et al.* (2019)
Exchange rate	$\text{Exchange rate} = \text{Average rate in a year}$	Issah and Antwi (2017)
Monetary policy	$\text{Monetary policy rate} = \text{Interest rate (T-bills)}$	Al-Homaidi *et al.* (2018)