

Banking Transparency, Financial Information and Liquidity Risk Management: Case of Saudi Banks

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Received: August 18, 2023

Accepted: October 23, 2023

Online Published: October 27, 2023

doi:10.5539/ibr.v16n11p42

URL: <https://doi.org/10.5539/ibr.v16n11p42>

Abstract

The article aims to assess the impact of banking transparency on liquidity risk. To do so, we first test the determinants of Liquidity Coverage Ratio (LCR) as well as ensure the resilience of the Saudi banking system over the period from 2014 to 2021. Using System GMM with bank-specific and macroeconomic variables, results show that capital adequacy ratio, SIZE, GDP growth as well as past LCR levels significantly influence the LCR. Secondly, we adopt the Panel Vector Auto Regression (PVAR) approach to assess the response of the LCR to various shocks. Impulse Response Functions (IRF) and variance decomposition demonstrate that the shocks to past LCR, AQ, CAR and GDP increase future liquidity risk. Thirdly, we prove that Saudi banks implement less than 50% of the transparency dimensions. They mainly disclose financial information and information on information credibility. Barely 18% of information on non-financial components of banking activity is made available to the public. Information on liquidity risk and on the timeliness of information is not available either in annual reports or on the bank's website. On average, the banks in the sample do not give importance to the publication of reports. These results may undermine the effectiveness of the guidelines of the Basel Committee agreements to reduce risk-taking by Saudi banks.

Keywords: banking transparency, financial information, liquidity risk, stress tests, Saudi banks, GMM, PVAR

1. Introduction

The subprime crisis has encouraged researchers to focus on the subject of liquidity risk, since it was one of the main factors of the noted financial contagion and credit crunch. Most researchers pointed out that liquidity risk management in the banking sector reinforces financial stability, and an adequate management should have an accurate system of identification to control and monitor liquidity risks (El Chaarani, 2019). Basel III underscored the importance of maintaining an adequate level of liquid assets and encouraged banks to increase their liquidity level in order to fulfil their commitments and limit risks arising during crises in order to limit losses. Banks must be cautious when managing liquidity risk, as they cannot risk having liquidity problems, which will harm their reputation. Banks often rely on assets and liabilities management to deal with liquidity position and prevent liquidity runoff (Ahamed, 2021). Furthermore, the Basel III accord introduced several regulatory reforms aiming to monitor liquidity risk and reinforce stability and soundness of banks. Indeed, the Basel III accord underlined the need to develop a more robust and sound stress tests unlike Basel II. The reason is that, stress tests have become efficient tools for analysing financial stability, especially from the view of central banks where stress testing became a prudential measure to analyse risk exposure in banks (Jiang *et al.* 2018). Stress tests are a tool used to manage risks in the banking sector in order to examine the possible impact of extreme but plausible shocks on banks. This final stage of the Basel III framework, which is referred to as “Basel IV” by the industry, was published by the BCBS in December 2017. Basel IV comprises measures that aim at enhancing the robustness and risk sensitivity of the standardised approaches (SA) for credit risk and operational risk. In addition, it constrains the use of internal ratings-based (IRB) approaches to credit risk, removes the use of internal modelling approaches to operational risks from the calculation of regulatory capital requirements and overhauls standards with respect to credit valuation adjustment (CVA). These reforms are expected to facilitate the comparability of banks’ capital ratios.

According to Flannery *et al.* (2017), reporting stress test results offers crucial information about the tested institutions. Indeed, disclosing stress test results boosts financial stability by restoring trust and reducing bank

opacity as these test help investors to identify resilient and vulnerable banks. Following the financial scandals that rocked the world, particularly the financial sector, the Basel Committee adopted more restrictive transparency standards. Indeed, the Basel 2 accords have been applied in several developed countries since early 2006, while most emerging countries have yet to follow. Indeed, since its creation in 1974, one of the Basel Committee's main objectives has been to increase the resilience of the global banking system. To achieve these objectives, the committee has sought to improve bank transparency, through the three pillars that make up the Basel Accords. In addition, the Basel Committee published a report in October 2010 in which it stressed that the 2007-08 international financial crisis had highlighted the inadequacy and inconsistency of the financial information provided by many banks on their risk exposure and regulatory capital. To address these reporting deficiencies, and following a careful assessment of best practices, the Committee decided in July 2009 to review Pillar 3 requirements for securitization exposure and support for off-balance sheet structures, among others. In addition, there is insufficient information on the components of equity, making it difficult to accurately assess their quality or to make relevant comparisons between banks. Furthermore, there is often no reconciliation with the published accounts. To improve transparency and market discipline, the Committee requires banks to disclose all the components of regulatory capital. Banks are required to ensure that the main features of capital instruments are easy to understand and consult. This crisis has revealed considerable shortcomings in the application of the basic principles of liquidity risk management. It has also highlighted the shortcomings and inadequacies of the Basel II framework and the shortcomings of financial institutions in monitoring liquidity risk. As a result, the Basel Committee for Banking Supervision has introduced international standards and prudential rules for managing and measuring liquidity risk as convened in the Basel III agreements, to enable banks to improve their liquidity and solvency.

In this study, we try to answer the following questions: What are the main determinants of liquidity risk in Saudi banks? Specifically, we try to answer the following two sub-questions: 1- To what extent are these determinants influential? 2- What is the impact of the main micro and macroeconomic shocks on bank liquidity risk? It is also a question of knowing the impact of banking transparency and the disclosure of financial information on liquidity risk. Our contribution consists of (1) adopting the Panel Vector Auto Regression (PVAR) approach to assess response of Liquidity Coverage Ratio (*LCR*) to adverse shocks; (2) Construction of the multidimensional index of banking transparency and measurement for the case of Saudi bank and (3) Test of the impact of banking transparency and the disclosure of financial information on the liquidity risk of banks.

The rest of the paper is structured as follows. Section 2 reviews the relevant literature. Data analysis and methodology are presented in Section 3. Section 4 reports and discusses the empirical results. Finally, Section 5 concludes the paper.

2. The Relevant Literature

2.1 Liquidity Risk Factors

Several studies have examined the main bank specific and macroeconomic factors that affect liquidity risk. Anindyajati & Hanggraeni (2022) studied 33 commercial banks in Indonesia during the 2018-2021 period in order to examine the determinants of *LCR* before and during the covid-19 crisis. They found that the factors that affected *LCR* before the pandemic are the Capital Adequacy Ratio (*CAR*), Non-Performing Loans (*NPL*) and Return on Assets (*ROA*). Kasana *et al.* (2022) studied the determinants of liquidity risk in the Indian banking system during the 2008-2020 period using two different liquidity measures. They found that the liquid assets to total assets ratio has a significant relationship with the Size, Net interest Margin (*NIM*) and Gross Domestic Product (*GDP*), while the loans to total assets ratio has a significant relationship with *NIM* and interest rate. Hussain *et al.* (2022) focused on liquidity risk in Islamic banks using the Loan to Deposit (*LTD*) ratio and found that non-performing loans, bank size, leverage ratio and return on assets are key unsystematic determinants of the liquidity risk of Islamic banks. Ahamed (2021) examined 23 commercial banks in Bangladesh during the 2005-2018 period and found that Bank size, *GDP* and domestic credit positively impacted liquidity while inflation negatively impacted it. El-Chaarani (2019) studied 183 Middle Eastern banks during the 2014-2016 period using two different liquidity measures and found that economic growth, assets quality, capital level and size all had a significant impact on liquidity. Khanal (2019) examined 10 Nepalese commercial banks during the 2007-2017 period using the *LTD* ratio. The author found that *ROE*, *SIZE* and inflation impact liquidity significantly and negatively while *ROA* impacts liquidity significantly and positively. Shah *et al.* (2018) used two liquidity measures to study liquidity risk in 23 Pakistani banks during the 2007-2016 period. They found that unemployment and *GDP* have a significant effect on liquidity while deposits have a significant negative impact on liquidity. Ghenimi *et al.* (2021) examined liquidity risk in 25 Islamic banks in the MENA region during the 2006-2014 period. They found that *NPL*, bank size, liquidity gap, capital adequacy and *GDP* all have a

