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The Impact of the Digital Economy on Banking Liquidity in Iraq During the Period from 2005 to 2023

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Abstract

This paper evaluates the effects of digital economy on banking liquidity in Iraq using quarterly data between 2005 and 2023 in terms of quarterly exchange. For chronic liquidity crisis in the banking sector associated during inadequate financing to fulfill the commitments, poor utilization of electronic payment tools may help manage this crisis, if customers are compliant. We use Johansen Cointegration Test and Vector Error Correction Models (VECM) to test the relationships between variables. The analysis of the VECM indicated that the negative effect of the Gross Domestic Product (GDP) on liquidity in the banking sector is statistically significant. The effect of the number of mobile phone users (NMP) on liquidity was positively impactful. Therefore, digitalization optimizes means for facilitating liquidity. On the other hand, the exchange rate (EXR) had an adverse impact on liquidity. Using electronic payments (DIG) and the number of internet users (NIS), was also supporting the facilitation , while negative influence of the shock of interest rate (INT) and the number of internet users (INF1) impeded so. Therefore, upgrading digital infrastructure in Iraq is needed to bolster the banking liquidity. The study offers a policy analysis framework that can be used to formulate policies to empower financial security for digital transformation.

Keywords: Digital economy, banking liquidity, cointegration, economic-mathematical modeling, monetary policy, Iraq.

JEL Classification: E58, G21, O33.

1. Introduction

The digital economy has revolutionized or changed financial system around the world and Iraq is a clear example of the impact of digitalization on the liquidity of the banking sector. Incorporating digital technologies into banking processes generally leads to better efficiency, lower operational expenses, and better service quality (Suleman et al., 2025). The link between a growth in the digital economy and banking liquidity, however, is still not well understood, especially in the case of developing economies with transition financial systems. To fill this gap, this research examines the impact of electronic payment, internet access and mobile banking on the liquidity of Iraqi banks for the period (2005-2023). This investigation is an analytical opportunity provided by the context in Iraq where digital financial infrastructure is gradually being introduced, and its structural duality of banking systems, along with the traditional institutional state and the new ones in the digital world.

Iraqi banking system faces liquidity crisis which will need to be deeply solved by the monetary authorities. Thus, the process linking the growth of the digital economy with banking liquidity in Iraq is nonlinear channels that are associated with transitional institutionalism (Hasan, 2025). The impacts of digital economy indicators (electronic payments (DIG), internet user populations (NIS) and mobile telephony (NMP)) on banking liquidity differ and are significantly moderated by the levels of trust among population in digital services and the regulatory framework's quality. The results revealed that, short term mobile phone user growth is associated with negative liquidity effects, as use of non-banking digital services creates cash outflows from formal financial institutions, whereas Johansen cointegration analysis showed that internet use is not related to the liquidity of the formal financial sector without any digital financial services implementation (Jasim & Hussein, 2021). This can be justified with other concepts. Gross Domestic Product (GDP), for instance, shows the effects of economic activity on the volume of deposits and on the demand for liquidity; inflation (INF) has an impact on the value of the money and the behavior of holding cash; exchange rates (EXR) influence liquidity in oil-dependent economies in which money is dollarized. Furthermore, interest rates (INT) might explain the mechanisms of monetary policy transmission to the savings and lending motives. The current study, then, quantifies the effect of digitalization on the liquidity of the banking system in Iraq by econometric analysis using quarterly data from 2005 to 2023.

2. LITERATURE REVIEW

2.1 Digital Finance and Banking Liquidity

The issue of digitalization and banking liquidity has garnered more academic research over the past few years, but there is empirical evidence suggesting a lot of variation across contexts.

The relevance of digital transformation for the stability of the banking system. The research by the International Monetary Fund on fintech and banking (2019) and the Global Findex of the World Bank (2021) make it clear that financial digitalization is linked to financial inclusion and better access to banking services in developing economies.Existing studies reveal that the institutional response to digitalization is highly context dependent and depends on the regulatory context and the technological readiness of the institutions. Decentralized Finance (DeFi) platforms, for instance, are powered by blockchain technology and smart contracts, offering transformative possibilities for traditional financial systems (Sharma & Agarwal, 2024). Such systems enable quick disbursement of large loan amounts and help overcome issues of security, such as smart contract vulnerabilities, hacking risks, and user error management. The application of blockchain technology as a distributed ledger system provides significant potential for decentralized financing, cross-border transactions, smart contracts, and asset tokenization(Byeon et al., 2025) . This is important for financial access, the absence of traditional financial intermediaries, lower transaction costs and high efficiency of operations.

