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The Impact of Financial Technology Innovations on Liquidity Risks in Islamic Banks – Digital Payments as a model: Standard Study of a Sample of Saudi Islamic Banks during the Period (2015-2021)

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Abstract:

This research paper aims to demonstrate the impact of financial technology innovations, specifically digital payments, on liquidity risks in Saudi Islamic banks during the period (2015-2021). The study utilizes panel data models and the STATA 15 software, in which liquidity risks as the dependent variable, digital payments as independent variable, and bank asset size as control variable. The study found a significant positive impact of digital payments on liquidity risks in Saudi Islamic banks, indicating that digital payments have a positive effect on liquidity risks due to their recent adoption in these banks. Additionally, the study found that bank asset size has a significant negative impact on liquidity risks in the sample of Saudi Islamic banks, as larger bank assets increase liquidity levels and consequently reduce liquidity risks compared to smaller and medium-sized banks, which have less control over liquidity risks.

Keywords: Financial technology innovations; digital payments; liquidity risks; Islamic banks.

Jel Classification Codes: C33, G21, G32, O32.

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1. Introduction

The global economy has witnessed rapid technological advancements across various sectors following the 2008 global financial crisis, especially after customers lost confidence in the traditional financial and banking system. Financial technology companies seized this opportunity to emerge as a more suitable alternative to meet their requirements. This compelled financial institutions to embrace financial technology in their business models and invest in their infrastructure to ensure competitiveness and sustainability. When necessary, they entered partnerships with startups to enhance their competitive capabilities and keep pace with the changes in the global financial environment.

The payment sector is considered the most crucial sector in the fintech industry in terms of investments. Financial technology applications, particularly quantitative computing and blockchain, have revolutionized payment systems in the financial and banking sector. Financial and banking services have been developed, and innovative financial services have been launched that respond to customers' digital requirements in terms of cost, quality, and speed. Despite the opportunities that fintech offers to the financial and banking sector, the pace of development in this industry poses a threat to its stability and safety.

Financial technology innovations carry new risks, including electronic risks, in addition to the risks inherent in the banking industry. This presents a challenge to all types of banks. However, the unique nature of Islamic banks makes them more vulnerable to risks similar to those faced by traditional banks, increasing the likelihood of exposure to banking risks, especially liquidity risks.

The fintech industry in the Kingdom of Saudi Arabia has experienced significant growth in recent years. Saudi Islamic banks have shifted their financial banking services to various digital systems and platforms, which has had a positive impact on their performance. They have demonstrated their efficiency in facing the unprecedented consequences imposed by the COVID-19 pandemic.

1.1. Research Problematic:

The problem of this study can be formulated in the following main question:

What is the impact of digital payments on liquidity risks in Saudi Islamic banks?

1.2. Research Hypotheses:

This study proceeds from the following hypotheses:

- **Hypothesis 1:** There is a statistically significant impact of the digital payments index on liquidity risks in Saudi Islamic banks.
- **Hypothesis 2:** There is a statistically significant impact of the bank's asset size on liquidity risks in Saudi Islamic banks.

1.3. Research Importance:

The importance of the study lies un discussing one of the most crucial topics in the financial and banking industry, and the efforts of Islamic banks to keep pace with the developments in the banking environment to develop their banking services in the field of digital payments to ensure competitiveness and sustainability, especially in the face of liquidity risks surrounding them due to the specificity of these banks.

1.4. Research Aims:

The main objective of this study is to determine the impact of digital payments as one of the prominent innovations in financial technology on the level of liquidity risks in the studied Saudi Islamic banks.

1.5. Study Methodology and Tools:

In line with the nature of the study's subject matter and the attempt to address the posed problem, a descriptive approach was adopted. This involved reviewing theoretical concepts related to financial technology, digital payments, liquidity risks, and analyzing the relationship between them. Additionally, the study involved presenting and analyzing the study's results and their interpretation.

Regarding the tools used, the study relied on relevant books, articles, and scientific research, in addition to financial statements and annual reports provided by the selected banks in the study sample on their official websites. As for the statistical software used for processing panel data, STATA 15 was employed.

2. Literature review:

There are numerous previous studies that have examined the effects of technology on economic growth, but studies analyzing the impact of technology on bank liquidity are relatively scarce. Most indicators used to measure technology in banks have relied on metrics such as the number of ATMs, point of sale devices, or the number of customers using online banking and mobile banking services. Additionally, the number and value of transactions conducted through electronic channels were often considered. Currently, banks are susceptible to technological advancement, especially with the developments in financial technology, particularly digital payment methods that are directly related to bank liquidity. Among these studies are:

- **Deng, Zhao Yiwen, Liu & Lv (2021) - "Impact of Fintech on bank risk-taking: Evidence from China":** This study aimed to demonstrate the impact of financial technology on risks in Chinese banks from 2011 to 2016, analyzing it through panel data using the Stata program. The study measured financial technology using the Financial Technology Development Index and its techniques. It found that the development of financial technology contributed to reducing risks in banks, although this impact varied among different banks across regions and between small, medium, and large-sized banks.
- **Lee, Yu, Li & Zhao Jinsong (2021) - "Does fintech innovation improve bank efficiency? Evidence from China's banking industry":** This study aimed to determine whether the development of financial technology affects the banking efficiency of Chinese banks from 2003 to 2017. It measured the development of financial technology according to its four key sectors: lending, payments, investment management, and market support services. The study employed dynamic panel data models to analyze the impact of financial technology innovations on the efficiency of

traditional banks. The study concluded that financial technology innovations enhance the efficiency of banks, with a greater effect on private banks compared to public banks.

- **Pascal & Ochei (2019) - "Financial technology and liquidity in the Nigerian banking sector":** This study explored the impact of financial technology on liquidity in the Nigerian banking sector from 2009 to 2017. It used the Autoregressive Distributed Lag (ARDL) model in Eviews to analyze the relationship. Liquidity was measured by the cash ratio, liquid assets to total assets ratio, and the loan-to-deposit ratio. Financial technology was measured by transactions through ATMs, automated clearinghouse systems, point of sale terminals, and mobile phones. The study found that financial technology, particularly electronic payment transactions, does impact banking liquidity in Nigeria but over the long term.
- **Udin, Bujang & Beli (2019) - "Technology effects towards banks' liquidity risk on Southeast Asian commercial bank":** This study aimed to determine the impact of technology on liquidity risks for five banks in Malaysia, Indonesia, the Philippines, Thailand, and Singapore from 2012 to 2017. The study measured technology (independent variable) using the number of subscribers through online banking, mobile banking, and ATMs. Liquidity risks (dependent variable) were measured using the cash balance ratio, liquid assets to total assets ratio, and the loan-to-deposit ratio. Panel data models were used. The study concluded that the increasing use of ATMs and mobile phones affects banking deposits and, consequently, increases liquidity risks for banks if there is insufficient liquidity to cover loans.

What distinguishes this study from previous ones is its focus on Islamic banks, which have unique characteristics compared to traditional banks, specifically Saudi Islamic banks. Additionally, this study will emphasize payments made through smartphones, digital platforms, interactive ATMs, and self-service branches, distinguishing it from previous studies that mainly focused on ATMs, point of sale terminals, mobile phones, and the internet.

3. Conceptual Framework of Financial Technology and Digital Payments:

3.1 Concept of Financial Technology and Its Key Sectors:

The term "financial technology" is a relatively modern term, first mentioned through the Citigroup Financial Services Technology project. This project aimed to facilitate technological cooperation efforts in the financial and banking sector in the United States. The term was later shortened to "FinTech," as reported in an article by American Banker titled "Friday Flashback: Did Citi Coin the term 'Fintech'," published on August 13, 1993 (Schueffel, 2017, p. 36). "FinTech" gradually became widely used in the public discourse of the financial and banking sector at the beginning of 2011. The emergence of the FinTech era is believed to have occurred in the aftermath of the global financial crisis in 2008. The loss of trust in traditional financial institutions contributed to the rise of financial technology companies (Bowden, King , Koutmos, Loncan, & Stentella Lopes, 2021, p. 53).

There is a diverse range of academic and practical definitions for financial technology, but there is no universally agreed-upon definition to date. Oxford Dictionary defines it as "various computer programs and other technology used to support or enable banking and financial services" (Alam, Gupta, & Zameni, 2019, p. 12). The Basel Committee on Banking Supervision defines it as "technology-driven innovation that results in new business models, applications, processes, or products with material impact on financial markets and institutions" (Griffiths, 2020, p. 249). It is also succinctly defined as "a collection of technology-supported financial solutions" (Burke, 2021, p. 113).

The significance of adopting financial technology innovations in banks lies in their ability to respond to customer needs and align with their digital preferences. Financial technology contributes to revenue growth through digital technologies that reduce the costs of financial services. It enhances the speed and efficiency of financial and banking transactions, fosters the development of banking products and business models, and introduces new products (Dandapani, Joo, &

Nishikawa, 2021, p. 221). Additionally, it contributes to increasing financial inclusion by attracting previously underserved customers to the banking sector (Burke, 2021, p. 114).

The financial technology industry has experienced rapid growth in a short period, with substantial financial investment over the past five years. Financial technology innovations have diversified across various sectors, leveraging technologies such as blockchain, quantum computing, artificial intelligence, big data, and more. Figure 1-1 illustrates the five key sectors of financial technology and some of their prominent innovations.