significant impact on liquidity and that Islamic banks are more sensitive to bank-specific factors, because of prohibition of Riba. Taleblo *et al.* (2022) used macro stress tests to assess liquidity in the Iranian banking system. They found that exchange rate shocks and stock market price index have the greatest impact on banks' liquidity risk. Ekananda (2022) studied the response of the stock price index, inflation, consumer price index, and GDP in Southeast Asia countries to disturbances from global variables such as world liquidity. The author found that the shock on the world GDP and world liquidity affected inflation and GDP in the selected SEA countries. Patra & Padhi (2022) found that the impact of stress tests is substantial for public banks unlike for private and foreign banks. Khammasi *et al.* (2020) examined a sample of conventional and Islamic banks operating in the MENA region in order to assess the financial resilience of liquidity risk in the face of adverse shocks. They found that liquidity risk positively reacts to shocks arising from inflation, credit risk, size and GDP. Jiang *et al.* (2018) used macro stress tests to study resilience of the Chinese banking system. They found that shocks to GDP and exchange rate negatively affect the Chinese banking sector and that the Chinese banking sector proved to be resilient to interest rate shocks.

2.2 Measuring Banking Transparency

Few studies have addressed the issue of banking transparency. Three indices of bank disclosure are proposed in the literature. The first indicates that banks listed on the New York Stock Exchange, the Nasdaq or the American Stock Exchange must comply with the restrictive disclosure rules required by these markets, which, according to the authors, guarantees their transparency. As a result, the return demanded by depositors is relatively low compared with banks trading outside these markets. Leuz & Verrecchia (2000) have shown that German companies which voluntarily adopt US GAAP (Generally Accepted Accounting Principles in the United States) for their activities have recorded low levels of information asymmetries and high liquidity of their securities, in contrast to firms which have adopted the German regime. The second indicator is based on bank ratings. If an internationally recognised rating agency (Standard & Poor's, Moody's or Fitch) rates a bank, investors should have more information about the bank. Rating agencies act as intermediaries in the information disclosure process. They access information not obtained publicly by investors and incorporate it into the bank's rating estimates. In fact, Klinger & Sarig (2000) believe that this is the real reason why companies generally pay estimated costs. It allows companies to incorporate internal information into the assigned estimates without revealing specific details to the public. The index takes the form of indicator variables. If the bank is rated by an internationally recognised rating agency, the index value is 1, otherwise it is 0. The third information measure is based on the information contained in financial statements. This index provides information on 17 types of information disclosed in the annual report by the bank as indicated in the "Bank scope" database. All categories relate to one or more dimensions of the bank's risk profile (interest rate risk, credit risk, market risk, liquidity risk). Each category is represented by a sub-index, which measures the level of detail that the bank publishes in its annual report. Baumann & Nier (2004) and Nier (2005) also use this indicator as a transparency indicator. The first two indices are an indirect measure of the amount of information available to investors. The advantage of the third index is that it is a direct measure of the amount of information disclosed to the market. However, it does not take into account all the dimensions of information (exhaustiveness, periodicity, opportunities and accessibility). In addition, it ignores non-financial information disclosed by banks.

According to Nelson (2001), appropriate measurement standards include the following four dimensions: (1) completeness of information; with the exception of some information designated as undisclosed (internal staff issues, confidential negotiations with the private sector, etc.); (2) the accessibility of the information; depending on the nature of the publication medium (websites, specialist magazines, etc.), the language reporting the documents, the cost of consulting the documents, etc.; (3) the timeliness of the information: this is appropriate if the timing of the disclosure of the information enables investors to respond to company announcements. (Example: disclosure of project details before the board vote); (4) Investors' right of recourse; the possibility for investors to influence the bank's decision-making process. Furthermore, Baumann & Nier (2004), recognized that their disclosure measures could be improved by incorporating periodicity and timeliness of the information exchanged. Ben Douissa's (2011) study is the first to display a transparency measure based on four dimensions (completeness, timeliness, credibility and accessibility) of information. It should be noted that to study transparency, the author used elements disclosed by the bank in line with the recommendations of the third pillar of the Basel III agreements. The index developed includes 43 sub-indices. Each set of indices represents a specific dimension of information. Binary notation is used to score the sub-indices. Empirically, the author constructed a banking transparency index for a sample of 69 banks in 7 emerging economies. The results show that Turkish and Thai banks are ahead in terms of disclosure of financial information. However, North African banks are the most likely to lack transparency. According to Ben Douissa (2010) the major deficiencies in bank transparency in

emerging countries do not essentially affect the quantity of information disclosed but rather its quality. Nier's (2005) empirical study of 550 listed banks in 32 countries (developed and emerging) clearly showed that bank transparency has a positive impact on resilience. In the banking sector, depositors can strengthen controls and protect themselves more effectively against excessive risk-taking. Consequently, as a result of increased transparency, shareholders have imposed stricter controls on management. Bushman *et al.* (2004) constructed an average index of the frequency and completeness of interim reports for a sample of 60 countries. Therefore, disclosure credibility measures the degree to which the information disclosed by the bank has been checked by independent, professional and strict external audits (such as bank audit practice management regulations). Therefore, a high degree of transparency is required in a banking system marked by high information asymmetry, high risk and high risk of inefficient banks (Diamond & Verrechia, 1991; Hirtle, 2007; Akhigbe *et al.* 2017). A high degree of transparency is also necessary when a large number of banks are state-owned (Srairi, 2013). On the contrary, when the financial system is not well developed, banking activity is not very complicated, bank capital is concentrated and the quality of governance of the institution is poor, less transparency is required (Schadewitz & Blevins, 1998; Srairi, 2013). Similarly, according to Andrievskaya & Semenova (2016), a low degree of transparency is required when there are a large number of banks with doubtful assets (Andrievskaya & Semenova, 2016).