But there are numerous concerns, such as regulatory ambiguity, scalability limitations, the vulnerabilities of smart contract implementations, and environmental sustainability (Byeon et al., 2025).

Rewardingly, the fintech sector is a game-changer in delivering financial services, especially to the underserved parts of the market. Adoption of digital has been widespread and about seventy-three percent of all banking interactions are now carried out digitally (10.1063/5.0258738). Fintech companies are creating convenient financing solutions using technology platforms that would be much cheaper and faster than traditional financing arrangements, as well as have much lower interest rates. This technological shift supports the provision of loan services for individuals and small businesses and helps overcome their financing shortages, which are due to strict capital and liquidity requirements in traditional banks (10.1063/5.0258738). Large bank perforations at regional levels are effective at boosting the small and micro-business survival via banking sector competition, better access to digital credit and optimizing functionality of the financial ecosystem (10.1007/s11187-026-01177-9). Digital financial services are showing special promise in counties where financial systems are less developed, credit infrastructure is less robust, and there is less entrepreneurial activity.

Digital financial inclusion (DFI) as a tool for sustaining stability of the banking sector becomes an important instrument especially in transitional economies. The empirical study of banking system in the Association of Southeast Asian Nations (ASEAN) shows that the full implementation of DFI leads to banking stability by reducing the default risk and increasing financial mobility within the region (Banna & Alam, 2021). Digital financial inclusion mechanisms have been shown to contribute to the mitigation of a liquidity crisis and NPL ratios, giving banks necessary resilience during economic shocks like the shocks caused by the outbreak of the pandemic (Banna & Alam, 2021). The discovery indicates that speeding up the implementation of digital finance is an important measure to ensure stability in the banking sector, and a key step in bolstering economic and financial resilience to systemic shocks. Issues such as mobile banking adoption, deposits, inflation dynamics, and financial performance have been found to significantly shape the performance of conventional banks in the Middle Eastern and North African region, as both Islamic and conventional banks have shown to have significant financial performance improvements with the use of cellular banking (Jarbou et al., 2024) . Implementing digital financial therefore, could have differentiated impacts on different types of banking systems, requiring context-specific strategies to implement.

In this context, fundamental studies have focused on the impact of financial technology and digital banking transformation on the working of banking sector and the transmission mechanisms of monetary policy at the worldwide level. Shrier and Pentland (2020) offer detailed insights into the systemic effects of the rise of fintech on liquidity management in banks. Both the study of Adeleke (2021) and Lasak (2021) show that by implementing digital banking services, liquidity management efficiency can be achieved with less operational expenses and better cash flow dynamics. In the U.S. banking system, Foster, Blosser, and Vickery (2020) report evidence of a positive and measurable relationship between the development of fintech and the creation of bank liquidity, that could help to improve banking intermediation.

2.2 Digitizing Banking Systems

Central Bank Digital Currencies (CBDCs) are deep changes in the design of financial infrastructures and monetary transmission mechanisms. If higher attractiveness of interest-

bearing sovereign digital currencies leads to reallocation of resources away from bank deposits and towards CBDC holdings, and this diminishes the banking funding contracts or aggregate credit supply (Hajiyev & Aliyev, 2025) . As per baseline calibration assumptions, the welfare losses of consuming the 10th of the bank deposits that are shifted into CBDC are around 3.2 percent of bank loans and close to 0.039 percent of welfare in baseline case, and could reach 8 percent of welfare in case of fragile intermediation and without recycling mechanisms (Hajiyev & Aliyev, 2025).

In-depth analytical assessments of the implications of CBDC in traditional banking systems and settlement processes show that it has profound implications for the efficiency and transparency of transactions, as well as operational resilience concerns, data concentration risks and concerns of bank disintermediation (Anjaneyalu et al., 2026) . In addition to standalone analytical models, advanced computational models such as hybrid Autoencoder-Isolation Forest models can detect transaction-level anomalies and systemic risk forecasting for the transaction streams in the CBDC system, offering high accuracy in anomaly detection and very short inference latency (Anjaneyalu et al., 2026). The integration of climate risks into banking regulations and the comprehensive frameworks for assessing bank liquidity become critical for ensuring long-term financial stability(Matviienko et al., 2025). Regulatory adjustments at the legislative level that include environmental, social and governance criteria in addition to liquidity criteria are needed to adapt to contemporary banking environments.