Fig. (01): Major Financial Technology Sectors

Payments	• Online Payments, Mobile Payments, Point of Sale (POS), Peer-to-Peer Payment Platforms...
Savings and Investment	• Online Savings Solutions, Digital Investment Platforms, Robo-Advisors, Wealth Management through Digital Platforms...
Lending	• Digital Credit, Online Small and Medium-sized Enterprise (SME) Financing, Crowdfunding Platforms...
Insurance	• Digital Insurance, Smart Contracts...
Financial Markets	• Digital Brokerage, Digital Trading Platforms...

Source: Prepared by the researchers based on (Rose Innes & Andrieu, 2022, p. 3).

The payments sector was one of the first sectors to witness the use of financial technology applications and remains one of the fastest-growing and evolving sectors. This is evident both in terms of the investment volume and the increasing demand for its products and services. This explains why banks are inclined to invest in financial technology companies, either through acquisitions or by entering into partnerships and collaborative agreements. Traditional payment methods have experienced a significant decline in most national economies, given the rapid growth of alternative electronic payment methods.

3.2 Evolution of Digital Payments, Definition, and Forms:

The emergence of innovative payment systems, often referred to as "third-party payments," can be traced back to the 1970s and 1980s, with their origins in the United States (Qiu, Huo, & Dai, 2022, p. 27). The Federal Reserve Bank of San Francisco created a non-paper-based transfer system in 1972 (Bowden, King , Koutmos, Loncan, & Stentella Lopes, 2021, p. 64), marking the beginning of these payments. Companies issuing credit and debit cards, such as Visa and MasterCard, quickly dominated the market. Subsequently, e-commerce and technology companies, including eBay, Amazon, Google, and many others, emerged in the early 21st century. These companies played a significant role in promoting and developing digital payment systems such as PayPal, Amazon Payment, and Google Checkout (Qiu, Huo, & Dai, 2022, p. 27).

The period leading up to the global financial crisis in 2008 witnessed a surge in banking customers conducting banking operations through mobile phones from 2005 to 2010. Mobile banking transactions grew at a compound annual rate of nearly 100% in 2007, coinciding with the launch of smartphones, notably the iPhone by Apple (Burke, 2021, p. 112). After the global financial crisis, financial technology companies attracted investments from technology giants due to the pioneering investment opportunities they offered, taking advantage of the skepticism and distrust surrounding traditional financial institutions.

Despite credit and debit cards being around for decades, they have continued to be a field for growth and innovation worldwide. Apple, for instance, developed its credit card in collaboration with Goldman Sachs and MasterCard, launching the Apple Card in 2019. It was designed primarily for digital use within a digital wallet on Apple's iPhone devices. Furthermore, digital platforms and applications on smartphones, in partnership with various commercial banks and financial institutions, have been launched. Examples include PayPal, Apple Pay, and Ali Pay, especially with the adoption of financial technology such as quantum computing and the Internet of Things in recent years. Amid the repercussions of the COVID-19 pandemic, there was a shift towards digital payments, driven by efforts to enhance cybersecurity, digital identity, and digital platforms for international transfers (Bowden, King , Koutmos, Loncan, & Stentella Lopes, 2021, p. 65). Consequently, the digital payments sector witnessed a significant increase in global investment compared to other financial technology sectors during the pandemic, aiming to facilitate access to current and potential financial and banking services and enhance financial inclusion.

Digital payments represent one of the most prominent innovations in financial technology during the initial stages of adoption in financial institutions. They are defined as an innovative system relying on digital technologies such as quantum computing, blockchain, artificial intelligence, and more. These systems are provided by banks and financial institutions to their customers for conducting various financial and banking transactions securely and conveniently through online platforms or smartphone applications within legal frameworks, ensuring user privacy and confidentiality. After the spread of COVID-19, the term "contactless payments" was used interchangeably with digital payments in academic literature, although contactless payments, particularly NFC-based payments, represent one of the prominent forms of digital payments.

Table (01): Forms of Digital Payments and Digital Banking Channels

Forms of Digital Payments

<table>
<tr><td>Electronic Checks</td><td colspan="2">Electronic Funds Transfer (EFT)</td><td>Electronic Cards</td><td>Contactless Payments</td><td>(P2P/ B2B)</td></tr>
<tr><td colspan="6">Digital Payment Banking Channels</td></tr>
<tr><td>Automated Teller Machines (ATMs)</td><td colspan="5">Current ATMs offer a wide range of new features, including cardless devices that allow customers to make withdrawals and access broader banking services using contactless means. Other features include video banking services with the ability to interact with interactive ATMs, get assistance and support, and access banking services 24/7.</td></tr>
<tr><td>Online and Mobile Banking Services</td><td colspan="5">Different digital banking services are obtained through the internet and smartphone applications, such as opening accounts and checking their balances, transferring money, savings and investment, requesting checks, paying bills, and accessing various service guides.</td></tr>
<tr><td>Digital Financial Wallets (eWallets)</td><td colspan="5">Digital wallets operate like prepaid credit accounts, allowing customers to store their payment cards and use them without having to input personal banking details to complete transactions, relying on smartphone security features like fingerprint recognition.</td></tr>
<tr><td>Point of Sale (PoS)</td><td colspan="5">One of the most widespread channels for delivering new banking services is the Point of Sale (PoS) terminal, an electronic device used for credit and/or debit card transactions at retail locations, available 24 hours a day.</td></tr>
</table>