2.3 Transparency, Disclosure of Information and Banking Risk

There is an extensive theoretical literature on the relationship between transparency and banking risk. Overall, this literature shows that although credible public information about individual banks can improve the ability of regulators and market participants to monitor bank behaviour, transparency entails enormous internal costs. The consequences of transparency can be good or bad. However, it remains an open research question. According to Greuning & Iqbal (2008), transparency cannot prevent financial crises, but it can mitigate market players' reactions to bad news by helping them to anticipate and evaluate negative information. Empirical results show that greater information sharing will reduce banking risks and the possibility of financial crises. Moreover, in the event of a crisis, the cost of loss under a high disclosure system will be lower than under low disclosure systems. In a cross-border study of banking systems in 49 countries in the 1990s, Tadesse (2006) used a series of survey-based measures to find that in countries where disclosure and transparency are more regulated, banking crises are less likely. Furthermore, the literature points out that transparency and disclosure regulations can destabilize the banking system and hinder its growth. Cordella & Yeyati (1998) showed that when banks fail to control their risk exposure, the presence of informed depositors increases the possibility of bank failure. Transparency also affects financial institutions through information externalities. Yorulmazer (2003) showed that the collapse of sound banks can only be avoided with perfect information about bank assets, while Chen & Hasan (2006) argue that improving the accuracy of bank information for depositors will lead to the spread of banking panics. Acharya & Yorulmazer (2008) also showed that the threat of information contagion (spillovers) can lead banks to make correlated investments and amplify systemic risks. Information externalities do not just exist between banks. According to Bushman *et al.* (2004) financial accounting information plays an important role in corporate governance, supporting the oversight of the board, external investors and regulators, and the exercise of investor rights granted by existing laws. In the same line of thought, the banking literature assumes that transparency can promote banking stability by reinforcing market discipline in banks' risk-taking decisions (Flannery & Thakor 2006). The more information disclosed to the public, the stronger the market discipline (Wang *et al.* 2015). Market discipline is the process by which market participants use available information to monitor and prevent banks from taking excessive risks. Furthermore, according to Tadesse (2006) improving market discipline by reducing information asymmetry and increasing transparency contributes to resource allocation. Ariffin *et al.* (2007) argue that market discipline is a mechanism that can potentially inhibit the incentive to take excessive risks, thus making risk-taking more costly for banks. Sound banks are rewarded for their risk management and performance, while poorer banks are punished for higher funding costs. Market discipline encourages banks to manage risk prudently and operate efficiently. For example, Nier & Baumann (2006) used cross-country data to test the role of bank transparency in encouraging banks to limit risk. By constructing an index of 18 disclosure categories (interest rate risk, credit risk, liquidity risk, market risk and capital), they found that higher levels of transparency can strengthen market discipline and enable banks to improve their solvency, either by reducing their risk-taking or by increasing the coverage of risk by capital. Several studies have shown that with transparent information, banks can benefit from greater empathy from regulators (Kane, 1995). Furthermore, banks need to improve transparency of information in order to reduce the risk of disaster for the economy (Tadesse, 2006). Baumann & Nier (2004) studied the relationship between the long-term volatility of banks' share prices and level of transparency in annual reports and found that transparent bank information yielded better returns for investors. In addition, the more transparent the bank's disclosure of

information, the more profit it makes (Flannery et al. 2015) and the greater its incentive to manage risk (Nier & Baumann, 2006). Cheynel (2012), drawing on the theory of voluntary disclosure and cost of capital, explains that companies that voluntarily disclose their information have lower capital costs than companies that do not disclose.

The relationship between information disclosure and bank risk-taking is still debated in the literature. On the one hand, some studies have shown that regulation that requires accurate information to be disclosed can increase bank stability (Laeven & Levine, 2009; Flannery et al. 2015). Baumann & Nier (2004) have extensively studied the impact of information disclosure on banking operations. The results show that disclosure reduces stock volatility and increases the market value and usefulness of accounting information. Linsley & Shrivs (2006) point out that although it is impossible to obtain full disclosure, bankers are encouraged to do so. This would lead to better bank management and support market discipline mechanisms. Flannery et al. (2015) examined the relationship between the amount of information disclosed by banks and subsequent risk. The results showed that greater disclosure was associated with lower risk and higher returns. Building on recent research on bank disclosure and risk assessment, Wang *et al.* (2018) presented a risk disclosure index and link this index to bank soundness to measure the adequacy of bank risk-related disclosure in China. The study found a positive correlation between the disclosure index and bank soundness. Wang *et al.* (2018) also analysed the risk disclosure index into its components and found that the components linked to the profitability of risk offerings were the main drivers of banks' risk behaviour. On the other hand, some studies suggest that banks that disclose more information may face more risk-taking. Indeed, the more disclosure, the higher the bank's risk tolerance as some banks that disclose more information are subject to market discipline but then refuse to limit or control their risk-taking, (Kuranchie-Pong *et al.* 2016). Putu *et al.* (2012) also observed a negative correlation between voluntary disclosure and earnings management for banks listed on the Indonesian Stock Exchange. This affirms that profit margins decrease when banks voluntarily disclose additional information. According to Tadesse (2005) and Hirtle (2006, 2007), public disclosure of information by banks will enable supervisors to effectively assess bank soundness and provide appropriate solutions to help banks mitigate risks over the course of their operations. Chen *et al.* (2022), using a two-stage Generalized Method of Moments (GMM) approach combined with panel data from 28 Vietnamese commercial banks from 2007 to 2019, examined factors affecting Vietnamese commercial banks' risk-taking, including transparency and disclosure. Disclosure Index (TRANS), Disclosure Completeness Index (DISC), bank size and Capital Adequacy Ratio (CAR), before and after the adoption of Basel II. Furthermore, the results show that the implementation of Basel II will significantly contribute to the impact of transparency and disclosure on the Z-scores of Vietnamese commercial banks. The authors also demonstrated that large, well-capitalized banks are the least risky. As we learn more about the dynamics of financial stability, three interrelated features of the banking sector are increasingly attracting the attention of researchers and policy-makers alike: regulation in terms of disclosure requirements, competition and risk-taking. A relationship between these three factors was established by Keeley (1990). This paper sparked a lively debate on the possible link between these factors, at both the theoretical (see Hellmann *et al.*, 2000; Cordella & Yeyati, 2002) and the empirical levels (Salas & Saurina, 2002; Chen & Hassan, 2006). The mutual effects of transparency and competition measures show that banks with greater market power and less competition reduce credit market risk and improve financial stability, validating the competition-fragility hypothesis of Keeley (1990), Chen & Hasan (2006), Gorton & Huang (2002). Cordella & Yeyati (2002) studied banks' risk-taking behavior as a response to increased competition brought about by information disclosure and deposit guarantee schemes. Under mandatory disclosure, depositors and deposit insurance schemes tend to shift banks' risk-taking behavior from price-takers to asset-quality competitors. Cordella & Yeyati (1998) and suggest that transparency-enhancing practices can aggravate banks' default risks when exposed to exogenous shocks that lead to bank closures. The latter refers to mergers, acquisitions and bankruptcies that make some banks less competitive, increase their market power and reduce the number of competitors on the market. Gorton & Huang (2002) consider this exogenous shock to be systematic or idiosyncratic. Investors are unaware of the risks inherent in banks that are opaque to information. All market players expect the same outcome from an economic shock in the event of systemic risk. In turn, transparent systems enable investors to observe idiosyncratic risks and even reduce banking panics. Increased transparency also provides a powerful mechanism for market discipline, stimulating competition. However, a large number of risky banks leads to the accumulation of market power by a small number of very stable banks.

3. Methodology

3.1 Sample

The study considers all the Saudi Banks into consideration except for one Islamic Bank (Al-Inma Bank) due to

lack of annual data between the years 2014 and 2021. Ten banks chosen for the study consists of 3 Islamic Banks and 7 Conventional Banks. The selected banks in this study are for Islamic banks Al Rajhi bank, Bank Al Jazira and Bank Al Bilad. For the conventional banks, we have selected The Saudi British bank, Saudi investment bank, Banque Saudi Faransi. Riyad Bank. Samba Financial Group. AlAhli Bank, and Arab National Bank.