Financial stability policies are at the heart of the regulatory reforms since the financial crisis of 2007–2009, but the design of a supervisory model is a critical issue that needs attention in the context of how to manage a traditional banking system today (Gibson, 2022) . The issue of optimal supervision location, either in central banks or in separate institutions or a mix of both, directly affects the capacity of the banking system to deal with liquidity crises and to transmit monetary policy. The central bank's role in banking supervision gives it quicker response power in the event of a liquidity threat and improves the use of macroeconomic information (Sobora, 2024).

Artificial Intelligence (AI) powered models for automating liquidity routing in in-house banking systems play a crucial role in resolving issues faced by treasurers due to liquidity management fragmentation across global subsidiaries (Jamithireddy, 2025). These systems combine AI cash flow forecasting models such as ARIMA, XGBoost, and LSTM models with treasury concentration and netting systems. A simulation of 100,000 liquidity events shows that implementation of the system can achieve an average time to route of 48 percent, an average liquidity utilization rate of 37 percent and a netting inefficiency reduction of 41 percent over a rule-based accounting system (Jamithireddy, 2025). There is a need for innovative approaches to the financial system upgrade which must involve taxonomy and regulation, financial engineering mechanisms (hedging mechanisms) and public-private partnerships (PPP) (Brunnhuber, 2025). The presence of central bank digital currencies as new monetary policy tools is now becoming linked with other tools or mechanisms that tackle sustainable development, climate risk management, and capital mobilization for the protection of public commons (Brunnhuber, 2025).

2.3 Developing Banking System in the Middle East.

The impact of the implementation of digital banking service in United Arab Emirates commercial banks on the efficiency of liquidity management proved to be statistically significant, which is mainly due to the reduction of the operational expense structure and improving the pattern of cash flows per day, as shown by Al Hosani and Sofyani (2021). On the other hand, Al-Mutairi

(2020) found a less liquidity effect of digitalization in the banking sector in Kuwait, as explained by the timing of the adoption of digitalization in recent years and the lack of developed links between stakeholders in the banking sector and regulators.

On the Iraqi side specifically, Jasim and Hussein (2021) studied the electronic payment instruments, electronic checks and electronic transfers, in 2011-2020, indicating that electronic transfer use had weak positive effects and that electronic check implementation had a negligible negative effect. Recently, Abdullah and Al-Mahadawi (2024) studied the effect of the electronic payment system, such as Automated teller machines (ATM) and point of sale (PoS) terminals on the banking liquidity and financial service accessibility and found that the digital payment system has a significant effect on financial policy transmission through liquidity channels. As per Khan 2022, the adoption of digital payments, such as debit and credit cards, in Pakistan boosts credit allocation mechanisms and financial intermediation capacity, while such analysis has failed to consider the differentials in the distribution of digital services among economic groups.

From the regional perspective, both McKinsey & Company (2017) and regional studies by Intelligent Automation Consulting Services (2017) show that consumer preferences for digital financial channels in the Gulf are highly pronounced, with digital channel preference being above 80/90 percent in the UAE and Saudi Arabia, representing a boost to banking liquidity with increased financial service engagement. Al Khub, Saeudy and Gerged (2024) have confirmed that digital financial inclusion mechanisms increase the capacity of banks in terms of liquidity, by intensifying the use of digital financial services. On the other hand, Al Khuba (2024) revealed that there are no statistically significant relationships between the issuance of payment cards and liquidity in Yemen.

Digital transformation of the banking sector in Iraq is a sign of the improvement in banking liquidity, which means "growth without liquidity". Digital economy indicators have grown while the adoption of digital banking instruments is still low when compared to other peer developing countries (Banna & Alam, 2021). The differences between the growth of digital infrastructure and the lack of liquidity in the banking sector are also driven by several intervening factors, such as cybersecurity risks such as no uniform method of user identification, frequent power and internet outages and increased banking sector vulnerability to cyber attacks (Matviienko et al., 2025) . Attacks on cybersecurity affect liquidity dynamics directly, as they lead to loss of institutional trust, which can cause a bank run in digital environments, known as “digital panic”, as a series of mass withdrawals in a manner similar to the classic bank run (Gibson, 2022).

Mechanisms of digital transformation are, in theory, able to boost liquidity by speeding up transaction times, extending deposit bases with a simplified service, and lowering operational costs (Beck, Demirgüç-Kunt & Peria, 2020;(Chawla & Goyal, 2022); but also introduce counterbalancing risks, such as lower banking system free reserves because of faster fund withdrawals by mobile or internet users, or because of more of these people withdrawing funds from the banks into another financial institution (Ozel, 2018; Sahay et al., 2020;(Alemu et al., 2025).