Source: Prepared by the researchers based on (Bowden, King , Koutmos, Loncan, & Stentella Lopes, 2021, pp. 62-75) (Nazaritehrani & Meshali, 2020, pp. 4,6,7)

4. Liquidity Risks in Islamic Banks Amid Digital Payments Developments:

4.1 Overview of the Nature of Islamic Banks:

Islamic banks, as defined in the agreement establishing the World Islamic Banking Union in the first paragraph of Article 5, are banks whose establishment and basic system explicitly commit to the principles of Islamic law (Sharia) and refrain from engaging in usury (riba). They are also defined as financial institutions that provide financial and banking services, attract monetary resources, and use them effectively to ensure their growth, in line with the economic and social development goals within the framework of Islamic law (Daoud & Brahimi, 2022, p. 688).

Islamic banks differ significantly from conventional banks. Both are subject to central bank regulations and oversight. Additionally, Islamic banks operate under the supervision of various Sharia supervisory bodies, which do not have counterparts monitoring conventional banks. Islamic banks are also generally more resilient than conventional banks in times of uncertainty. This is because Islamic banking products are typically asset-backed and involve trading assets, leasing, and profit and loss sharing, which makes them less susceptible to liquidity risk. They have higher intermediation ratios, better asset quality, and more robust capitalization.

Since Islamic banks adhere to a Sharia-compliant model based on property rights or Islamic finance contracts, they face various risks related to intermediation activities. One of the most significant risks is liquidity risk. Liquidity risk is more pronounced in Islamic banks for several reasons (Melki & Behih, 2021, p. 822):

1. Prohibition of interest in Islamic law: Islamic banks cannot lend at interest to meet liquidity needs when necessary.
2. Inability to raise financial resources by selling debt-based assets: Islamic banks cannot sell debt-based assets and can only sell debt at its nominal value.
3. Central banks not acting as the lender of last resort for Islamic banks due to interest.

4.2 Liquidity Risks in Islamic Banks:

In recent years, liquidity risks have become one of the most significant contemporary challenges facing the global banking system, particularly the Arab banking sector. These risks are considered fundamental to banking operations according to modern financial intermediation theory. The role of banks in the economy is primarily to provide liquidity and manage risk (Hacini , Boulenfad, & Dahou, 2021, p. 68).

The definitions of liquidity risks vary, and one of the most widely accepted definitions among researchers is the inability of a bank to meet its obligations when they become due. It also refers to the inability to provide the necessary financing to meet obligations due to non-performing loans or failed investment projects, whether they are domestic or international. It can result from the inability to sell an asset at its fair value (Abdelrahman, 2020, pp. 732-733).

Liquidity risks are risks that a bank may face due to the unexpected outflow of customer deposits abroad resulting from sudden changes in depositor behavior. In such a situation, the bank may be forced to engage in extensive short-term financing activities to bridge the liquidity gap in the cash market at high rates (Gaidi & Bentoumi, 2018, p. 172). This primarily affects the bank's profitability and, in severe cases, can lead to the bank's insolvency.

4.2.1. Methods for measuring liquidity:

There are three methods for measuring liquidity risks (De Coussergues, 2005, p. 200):

- **Continuous Differentials Method**: This involves calculating the difference between assets and liabilities for each stage of maturity. This indicator provides information about the amount, period, and maturity of the bank's maturity transformation process.
- **Accumulated Differentials Method**: In this method, the differentials for each maturity period are accumulated over time.
- **Preferred Assets and Liabilities Method (Liquidity Risk Index)**: This method is based on the preference of assets and liabilities for each maturity stage, calculated by taking the average years for each stage. Then, the following ratio is calculated:

$$Liquidity\ Risk\ Index = \frac{Total\ Preferred\ Liabilities}{Total\ Preferred\ Assets}$$

If this ratio is greater than or equal to 1, it means that the bank is not engaged in maturity transformation, as the maturity of liabilities exceeds the maturity of assets, indicating significant liquidity risks. Conversely, if the ratio is less than 1, it means that the bank is engaged in maturity transformation, with liabilities maturing earlier than assets, indicating lower liquidity risks.