3.2 Research Model

This subsection aims to assess the financial resilience of liquidity risk in the Saudi banking system. To this end, we estimate an empirical model that combines bank specific and external factors and tests the effect of the shocks of these factors on liquidity risk (LCR), in order to simulate liquidity risk resilience of the selected banks. Estimation by ordinary least squares (OLS) or even more sophisticated traditional panel data regression methods (such as random effects or fixed effects) is likely to be inappropriate because it fails to address endogeneity problems associated with this type of empirical model. When a direct solution to these problems is not possible, a new method is needed to solve these problems, hence the use of the generalized panel method of moments (GMM). The Generalized method of moments was introduced by Arellano & bond (1991) and improved later in subsequent studies. The reasons behind this choice of estimator are that OLS estimation as well as fixed and random effects are biased because of the lagged dependent variable or the presence of an endogeneity problem. Moreover, system GMM estimation is efficient even in the presence of heteroscedasticity and autocorrelation. Furthermore, the generalized method of moments is more efficient in our study because of its ability to control for individual effects and time specific effects as well as endogeneity. The econometric model is formulated as follows:

$$LCR_{i,t} = \beta_0 + \beta_1 LCR_{i,t-1} + \beta_2 SIZE_{i,t} + \beta_3 AQ_{i,t} + \beta_4 CAR_{i,t} + \beta_5 INF_{i,t} + \beta_6 GDP_{i,t} + \beta_7 UNEMP_{i,t} + \epsilon \quad (1)$$

$$LCR = \frac{\text{Stock of High-Quality Liquid Assets (HQLAs)}}{\text{Total net cash outflows over the next 30 calendar days}} \quad (2)$$

β_0 : Constant; β_i ($i = 1, 2, 3, 4, 5, 6, 7$): the coefficients expressing the different independent variables; ϵ : error term and t : time period (2014-2021) ; GDP : GDP growth rate ; UNEMP : unemployment rate ; INF : inflation rate; CAR : capital adequacy ratio ; SIZE : bank size ; AQ : asset quality. After estimating these determinants using the generalized method of moments (GMM), we conduct a PVAR analysis in order to assess resilience of liquidity risk against adverse shocks. In the past few years, there has been an acceleration in the use of VAR. For instance, Panel-VAR (PVAR), global VAR (GVAR), and the factor augmented VAR (FAVAR)...etc. (Khammasi *et al.* 2020). P-VAR has the advantage of determining the effect of a shock from one variable on another, while maintaining the other variables constant. We try to test liquidity risk resilience of Saudi banks against macroeconomic and bank-specific shocks using the panel-VAR approach. In order to conduct a PVAR on liquidity risk, we use the same variables used in the previous estimation to test their effect on the short-term liquidity ratio (LCR), which is the dependent variable in our model.

$$Y_{i,t} = Y_{i,t-1}A_1 + Y_{i,t-2}A_2 + \dots + Y_{i,t-p}A_p + X_{i,t}\beta + \mu_{i,t} + e_{i,t} \quad (3)$$

$$i \in (1, 2, \dots, N), t \in (1, 2, \dots, Ti)$$

$Y_{i,t}$: vector of dependent variables ; $X_{i,t}$ is a vector of normally distributed exogenous covariates $\mu_{i,t}$ and $e_{i,t}$ are fixed effects vectors specific to the dependent variable and normally distributed errors ; A_1 , A_2 , A_{p-1} , A_p and β matrices are parameters to estimate. In order to determine which variable to exert shock, banks must choose the key risk factors. This implies choosing the variables of interest that are supposed to have a significant effect on liquidity.

$$Y_{i,t} = [LCR_{i,t}, CAR_{i,t}, AQ_{i,t}, SIZE_{i,t}, GDP_{i,t}, INF_{i,t}, UNEMP_{i,t}] \quad (5)$$

To do so, we proceeded as follows; first, we examined the evolution of our variables using unit root tests and the cointegration test. Next, we presented the results of our PVAR estimation. Then, we presented the results of the Granger causality test 'Wald test'. Finally, we calculated and plotted the impulse response functions (IRFs) through Cholesky variance decomposition. Our empirical study aims to examine the determinants of liquidity risk in Saudi banks; hence we target the largest ten banks in Saudi Arabia. The empirical validation of our study bears on annual data, covering a period extending from 2014 to 2021, more specifically during the Covid19 crisis and the Russo-Ukrainian war. The aim is to assess the financial resilience of liquidity risk in the face of adverse shocks, first by examining the factors that affect bank liquidity and second by assessing sensitivity of the

banking system to various macroeconomic and microeconomic shocks by analyzing their impact on LCR. To this end, we collected bank specific variables from the Bloomberg database and the annual report of each individual bank. The macroeconomic variables are taken from the World Bank database.

3.3 Construction of the Transparency Index

Our study draws on a 4-dimensional transparency analysis grid, inspired by Efogo (2019). Indeed, there is a variety of transparency indicators constructed in the literature (Baumann & Nier, 2004; Nier, 2005; Huang, 2006; Nier & Baumann, 2006; Tadesse, 2006; Ben Douissa, 2011; Manganaris *et al.*, 2017). These measures are more or less complementary and address different facets of information disclosure. Following Nelson (2001), we asserted that a complete indicator has 4 dimensions: completeness of information (*INF COMPL*), access to information (*INFACCES*), credibility of information (*INFCREDIB*) and timeliness of information (*INFOPPORT*). We propose a more complete transparency analysis grid; a four-dimensional grid from which a complete indicator can be built.

3.3.1 Information Completeness Dimension (INF COMPL)

We propose adding sub-indices to take into account all the information published by banks in their annual reports. Specifically, the information contained in financial statements (balance sheet, income statement, cash flow statement) is financial in nature. This information is not in itself enough to give a true and fair view of a company. It therefore seemed appropriate to include non-financial information in the calculation of the index. This involves considering risk management quality, corporate governance, the firm's strategic vision, management quality and socio-environmental performance (Perrini *et al.* 2006). By accessing the different interest groups, these dimensions provide a better understanding of the company's overall performance, strategy and growth prospects. The information provided by a bank is complete if it covers both the financial and non-financial sides of the bank's activities. Financial matters denote the bank's resources and use. More specifically, this information covers loans and deposits (form, duration, counterparty, etc.) and the associated risks. Non-financial information relates to governance, operational risk and forecasts. The financial information sub-dimension consists of 17 items. The non-financial information sub-dimension consists of 21 items. There are 38 items in all. From this grid, an information completeness indicator is calculated. These items do not all have the same measurement scale.

3.3.2 Information Timeliness Dimension (INFOPPORT)

In practice, timeliness of information is guaranteed by its regular updating. This dimension of information explains the need for interim reports (quarterly or half-yearly reports). These interim reports enable for checking the consistency of information published over different sub-periods. In this way, the indicator shows the extent to which information is published at the right time. Only one item is retained, namely availability of interim reports. This item takes 0 if there are no interim reports, 1 if the report is a half-yearly report and 2 if there is a quarterly report.

3.3.3 Information Credibility Dimension (INFCREDIB)

This dimension of transparency focuses on those features that contribute to the increased reliability of published information. As such, information is credible if it is checked by accredited bodies with a good-faith preemption. For the purposes of this study, 3 items were selected (external audit, audit company identity, application of accounting standards, international accounting standards and inflation-adjusted accounts). Today, they are all involved in four major businesses: auditing, consulting, transaction services and legal and tax advice. We assign 0 if the bank does not disclose the identity of the firm that audited its accounts, and 1 if the bank is audited by a firm that is not one of the "Big Four". Finally, 2 is given if the bank is audited by a Big Four firm. Banks also use the Accounting Standards sub-index. This distinguishes between two standards adopted by banks: local standards and international standards. Thus, if the bank adopts the IFRS standard, the rating is 1, otherwise it is 0. Finally, there is the inflation-deflated results item, where a bank that publishes annual inflation-adjusted accounts is more transparent than one that does not.