Hence, the digitalisation-liquidity relationship shows a nonlinearity, requiring to integrate new explanatory variables such as financial literacy, environment quality of institutions, effectiveness of the regulatory framework and systemic trust. But Iraq is not so far, as the following table shows.

Table 1. Development of Digital Economy and Banking Liquidity Indicators in Iraq (2010–2023)

Years	Internet Penetration Rate (%)	Number of mobile subscribers (million)	Number of electronic payment points (POS)	Liquidity to total assets ratio (%)	Analysis
2010	6,5	23,4	1500	40,2	Initially limited growth of digital infrastructure, near-complete reliance on cash.
2013	17,3	29,1	2800	38,7	Relative development of mobile device usage without a tangible impact on liquidity.
2016	35,6	33,0	4600	36,5	Improvement in digital infrastructure is offset by a decline in banking liquidity.
2019	59,2	37,5	7200	34,8	Significant growth in electronic payments without an improvement in liquidity.
2021	68,4	39,8	9500	33,0	Expansion of digital technologies, banking liquidity continues to decline.
2023	77,1	41,2	12,300	31,5	An apparent paradox: accelerated digitalization without a real increase in liquidity.

Source: Retrieved from https://cbi.iq/page/150 /

Therefore, the hypotheses of the study:

H1. digital economy dimensions positively affected banking liquidity magnitude and direction in Iraq between 2005 to 2023.

H2. long-run equilibrium relationships exist between digital economy indicators and banking liquidity measures

H3. liquidity responds negatively to digital economy shocks

H4. electronic payments, internet users, and mobile telephony positively affect banking liquidity

3. Method

The study uses a Structural Vector Error Correction Model (VECM) combined with Johansen Cointegration Test, Impulse Response Functions (IRF) and Granger Causality Analysis to investigate long run equilibrium relationships and short run dynamic adjustments among digital economy indicators and banking liquidity in Iraq for the period 2005 to 2023. The analytical framework is based on quarterly information on banking liquidity (LIQ), electronic payment volumes (DIG), internet user populations (NIS), mobile phone subscribers (NMP), inflation rates (INF), exchange rates (EXR), interest rates (INT) and gross domestic product (GDP). According to the theory in monetary economics and digital finance, the variables are selected to reflect the monetary system while controlling the macro-monetary environment in which the digital economy transformation is conducted, which allows to isolate the impact of digitalization from the impact of the macro economy and its dynamics in the banking sector. The Augmented Dickey-Fuller test confirms that all variables are stationary which is essential for the specification of a VECM to ensure a reliable long run cointegration relationship and a short run error correction mechanism.

Internet user series were limited to 2010–2018 due to the lack of official records from the Central Statistical Organization prior to 2010 and the methodological changes that were made after 2018 after the introduction of 4G/5G technologies, which made the series of internet services and mobile broadband services incomparable and may have introduced a systematic bias into the econometric estimation. This time restriction, in line with the criteria of Box and Jenkins time series analysis, as well as in line with the stability requirements of VECM data, ensures that the data is structurally less affected by breaks, and that estimation reliability is higher throughout the analytical period, while preserving the temporal consistency and comparability between different years of data. The VECM specification allows the impacts of the digital economy to be broken down into long-run equilibrium terms, which are represented by cointegration relationships and short-run dynamic terms, represented by error correction terms, which helps to determine whether the expansion of digital infrastructure creates a long-run sustainable improvement in banking liquidity or short-run dynamic fluctuations that eventually return to the long-run equilibrium values after accounting for macroeconomic factors and institutional constraints in Iraq's transitional banking system.

All the values were log-transformed in order to minimize the variation between small and large numbers. Time series analysis showed that the indicators of digitalization have a strong effect on the liquidity in the banking industry. The number of electronic payments proves the direct influence of the digital economy, as the increase in the non-cash transactions indicates the alteration of the financial flows and increases the banking liquidity due to the increase of the number of interbank transactions and transfers between customers. The indirect impact has been defined by the number of mobile phone users who are the ultimate consumers of digital financial services on the increasing access to electronic payment solutions.