4.2.2. Liquidity Risk Metrics:

Liquidity risk metrics are calculated based on the financial data from banks' annual reports. Some of the key liquidity risk metrics include (Gaidi & Bentoumi, 2018, p. 173):

- **Cash and Cash Equivalents to Total Assets Ratio:**

  Formula: $Liquidity\ Risk = \frac{Cash\ and\ Cash\ Equivalents}{\text{Total Assets}}$

  Interpretation: A higher value of this ratio indicates lower liquidity risk, as it reflects an increase in cash balances, either in the bank's vault or held with other banks, which can be used to meet various bank obligations.

- **Short-Term Investments and Cash to Total Assets Ratio:**

  Formula: $Liquidity\ Risk = \frac{\text{Short Term Investments + Cash and Cash Equivalents}}{\text{Total Assets}}$

  Interpretation: An increase in this ratio signifies reduced cash liquidity risk since it implies a growth in cash and short-term investments that can be used to cover the bank's different obligations.

- **Loans and Advances to Total Deposits Ratio:**

  Formula: $Liquidity\ Risk = \frac{Loans\ and\ Advances}{\text{Total Deposits}}$

  Interpretation: A higher value of this ratio indicates increased liquidity risk. It suggests a higher proportion of loans that may be difficult to liquidate quickly when the need for liquidity arises. Additionally, a rise in the loans-to-deposits ratio indicates the bank's need for new cash sources to fulfill new lending demands.

- **Liquid Assets to Total Deposits Ratio:**

  Formula: $Liquidity\ Risk = \frac{\text{Liquid Assets}}{\text{Total Deposits}}$

Interpretation: An increase in this ratio suggests reduced liquidity risk because it reflects a growth in liquid assets that can be used to meet various other obligations.

4.3. The Relationship between Digital Payment Systems and Liquidity Risks:

The adoption of financial technology applications has been on the rise in recent years in the business models of Islamic banks. They have become a fundamental pillar for developing their financial and banking services to ensure their survival and competitiveness. However, financial technology (fintech) did not attract the attention of regulators, financial industry stakeholders, and customers until around 2014 when the term "Islamic Fintech" emerged, combining financial technology with Islamic finance principles (Hassnian, Rose , & Zaini, 2019, p. 76). Concerning the permissibility of using fintech applications in Islamic finance, it is considered permissible as long as they comply with Shariah regulations and avoid prohibitions such as riba (usury), maysir (gambling), and gharar (excessive uncertainty) (Ab Razak, Dali, Dhillon, & Manaf, 2020, p. 3224).

Financial technology innovations offer various opportunities and advantages, in addition to the value they add to the financial and banking industry. However, they also come with a range of negative effects, leading many researchers and experts to coin the term "disruptive technology" (Deng, Lv, Liu, & Zhao, 2021, p. 100). The Financial Stability Board has pointed out that the adoption of fintech in financial institutions and banks increases the systemic risks arising from operational and electronic risks. In addition to the new risks introduced by various fintech applications, such as cyberattacks, data security, and customer privacy, the financial risk sensitivity has increased due to the impact of electronic risks on it (Liu , Tripe, & Jiang, 2017, pp. 3-4).

A study by Zhao, Deng, Liu, and Lv demonstrated that the development of financial technology in China has significant impacts on bank performance from various perspectives. Fintech innovations improve capital adequacy and management efficiency but reduce the quality of bank assets and their ability to achieve profits. These impacts became more pronounced after 2011 when the fintech industry began its rapid growth. Large banks have been better able to capitalize on fintech innovations to increase their profitability and control financial leverage and liquidity risks compared to banks with limited financial resources. Therefore, fintech innovations have significant and heterogeneous effects on different types of banks in addition to a variety of dimensions (Zhao, Li, Yu, Chen, & Lee, 2022, p. 3).

One of the most prominent and recent fundamental methods to enhance liquidity in the banking sector and ensure financial stability is the adoption of digital financial innovations and technologies. This explains why banks are investing in the payments sector, as advanced payment systems help enhance liquidity levels in banks and increase their growth potential (Pascal & Ochei, 2019, p. 246). Banks that have adopted banking services through automated teller machines (ATMs) have shown increased liquidity levels due to more efficient cash deposits through ATMs as opposed to traditional banking deposits (Udin, Bujang, & Beli , 2019, p. 296).

5. Standard Study of the Impact of Digital Payments on Liquidity Risks in Saudi Islamic Banks During the Period (2015-2021):

5.1. Study Methodology:

This study aims to demonstrate the impact of digital payments on liquidity risks in Saudi Islamic banks, as they represent one of the most significant financial technology innovations that the financial and banking sector witnessed in the early stages of the technology industry's development following the 2008 global financial crisis. This period saw increased activity in Islamic banks, especially in the context of the credit and liquidity risks surrounding them.

The study sample consists of five (5) Saudi Islamic banks out of eight (Al-Ahli Bank, Al Rajhi Bank, Riyadh Bank, National Commercial Bank, and Alinma Bank). The study excluded Islamic Development Bank, Al Jazeera Bank, and Bank AlBilad due to their delay in adopting a digital strategy and their failure to disclose data related to the study variables for the years from 2015 to 2021.