3.3.4 Information Accessibility Dimension (INFACCES)

To accurately measure accessibility of information, a distinction is made between public and private information. Public information is found in the financial statements that banks are required to publish in their annual reports. Private information, on the other hand, represents all elements that have not been disclosed to the public. Access to this information is restricted to key shareholders, financial analysts and risk rating agencies. Indeed, major shareholders rely on their decision-making power on the bank's Board of Directors to obtain private information. As for financial analysts, they can obtain private information about the bank through media briefings and

contacts with bank staff. This is the second channel for disseminating information. We propose to measure access to information through the first channel of dissemination (annual reports) by including or excluding these reports on the bank's website. On a bank's website, a certain amount of information is accessible (banking conditions, governance structure, proposed products, other branches, etc.). The choice of this measure stems from the fact that companies are generally required by law to publish their annual reports in at least one national daily newspaper. It will assign 1 to banks that publish annual reports on its website, otherwise 0. In addition, rating agencies are private companies whose main task is to assess the ability of debt issuers to meet their financial commitments. The main rating agencies currently on the market are Moody's, Standards & Poor's and Fitch Ratings. These three agencies alone account for around 85% of the market. This will be the third channel for disseminating information. Item three takes 1 if the bank is rated by an international agency, a regional agency including agencies such as Capital Intelligence, and 0 otherwise. This transparency dimension is designed to assess whether banks are open to the public.

4. Data Analysis, Results and Discussion

4.1 Factors Influencing Liquidity Risk and Resilience of Banks

We primarily use the following six variables: Real GDP growth rate; Unemployment rate; Inflation rate; Bank size; capitalization and Asset quality. In the GMM analysis, we assess the impacts of macroeconomic and bank-specific determinants on the liquidity coverage ratio (LCR). The Inflation rate and unemployment rate have an insignificant but positive effect on LCR. This means that in Saudi Arabia, these factors cannot be used to determine LCR. Their upward or downward fluctuations do not have a direct effect on this prudential measure. The Hansen test shows a P-value of 0.198, which is above 0.1, which means that we cannot reject the null hypothesis H_0 of validity of instruments. Then, the instruments used for this regression are valid, which means the results are valid. The test for absence of second order autocorrelation displays a value of (-1.75) with a P-value of 0.081. This indicates that the hypothesis of the absence of first-order autocorrelation of errors is rejected, while the hypothesis of the absence of second order cannot be rejected. This means that the empirical model has been correctly specified because there is no autocorrelation in the transformed residuals. This indicates the validity of the instruments. Moreover, we observe that the lagged dependent variable is positive and significant, which checks the dynamic character of the model's specification (Daher *et al.*, 2015). Accordingly, we confirm the appropriate use of a dynamic specification in our study. The obtained results indicate a negative and statistically significant relationship between bank size and the liquidity coverage ratio. The results also show that when bank size increases by 1%, LCR decreases by 2.796%. The variable "SIZE" has a significant and negative effect on LCR at the 1% level. Specifically, LCR is lower in large banks. This study confirms the results obtained by Anindyajati & Hanggraeni (2022), Shah *et al.* (2018), El Khoury (2015). Large banks hold fewer liquid assets because they consider themselves "*too big to fail*", so they are less driven to hold liquid assets. Indeed, they rely on their size to refinance themselves with the best conditions on the interbank market. Moreover, given their systemic importance, and to ensure the financial stability of the entire banking system, these banks also benefit from the help of monetary authorities (lender of last resort). The impact of the total capital ratio on LCR is significant and positive. A 1% increase in CAR leads to an increase of 0.582% in LCR. This result confirms those obtained by Anindyajati & Hanggraeni (2022) Hussain *et al.* (2022) Shah *et al.* (2018), Zaghdoudi & Hakimi (2017). This can be explained by the "risk absorption hypothesis" where a higher capital reinforces risk absorption and liquidity creation ability of banks (Berger & Bouwman, 2009). According to our results, economic growth has a negative and significant impact on liquidity. If GDP increases by 1% LCR decreases by 1.035%. This finding confirms those obtained by El Chaarani (2019) and Shah *et al.* (2018). This can be explained by the fact that during an economic recession the number of profitable investment projects is lower, which discourages banks to lend and encourages them to hold a high level of liquid assets. Another explanation is the fact that banks will lose confidence in the repayment ability of customers. On the other hand, during economic growth, banks are encouraged to lend more, which results in a lower level of liquid assets (Zaghdoudi & Hakimi, 2017).

Table 1. GMM estimation

<i>LCR</i>	Coefficient	p-value
<i>L</i>	0.8631***	0.000
<i>SIZE</i>	-2.7963***	0.000
<i>AQ</i>	-0.0622	0.642
<i>CAR</i>	0.5821***	0.005
<i>INF</i>	0.0781	0.736
<i>GDP</i>	-1.0351***	0.000
<i>UNEMP</i>	0.3558	0.161
<i>Constant</i>	48.717***	0.000
<i>Wald Chi-square (7)</i>	4367.70	0.000
<i>AR(1)</i>	-4.35	
<i>P-value AR(1)</i>	0	
<i>AR(2)</i>	-1.75	
<i>P-value AR(2)</i>	0.081	
<i>Hansen test of over identification</i>	31.85	
<i>P-value</i>	0.198	

Note: *** p<.01, ** p<.05, * p<.1

Source: Author's calculations

Before we begin our PVAR analysis, we have first to ensure stationarity of our variables. In order to test for stationarity, there are several test we can conduct on panel data. For instance, Levin, Lin and Chu (LLC), Im-Pesaran-Shin (IPS), Fisher augmented dickey fuller (ADF) and Fisher Phillips-Perron (PP). In our study, we conduct all these tests. Our results indicate that some variables are stationary in level while others are stationary in second order (first difference). The obtained stationary series will be used in our PVAR regression. Since the variables are integrated at a different order, it seems that there is cointegration between the variables, for that reason we perform the cointegration test.

Table 2. Panel unit-root test

Variable	Test	Level	Prob
<i>LCR</i>	LLC	Level	0.000
	Im-pesaron	First difference	0.000
	ADF	Level	0.000
	PP	Level	0.000
<i>SIZE</i>	LLC	First difference	0.000
	Im-pesaron	First difference	0.000
	ADF	First difference	0.000
	PP	First difference	0.000
<i>CAR</i>	LLC	Level	0.000
	Im-perason	Level	0.034
	ADF	Level	0.000
	PP	Level	0.000
<i>AQ</i>	LLC	Level	0.000
	Im-pesaron	First difference	0.000
	ADF	Level	0.000
	PP	Level	0.000
<i>GDP</i>	LLC	Level	0.000
	Im-pesaron	Level	0.000
	ADF	Level	0.000
	PP	Level	0.000
<i>INF</i>	LLC	First difference	0.000
	Im-pesaron	First difference	0.001
	ADF	Level	0.000
	PP	Level	0.000
<i>UNEMP</i>	LLC	Level	0.000
	Im-pesaron	First difference	0.000
	ADF	First difference	0.000
	PP	First difference	0.000

Source: Author's calculations

The cointegration test in a panel VAR (Vector Auto regression) model is used to check for cointegrating relationships between variables. The aim of this test is to assess the long-term relationship between the variables. In order to test for cointegration, we conduct the following tests: Kao test, Pedroni test and Westerlund test.