The selection of the time period for the study from 2015 to 2021 (7 years) is attributed to the recent adoption of financial technology innovations in Saudi Islamic banks (The digital strategy for using financial technology was implemented in the business models of these banks in 2014). This explains the sample size since the number of Islamic banks does not exceed five banks, which were pioneers in adopting digital payments compared to other banks that experienced delays in adoption.

The data related to the study variables were obtained from various financial and annual reports of the banks on their respective websites and analyzed using Panel Data with the STATA 15 software.

Below is an illustrative table of the various variables in this study:

Table (02): Study Variables

Variable	Implication	Code	Measurement
Dependent variable	Loan-to-deposit ratio (LDR)	LTD	$Liquidity\ risk\ ratio = \frac{Loans\ and\ advances}{Deposits\ and\ their\ equivalents} * 100$
Independent variable	Digital payment ratio	FTIP	$Digital\ payment\ ratio = \frac{Digital\ payment\ volume}{Total\ payment\ volume} * 100$
Control variables (bank-related variables)	Bank asset size	TA	Natural logarithm of the total assets of the bank

Source: Prepared by the researchers based on previous studies.

To achieve the study's objective, the Panel Data approach was used, which deals with a number of cross-sectional units (i) represented by 5 Saudi Islamic banks (N=5, where i=1, 2,…, N), and each bank covers a time period T=7 (where t=1, 2,…, T). Thus, the number of observations used in the model is 35 observations (T×N).

Therefore, the model used in the study is as follows:

$$\mathbf{LTD_{it} = \beta_0 + \beta_1 FTIP_{it} + \beta_2 TA_{it} + \varepsilon_{it}}$$

- $\mathbf{LTD_{it}}$: The ratio of loans to deposits for bank (i) in period (t).
- $\mathbf{FTIP_{it}}$: The ratio of digital payments for bank (i) in period (t).
- $\mathbf{TA_{it}}$: The natural logarithm of the total assets for bank (i) in period (t).

Appendix 1 displays descriptive statistics related to the study variables. The table shows that there are differences in the maximum values of the model variables, which can be attributed to variations in the level of adopting digital payments and the size of the banks.

The study model parameters are estimated using three forms of Panel Data models for comparison to select the most suitable model for the study. These forms include the Pooled Regression Model (PRM), Fixed Effects Model (FEM), and Random Effects Model (REM).

The following table presents the estimation results using STATA 15:

Table (03): Results of the Aggregated Model Estimation (PRM) and Fixed Effects (FEM) and Random Effects (REM) Effects

Explanatory variables	**Estimation models**		
	PRM	FEM	REM
FTIP	0.1412**	0.05651	0.1503***
TA	-0.1408**	0.134	-0.0953
Constant	1.9616***	-0.2991	1.5733
$\mathbf{R^2}$**(squared)**	0.2815	0.248	0.2022
F (statistic)	6.27	4.62	-
Prob-F	0.005	0.0185	-
Number of obs	35	35	35

Source: Prepared by the researchers based on the outputs of STATA 15 software.

The results indicate that the coefficients of the independent variables are significant in the Pooled Regression Model but not significant in the Fixed Effects Model. The results in the table show that all three estimated models are statistically acceptable at a 5% significance level. The coefficient of determination (R^2) appears to be low but statistically acceptable in this type of estimated model, suggesting that the independent variables can explain 28% of the variation in the dependent variable (Appendix 2).

To compare the three models, the following tests are conducted:

- **Fisher Test:** To compare the Pooled Regression Model and the Fixed Effects Model, with the following hypotheses:
  - **Null Hypothesis:** The Pooled Regression Model is more appropriate.
  - **Alternative Hypothesis:** The Fixed Effects Model is more appropriate.

The results of the Fisher Test indicate that the p-value is less than 5%, which means that the Fixed Effects Model is better than the Pooled Regression Model, leading to the rejection of the null hypothesis.

- **Breuch and Pagan-LM Test:** This test is used to differentiate between the Pooled Regression Model and the Random Effects Model, with the following hypotheses:
  - **Null Hypothesis:** The Pooled Regression Model is more appropriate.
  - **Alternative Hypothesis:** The Random Effects Model is more appropriate.

The results of the Breuch and Pagan-LM Test show that the Chi-bar value is 16.70, and the p-value is 0.0000, which is less than 5%, leading to the rejection of the null hypothesis, indicating that the Random Effects Model is better (acceptance of the alternative hypothesis).

- **Hausman Test:** This test is used to differentiate between the Fixed Effects Model and the Random Effects Model, with the following results:

- The statistical value for the Hausman Test is 4.84.
- The p-value for the Hausman Test is 0.3814, which is greater than 5%.