H0: No cointegrating equation

H1: All panels are cointegrated

Table 3. Cointegration test

Test	P-value
<i>Kao</i>	0.0005
<i>Pedroni</i>	0.0000
<i>Westerlund</i>	0.0001

Source: Author's calculations

Our results indicate that the P-value of all tests is under 0.05%, which means that we reject the null hypotheses, the cointegration relationship is checked and all panels are cointegrated. In order to assess response of bank liquidity to negative shocks, we run a PVAR analysis (Panel vector auto regressive). This method allows us to examine bank fragility and put their resilience to the test by determining the impact of shocks as well as the response of our liquidity measure (LCR). The panel vector auto regressive (PVAR) is a combination of the standard VAR approach, where all variables are considered endogenous, with the panel data technique, which allows the induction of a fixed effect in the model (Shank & Vianna, 2016). According to Canova & Ciccarelli (2013), the PVAR approach adds a cross-sectional dimension to traditional VARs, making them an effective estimation tool. Grossmann et al. (2014) note that the key advantage of the VAR system is that it allows us to determine the impact of orthogonal shocks, i.e., how a variable impacts another variable, while maintaining the variables constant.

Our results indicate that most variables have a significant relationship with liquidity i.e., LCR, AQ, CAR and GDP. LCR and CAR are significant at the 10% level while AQ and GDP are significant at the 5% level. The first lag of LCR shows a positive relationship with LCR with a coefficient of 0.6771. This indicates that an LCR shock increases future liquidity levels. On the other hand, the first lag of AQ, CAR and GDP shows negative coefficients of -3.03265, (-12.7944) and (-1.33268) respectively. This means that a shock arising from these variables decreases future liquidity levels. Bank size, inflation and unemployment present an insignificant relationship with LCR.

Table 4. PVAR estimation

	<i>L.LCR</i>	<i>L.SIZE</i>	<i>L.AQ</i>	<i>L.CAR</i>	<i>L.INF</i>	<i>L.GDP</i>	<i>L.UNEMP</i>
<i>LCR</i>	0.67711 (0.061)	115.8033 (0.235)	-3.03265 (0.044)	-12.7944 (0.074)	-1.33268 (0.768)	-1.33268 (0.047)	-0.55496 (0.874)
<i>SIZE</i>	0.00027 (0.679)	0.94527 (0.000)	-0.00464 (0.111)	0.017330 (0.216)	-0.00326 (0.483)	-0.00162 (0.361)	0.00684 (0.380)
<i>A</i>	-0.0008 (0.872)	0.88727 (0.605)	0.80537 (0.000)	-0.04947 (0.699)	0.12747 (0.318)	-0.00853 (0.821)	0.12917 (0.306)
<i>CAR</i>	-0.0452 (0.117)	-6.3298 (0.396)	-0.1311 (0.100)	1.1028 (0.129)	0.17919 (0.276)	-0.0405 (0.409)	-0.49841 (0.041)
<i>INF</i>	0.06181 (0.019)	9.927995 (0.090)	.267127 (0.060)	.804164 (0.092)	0.099378 (0.737)	.083391 (0.175)	1.09350 (0.002)
<i>GDP</i>	0.02946 (0.276)	18.8623 (0.002)	0.149000 (0.309)	0.395117 (0.480)	-0.64992 (0.002)	-0.28510 (0.000)	1.37256 (0.000)
<i>UNEMP</i>	0.005078 (0.371)	-3.16342 (0.034)	.01010 (0.703)	-0.20375 (0.094)	-0.04719 (0.435)	-0.06987 (0.000)	0.643931 (0.000)

Note: The parentheses indicate the P-value

Source: Author's calculations

Granger causality Wald test results for a first-order PVAR statistically proves the presence of a causal relationship between variables. Indeed, we found that asset quality and GDP are significant at the 5% level, while CAR is significant at the 10% level. Thus, asset quality, GDP and capitalization powerfully explain the liquidity risk of Saudi banks.

Table 5. Granger causality test

Variable		Df	Prob > chi2
LCR	SIZE	1	0.235
	AQ	1	0.044
	CAR	1	0.074
	INF	1	0.768
	GDP	1	0.047
	UNEMP	1	0.874

Source: Author's calculations

Panel-VAR-Granger causality Wald test.

H0: excluded variable does not Granger-cause equation variable.

H1: excluded variable Granger-causes equation variable.

IRF displays the response of our variable of interest (response variable) over time to a one-unit shock in the other variables (impulse variables). We can interpret IRF as the causal impact of a shock of one variable on the other variable in the model. Our results indicate that a positive liquidity risk shock causes a positive response to the future liquidity risk of Saudi banks. This can be explained by the fact that an increased liquidity risk shock increases future liquidity risk. This result confirms the findings of Khammasi *et al.* (2020). The impact of an AQ shock on the liquidity risk of Saudi banks is positive throughout the period. This indicates that an increased AQ shock increases future liquidity risk, confirming the results of Khammasi *et al.* (2020). Saudi banks' liquidity risk response to a CAR shock is negative during the first period, but from the second year onwards, it becomes positive. Thus, an increased CAR shock begins to increase liquidity risk from the second year onwards. A shock to economic growth (GDP) has a significant negative effect on LCR in Saudi banks during the first year. Then, the reaction is cancelled out until the end of the period. This indicates that a GDP growth rate shock increases liquidity risk in the subsequent years. This confirms the results obtained by Khammasi *et al.* (2020) El Chaarani (2019) and Shah *et al.* (2018).

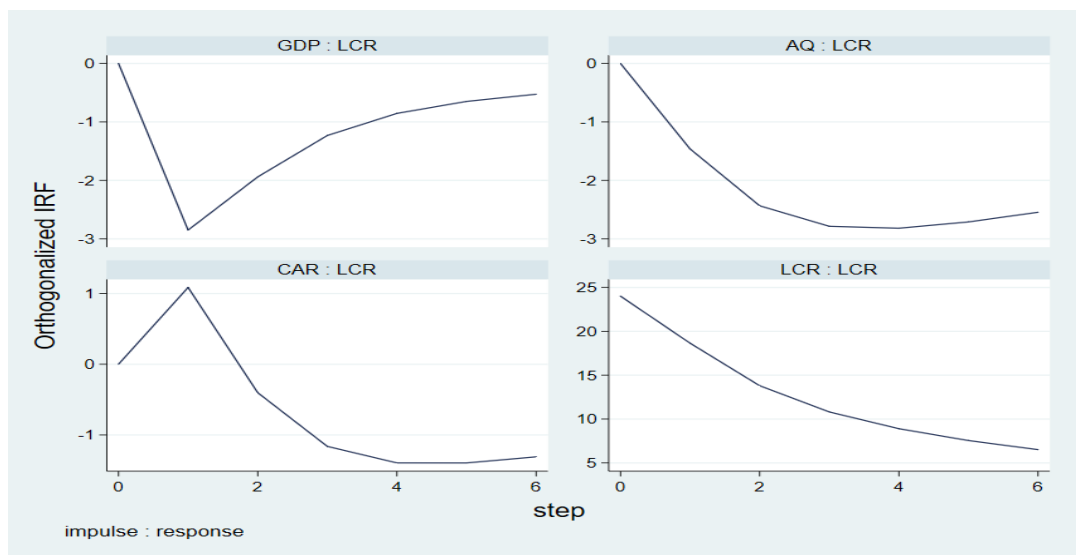


Figure 1. Impulse Response Variables

Source: Author's calculations

Variance decomposition in panel VAR is a method that explains the total variance of a variable into the contribution of shocks of other variables in the model; it is useful to comprehend the importance of different variables in steering fluctuation of our variable of interest, i.e., the liquidity coverage ratio (LCR). Our results indicate that at the beginning of the period, LCR could be explained by itself at about 78.5% (LCR=78.5% LCR). This means that past observations of liquidity risks largely contribute to explaining future observations. For the capital adequacy ratio, the effect gradually increases over time, varying from 17.7% until it reaches 30.6%. As for the other variables, the results show that SIZE, GDP and INF can explain the liquidity coverage ratio at the 3.2%, 0.5% and 0.1% levels respectively.

Table 6. Variance decomposition

<i>Horizon</i>	<i>LCR</i>	<i>SIZE</i>	<i>AQ</i>	<i>CAR</i>	<i>GDP</i>	<i>INF</i>	<i>UNEMP</i>
<i>LCR</i>							
0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0
2	0.785	0.032	0.000	0.177	0.005	0.001	0.000
3	0.698	0.052	0.001	0.243	0.003	0.003	0.001
4	0.650	0.064	0.002	0.266	0.007	0.009	0.002
5	0.620	0.066	0.002	0.289	0.009	0.011	0.002
6	0.610	0.065	0.003	0.299	0.009	0.012	0.003
7	0.606	0.063	0.003	0.303	0.010	0.012	0.003
8	0.604	0.061	0.003	0.306	0.010	0.012	0.003

Source: Author's calculations

4.2 Breakdown of the Banking Transparency Index (BANKTRANS)

We propose a breakdown of the bank transparency (BANKTRANS) indicator. Table 7. Shows the statistics relating to the disclosure of financial information (2014-2021).

Table 7. Statistics relating to the disclosure of financial information (2014-2021)

<i>Dimensions</i>	<i>INFCOMPL</i>				
	<i>N_SIF</i>	<i>N_SINF</i>	<i>INFOPPORT</i>	<i>INFCREDIB</i>	<i>INF ACCES</i>
<i>Bank 1</i>	52,63%	25%	0%	50%	95,83%
<i>Bank 2</i>	65,79%	26,70%	0%	31,25%	66,67%
<i>Bank 3</i>	60,53%	26,14%	0%	50%	66,67%
<i>Bank 4</i>	61,84%	26,71%	0%	31,25%	66,67%
<i>Bank 5</i>	43,43%	23,87%	0%	50%	83,34%
<i>Bank 6</i>	55,26%	17,05%	0%	50%	66,67%
<i>Bank 7</i>	57,89%	21,59%	0%	50%	66,67%
<i>Bank 8</i>	55,92%	32,39%	0%	25%	66,67%
<i>Bank 9</i>	59,21%	23,35%	0%	50%	66,67%
<i>Bank 10</i>	52,63%	25,57%	0%	43,75%	66,67%
<i>Total</i>	56,51%	25%	0%	43%	71,25%

Source: Author's calculations based on banks' annual reports

It seems that the best performance relates to the information accessibility for most banks (*INF ACCES* = 71.25%). The information accessibility dimension (*INF ACCESS-AVERAGE*=71.25%) is made up of 3 items, namely the availability of a website, access to annual reports via the Internet and bank ratings by international agencies (Standard & Poor's Global Rating; Moody's; Fitch Ratings). This shows that, on average, the banks in the sample are increasingly reluctant to disclose information on their websites. Moreover, on average, banks tend to be rated by less internationally renowned institutions over the study period. All banks have a website. However, the annual report is not always available for subsidiaries of international groups. The second dimension covers the completeness of financial information. Indeed, the banks met most of the criteria for financial transparency (*N_SIF- AVERAGE* = 56.51%). There has been a marked increase, reflecting a growing willingness by banks to disclose financial and non-financial information. This disclosure of information also makes it possible to carry out empirical analyses of the impact of this transparency dimension in these banks. Comparing this result with that reported by Chen et al. (2022), we observe an upward trend in financial transparency indicators in the post-crisis period (2014-2021) compared with the pre-crisis period (1994-2016) studied by the author (56, 51% > 49%). The dimension with the third-highest score, information credibility, is made up of 3 items dealing respectively with the presence of an external or internal audit firm, the application of international accounting standards and the publication of accounts net of inflation. These criteria contribute to increasing the credibility of the information published by the bank in its annual report. Each bank includes a reminder of the standards applied in its annual report. The BANKTRANSP indicator confirms that the banks in the sample provide 66.67% of public information, with the exception of Bank 1 and Bank 2. For the *INFACCESS* dimension, banks have an average practice, except for Bank 1 and Bank 2, which have a high practice. On the other hand, for the *INFCREDIB* dimension, bank practice is average, with the exception of Bank 2, Bank 6, Bank 8 and Bank 10, which scored low. As far as the completeness of information (*INFCOMPL*) is concerned, banks seem to have a tendency to disclose financial information and ignore the publication of non-financial information. To this end, they publish information on more than 50% of financial transparency items and less than 20% of non-financial transparency items. Finally, the *INFOPPORT* dimension is not put into practice. To sum up, the banks in the sample have a low level of transparency, as they have not implemented all the dimensions of transparency. More specifically, the information published is accessible (*INFACCESS*) and

credible (*INFCREDIB*) for some banks. In return, some dimensions need to be strengthened. Absolutely, banks need to make efforts on the dimension of timeliness of information (*INFOPPORT*), where they scored zero, and on the dimension of completeness of non-financial information, where the average level of practice is less than or equal to 25%. Table 8 shows the degree of bank transparency and its sub-indexes (2014-2021)

Table 8. Degree of bank transparency (2014-2021)

<i>Banks</i>	<i>Dimension 1</i>	<i>Dimension 2</i>	<i>Dimension 3</i>	<i>Dimension 4</i>	<i>TRANS Average</i>
<i>Bank 1</i>	77,63%	0%	50%	95,83%	55,87%
<i>Bank 2</i>	92,49%	0%	31,25%	66,67%	47,60%
<i>Bank 3</i>	86,67%	0%	50%	66,67%	50,84%
<i>Bank 4</i>	72,31%	0%	50%	66,67%	47,25%
<i>Bank 5</i>	67,30%	0%	50%	83,34%	50,16%
<i>Bank 6</i>	88,55%	0%	31,25%	66,67%	46,62%
<i>Bank 7</i>	79,48%	0%	50%	66,67%	49,04%
<i>Bank 8</i>	88,31%	0%	25%	66,67%	45,00%
<i>Bank 9</i>	82,56%	0%	50%	66,67%	49,81%
<i>Bank 10</i>	78,20%	0%	43,75%	66,67%	47,16%
<i>Total</i>	81,35%	0%	43,13%	71,25%	48,93%

Source: Author's calculations based on banks' annual reports

4.3 Transparency and Bank Liquidity Risk

The model adopted is a dynamic *GMM*-type model that allows us to study the effect of transparency on bank liquidity risk. We found that the application of the generalized method of moments system was the most appropriate. In fact, the first-order self-creation test is less than 5% and the second-order self-creation test is greater than 5%. This confirms the absence of a second-order autocreation problem in our model. Sargan's instrument validity test also shows that the instruments are valid (probability > 0.05).