Therefore, the null hypothesis that the Random Effects Model is more appropriate is accepted, and the alternative hypothesis is rejected.

Based on the results of these tests, it is evident that the most suitable model for explaining the impact of digital payments on liquidity risks in Saudi banks is the Random Effects Model.

To ensure the validity of the Random Effects Model, standard problems such as multicollinearity, autocorrelation, and heteroscedasticity were assessed:

- **Multicollinearity Test:** The results show that the average values of VIF for all variables do not exceed 5, indicating that the Random Effects Model does not suffer from multicollinearity.
- **Autocorrelation Test:** The Wooldridge test results indicate that the p-value is less than 5%, signifying the presence of autocorrelation in the study model.
- **Heteroscedasticity Test:** The Breusch-Pagan / Cook-Weisberg test results indicate that the p-value is less than 5%, suggesting the presence of heteroscedasticity in the study model.

The study model is adjusted for both autocorrelation and heteroscedasticity through the Panel FGLS method as indicated by Danial Hoechle in a study published in The Stata Journal (Hoechle, 2007, p. 285). The results of this estimation (Table 04) show that the model is statistically significant, with a p-value of 0.0011 at a 5% significance level.

Statistically, for the digital payments variable, it has a positive effect on the loan-to-deposit ratio, with an increase in digital payments by one unit leading to a 0.1412 increase in the loan-to-deposit ratio. This result is statistically significant at the 0.009 level. Regarding the variable of bank assets, it has a negative impact on bank liquidity (loan-to-deposit ratio). An increase in bank assets by one unit results in a 0.1408 decrease in the loan-to-deposit ratio, which is statistically significant at the 0.001 level.

Table (04): Estimation the Panel model by the pooled FGLS method

```
. xtgls LTD FTIP TA

Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        homoskedastic
Correlation:   no autocorrelation

Estimated covariances      =         1          Number of obs     =         35
Estimated autocorrelations =         0          Number of groups  =          5
Estimated coefficients     =         3          Time periods      =          7
                                                Wald chi2(2)      =      13.71
Log likelihood             =  52.96198          Prob > chi2       =     0.0011
```

LTD	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
FTIP	.1412718	.0541675	2.61	0.009	.0351054	.2474381
TA	-.1408269	.0408532	-3.45	0.001	-.2208977	-.060756
_cons	1.96161	.3321088	5.91	0.000	1.310689	2.612532

Source: Prepared by the researchers based on the outputs of STATA 15 software.

5.2. Results Analysis and Hypothesis Discussion:

Based on the results presented in Annex 3, it becomes evident that there is a statistically significant positive direct impact of digital payments, expressed as the proportion of digital payments to total payments made through various digital banking channels, on liquidity risks expressed as the loan-to-deposit ratio (employment ratio). This implies that an increase in the proportion of digital payments increases liquidity risks in Islamic banks in Saudi Arabia. Since the loan-to-deposit ratio is inversely related to other liquidity ratios, an increase in it leads to a decrease in liquidity at the bank level and consequently an increase in liquidity risks. These results are contrary to what is assumed in the economic literature, which suggests that various financial technology innovations contribute to reducing the risks facing banks, especially digital payments, as their adoption increases liquidity levels in banks. However, studies by Deng, Zhao Yiwen, Liu, and Lv (2021), Udin, Bujang, and Beli (2019), and Pascal and Ochei (2019) all indicated that banks' adoption of various financial technology innovations has two contradictory effects: initially, it increases their risk levels, while in the long term, these innovations reduce risk levels. Similarly, regarding digital payments, in the initial stage of their adoption in banks, they tend to increase liquidity risks, while in the long run, they contribute to reducing them. On this basis, we reject the first hypothesis, which states, "There is no statistically significant effect of the digital payments index on liquidity risks in Saudi Islamic banks."

As for the bank's asset size, the results indicate a negative impact on the employment ratio. This means that, as the bank's asset size increases by one unit, the employment ratio decreases by 0.1408, with statistical significance at 0.001. This implies that as the size of the bank's assets increases, the employment liquidity ratio decreases, indicating a decrease in liquidity risks at the bank. This suggests that larger banks have the capacity and capability to control liquidity risks in the adoption of digital payments better than smaller and medium-sized banks. When digital payments are included in their banking services, the level of liquidity risks in larger banks is relatively lower compared to smaller and medium-sized banks. This result is consistent with the findings in studies by Deng, Zhao Yiwen, Liu, and Lv (2021) and Lee, Yu, Li, and Zhao Jinsong (2021). Therefore, we reject the second hypothesis, which states, "There is no statistically significant effect of the bank's asset size on liquidity risks in Saudi Islamic banks."

6. Conclusion:

Financial technology is considered one of the most crucial pillars shaping the future of the financial and banking sector. It works to provide innovative financial services, enhance existing financial services, improve business models' efficiency, and enable all segments of society to access financial and banking services that meet their needs and align with their financial capabilities. Islamic banks are not isolated from these technological advancements. They have sought to adopt digital strategies within their business models to support their competitiveness in the banking environment and mitigate the risks associated with their operations.