Table 9. Estimation results

<i>Variables</i>	<i>Coefficients</i>	<i>t-student</i>	<i>Prob</i>
<i>LCR_{t-1}</i>	0.92*	4.75	0.000
<i>BANKTRANS</i>	-0.08	-0.66	0.512
<i>ROA</i>	-0.04***	-1.93	0.053
<i>SIZE</i>	0.084***	1.65	0.099
<i>CAR</i>	-2.10***	-1.87	0.062
<i>GDP</i>	0.419*t	4.17	0.000
<i>Cst</i>	-1.05	-1.20	0.231
<i>AR(1)</i>	0.0078		
<i>AR(2)</i>	0.333		
<i>Test de Sargan</i>	2.37		
<i>Prob.</i>	0.9967		

Note: *** p<.01, ** p<.05, * p<.1

Source: Author's calculations

The coefficient of the lagged value of liquidity risk is statistically significant and positive at the 1% threshold. In fact, it is 92%, with a probability of 0.000, indicating a strong correlation between the LCR ratio and its lagged values. Thus, a deterioration in bank liquidity in one year is likely to have a negative impact on the bank's liquidity in the following year. This also means that the banks in our sample are only managing to achieve 92% of the expected trend in terms of converting deposits into loans. We can conclude that the effect of liquidity risk is cumulative. Liquidity risk at time T-1 contributes significantly to an increase in liquidity risk at time T. The estimation results of our dynamic panel model show that, over this period (2014-2021), transparency has no significant effect on liquidity risk for the banks in the sample. This is an expected result. It can be explained by the fact that the transparency variable does not show significant variation between banks something we concluded from the measurement of the transparency index in the 10 Saudi banks between 2014-2021. Indeed, the results of the transparency index measurement show overall that transparency practice is similar for all banks. (Table. 8). In practical terms, banks implement less than 50% of the transparency dimensions. They mainly disclose financial information and information on information credibility. Barely 18% of information on non-financial components of banking activity is made available to the public. Information on operational risk and on the timeliness of information is not available either in annual reports or on the bank's website. In fact, the *INFOPPORT* dimension is not implemented in practice. Some dimensions need to be strengthened. Absolutely, banks need to work harder when it comes to the timeliness dimension of information (*INFOPPORT*), where they

scored zero, showing that on average the banks in the sample do not give importance to the publication of quarterly or half-yearly reports. We can explain this finding by the fact that banks have different risk-taking policies depending on the period. The completeness dimension of non-financial information or the average level of practice is less than or equal to 25%. (Table. 8). Thus, the transparency index (BANKTRANSP) shows that, for all observations, the average transparency between 2014 and 2021 was 48.94%. This means that overall bank transparency is low. The banks in the sample are well behind the Basel 2 transparency requirements. Indeed, the rationale behind Pillar 3 is that improving financial communication strengthens market discipline, which is seen as a behavioural response to action by the supervisory authorities. Information is made available to the public on assets, risks and their management, so practices must be transparent and standardized.

The impact of performance, measured by ROA, on liquidity risk is negative and significant at the 10% threshold. This indicates that an increase in performance leads to a 4% decrease in liquidity risk. This result can be explained by the fact that a bank's performance can reflect the quality of its bank management. In fact, good performance means that the bank succeeds in maximizing the profits generated by its different activities, while maintaining sufficient liquidity to meet withdrawal requests and commitments with other creditors. This is a significant and expected result, in line with the assumptions of Louzis et al. (2012). Bourke (1989) studied a sample of 90 banks in Europe, North America and Australia between 1972 and 1981. The author found a positive relationship between holding liquidated assets and bank profitability (measured by ROA). Indeed, it shows that banks with high profitability generally hold more liquidity (low liquidity risk) than banks with low liquidity, as the latter want to increase their profitability by holding illiquid assets that are more profitable than liquid assets. This means that the less profitable a bank is, the less liquid it will be, thereby increasing its exposure to liquidity risk. Similarly, bank size positively and significantly affects liquidity risk at the 10% threshold, i.e. the larger the bank, the greater the liquidity risk. In fact, a 1% improvement in the logarithm of total assets leads to an 8.4% increase in liquidity risk. This result is expected and corroborates the work of Dietrich et al. (2014), who have shown that large banks generally engage in severe restructuring activities that lead to a decrease in bank liquidity and thus increase its exposure to liquidity risk. Furthermore, the capital ratio shows a negative and significant impact at the 10% threshold on liquidity risk. This implies that an increase in the capital ratio leads to a decrease in liquidity risk. This finding is explained by the fact that an increase in the capital ratio results mainly from an increase in equity, which reduces liquidity risk. This result is inconsistent with that of Vodova (2011), Horváth et al. (2012), Roman & Sargu (2015). The impact of the macroeconomic variable, economic growth rate, on liquidity risk is positive and significant at the 1% threshold. This shows that higher economic growth leads to a 41.9% increase in liquidity risk.

5. Conclusion

Our study allows us to identify the main factors that affect liquidity risk in the Saudi banking sector as well as assess its resilience to different microeconomic and macroeconomic shocks. We focused on ten banks in Saudi Arabia over the 2014-2021 period. Our first analysis indicated that capital adequacy ratio, *SIZE*, *GDP* growth as well as past *LCR* levels significantly affect *LCR*. This amounts to saying that these are crucial variables to consider when studying liquidity risk. For our second analysis, we found that shocks to past *LCR*, *AQ*, *CAR* and *GDP* increase future liquidity risk. At this level, our study has some interesting implications: (1) Supervisors and policy makers can use these results to reinforce their liquidity risk management, since our results provide a better understanding of factors that impact liquidity within the Saudi banking system. (2) This study helps to identify most resilient banks during stress periods, where adverse macro and micro shocks impacted all of them equally and (3) This study may be useful for examining the preparedness of banks to face crisis periods and helps them to get themselves equipped with the needed liquidity levels to meet those adverse but plausible scenarios. Stress tests, without a doubt, are regularly used as a tool for macro-prudential analysis and crisis prevention. However, they are of great value only when they are followed by concrete and appropriate actions, first by the central authority and then by each bank separately. The banking system should be more forward-looking in order to increase liquidity provision levels, even in good times, so that in the event of an economic downturn, banks will be better protected and more resilient to various shocks.

The second aim of this paper is to study the effect of bank transparency on liquidity risk. We used the variable *BANKTRANS* as an indicator of interest that measures the degree of transparency in banks. In fact, national averages of bank transparency show a wide disparity between banks in the same country. Some Banks had a transparency index of over 50%, while others had an index of less than 50%, reflecting a disparity in voluntary transparency practices between banks in the same country. The result also shows that Saudi banks are taking advantage of the legal delay in banking regulation.

Firstly, we have noted that there is no measure of transparency in the literature that respects the specificities of

banking. Indeed, the measures put forward by previous studies on banking transparency do not take into account new banking risks, such as liquidity risk. The first contribution of our study is that we have calculated a multidimensional average transparency index. We used the transparency variable as an indicator of interest that measures the degree of transparency in banks. The result shows that banks are taking advantage of the legal delay in banking regulation. In fact, market discipline can fail when investors have no knowledge of the bank's risk profile, or more when the information disclosed is limited. Hence, practices cannot be transparent in terms of the information made available to the public on assets and their management. Some dimensions need to be strengthened. Absolutely, banks need to improve on the timeliness of information dimension (*INFOPPORT*), where they scored zero, showing that on average, the banks in the sample do not give importance to the publication of quarterly or half-yearly reports. We can explain this finding by the fact that banks practice different risk-taking policies depending on the period. The completeness of non-financial information or the average level of practice is less than or equal to 25%, which shows the weakness and ineffectiveness of market discipline mechanisms.

In this paper, we use only the accounting-based risk measure since in our sample a limited number of banks are listed in the stock exchange market. This issue constitutes the major limitation of this study. With regard to future research, it is recommended to extend the sample to GCC countries and make a comparison between Islamic versus conventional banks. Furthermore, as banks are sensitive to sustainability themes, we suggest considering the importance of non-financial disclosures, namely sustainability reports, which could represent an advance in future research.

Acknowledgments

Not applicable

Authors contributions

Not applicable

Funding

Not applicable

Competing interests

Not applicable

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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