Through this study, the impact of digital payments, one of the prominent innovations in financial technology, on liquidity risks in Islamic banks was examined. The study yielded a set of results and recommendations summarized as follows:

6.1 Study Results:

- There is a statistically significant positive impact of digital payments on liquidity risks in Saudi Islamic banks. An increase in the value of digital payments leads to higher liquidity risks in the studied banks during the period 2015-2021.
- There is a statistically significant inverse impact of bank asset size on liquidity risks in Saudi Islamic banks during the study period. Larger Saudi banks have the capacity to provide the necessary liquidity to meet their obligations due to their digitized banking systems compared to smaller and medium-sized banks.
- Saudi Islamic banks go through two phases: an initial phase where the impact of financial technology innovations on banking risks is positive, with the adoption of these innovations leading to increased risks. In the long term, these innovations work to reduce risks.

6.2 Recommendations:

Based on the study's results, several recommendations are provided for Islamic banks, which can be summarized as follows:

- Islamic banks must ensure the availability of the necessary digital infrastructure to adopt financial technology innovations while considering their specific requirements.
- It is essential for Islamic banks to verify that the financial technology innovations they adopt comply with Islamic Sharia principles. They should also develop a comprehensive and flexible strategy to manage and mitigate associated risks effectively.
- Islamic banks should explore partnerships and cooperative agreements with financial technology companies to offer digital financial products and services that align with Sharia principles while enhancing their competitive position.

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8. Appendices:

Appendice (1): Descriptive statistics data

```
. summarize LTD FTIP TA
```

Variable	Obs	Mean	Std. Dev.	Min	Max
LTD	35	.8636429	.0637787	.734	1.043
FTIP	35	.6171429	.1837289	.39	.98
TA	35	8.415669	.2436071	7.948	8.961

Source: Prepared by the researchers based on the outputs of STATA 15 software.

Appendice (2): Static Panel data models
Pooled Regression Model (PRM)

```
. regress LTD FTIP TA
```

Source	SS	df	MS		
				Number of obs =	35
				F(2, 32) =	6.27
Model	.038935035	2	.019467518	Prob > F =	0.0050
Residual	.099367711	32	.003105241	R-squared =	0.2815
				Adj R-squared =	0.2366
Total	.138302746	34	.004067728	Root MSE =	.05572

LTD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
FTIP	.1412718	.0566497	2.49	0.018	.0258801	.2566635
TA	-.1408269	.0427253	-3.30	0.002	-.2278555	-.0537982
_cons	1.96161	.3473277	5.65	0.000	1.254127	2.669094

Source: Prepared by the researchers based on the outputs of STATA 15 software.

Fixed Effects Model (FEM)

```
. xtreg LTD FTIP TA, fe

Fixed-effects (within) regression               Number of obs     =         35
Group variable: entre                           Number of groups  =          5

R-sq:                                           Obs per group:
     within  = 0.2480                                         min =          7
     between = 0.5363                                         avg =        7.0
     overall = 0.0733                                         max =          7

                                                F(2,28)           =       4.62
corr(u_i, Xb)  = -0.7470                        Prob > F          =     0.0185

------------------------------------------------------------------------------
         LTD |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        FTIP |   .0565133   .0854116     0.66   0.514    -.1184444     .231471
          TA |   .1340288   .1759448     0.76   0.453    -.2263778    .4944355
       _cons |  -.2991762   1.433983    -0.21   0.836    -3.236557    2.638205
-------------+----------------------------------------------------------------
     sigma_u |  .08150658
     sigma_e |  .04050648
         rho |  .80193682   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(4, 28) = 8.14                       Prob > F = 0.0002
```

Source: Prepared by the researchers based on the outputs of STATA 15 software.

Random Effects Models (REM)

```
. xtreg LTD FTIP TA, re

Random-effects GLS regression                   Number of obs     =         35
Group variable: entre                           Number of groups  =          5

R-sq:                                           Obs per group:
     within  = 0.2022                                         min =          7
     between = 0.2989                                         avg =        7.0
     overall = 0.2505                                         max =          7

                                                Wald chi2(2)      =       8.68
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0130

------------------------------------------------------------------------------
         LTD |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        FTIP |   .1503991   .0537303     2.80   0.005     .0450896    .2557085
          TA |  -.0953608   .0805772    -1.18   0.237    -.2532892    .0625676
       _cons |    1.57335   .6567403     2.40   0.017     .2861624    2.860537
-------------+----------------------------------------------------------------
     sigma_u |  .03948444
     sigma_e |  .04050648
         rho |  .48722515   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Source: Prepared by the researchers based on the outputs of STATA 15 software.