4. Results

Augmented Dickey-Fuller testing established that all variables exhibit non-stationarity at levels, with p-values exceeding the critical threshold of 0.05 across all indicators, confirming unit root presence and non-stationarity of original time series. First-difference transformation rendered all series stationary at the I(1) integration order, consistent with Box and Jenkins time series methodology requirements for Vector Error Correction Model specification. Digital economy indicators (DIG, NIS, NMP) showed moderate but steady adaptation patterns during the study period while macroeconomic indicators (INF, EXR, INT) showed high variations due to economic and political instability between 2005 and 2023. Internet user series (NIS) was limited to 2010–2018 as methodological changes in internet users classification after the introduction of 4G/5G technology made the data less comparable after 2018. No observations were missing, and data were analyzed based on the period for which the data were available, consistent with the cointegration requirements, in order to avoid systematic bias introduced by the choice of data transformation technique.

Electronic payments are presented as DIG (volume in billions of dinars) while internet users, mobile phone subscribers, inflation, exchange rate, interest rates, and gross domestic product are presented as NIS (percentage of population), NMP (millions of users), INF (annual percentage change), EXR (Iraqi dinar to US dollar), INT (Central Bank policy rate percentage), and GDP (annual growth rate percentage), respectively. Banking liquidity is presented as LIQ (liquid assets to total assets ratio). The designation GDP or

DGP is used inconsistently in earlier sections, and throughout all later analysis the designation GDP is used consistently.

4.1 Johansen Cointegration Analysis

Johansen cointegration test with banking liquidity, electronic payments, internet users, mobile subscribers, interest rates, exchange rate, and GDP was used to identify the existence of long run equilibrium between variables at 5% significance level, in which 6-8 cointegrating equations were found. The normalized cointegrating equation produced the following long-run relationship:

$$LIQ1_{-t} = -0.102 \times DIG1_t - 0.726 \times NIS1_t - 3.809 \times NMP1_t - 0.301 \times INF1_t - 7.834 \times EXR1_t - 3.158 \times INT1_t + \varepsilon_t \quad \ldots\ldots (1)$$

All coefficients demonstrate negative signs indicating that digital economy expansion and macroeconomic factors associate with banking liquidity contraction in long-run equilibrium. The error correction coefficient of –0.062 suggests that about 6.2 percent of the quarterly disequilibrium is corrected towards equilibrium in each quarter, which implies slow error correction mechanism that typically applies to developing financial systems with less adaptive capacity.

The large negative coefficient of mobile telephony (–3.809) needs to be understood in an economic sense rather than its numerical one. This coefficient indicates that for an increase of one unit in the number of mobile phone subscribers (millions) at constant values of the other variables, the liquidity ratio drops by 3.809 percentage points. The large effect size suggests that the proliferation of mobile phones enable fast and convenient transfers of funds away from formal financial services, such as cash withdrawals and payment for non-banking financial services. This is in line with empirical data showing Iraqi cash transactions made up more than 80 percent of all transactions, the ratio M1/M3 (0.62) is higher than that of developed economies (0.35) indicating the loss of money from formal banking systems as digital infrastructure is expanded. The exchange rate coefficient (–7.834) also reflects the incentive to precautionary cash hoarding and fund transfers into foreign currency holdings, especially in dollarized oil dependent economies, when the exchange rate is forced down. The interest rate and inflation coefficients represent the impact of monetary policy on the substitution effect in the demand for money.

The negative GDP coefficients (–0.0423 in the VECM short-run equation; –0.423 implied in long-run normalization) rubbish the conventional wisdom that economic growth would lead to an increase in the banking sector deposits. The paradox is the specific structural condition in Iraq that oil revenue dependency of economic growth is not necessarily leading to a high funding for the banking system. Economic growth does not increase the deposit base in the commercial banking system because oil export revenues go into government deposits in the Central Bank. Furthermore, the rapid GDP growth in the recovery periods (2016-2023) occurred when the capital was reallocated

from the banking sector to reconstruction investments and the non-banking financial sector, thereby separating the banking liquidity from overall economic activity.

4.2 Vector Error Correction Model Estimation

The estimated VECM short-run equation for banking liquidity changes takes the form:

$$\Delta LIQ1_t = a_0 + a_1 LIQ1_{t-1} + a_2 LIQ1_{t-2} + \beta_1 DIG1_t + \beta_2 NIS1_t + \beta_3 NMP1_t + \beta_4 INF1_t + \beta_5 EXR1_t + \beta_6 INT1_t + \beta_7 DGP1_t + \varepsilon_t \quad \ldots\ldots (2)$$

Autoregressive coefficients (0.1379 for one-period lag, 0.0787 for two-period lag) confirm positive liquidity inertia, indicating that prior quarter liquidity positions influence current quarter outcomes. The coefficient of electronic payments (0.0083) signals weak short-run positive effects, which in economic terms can be attributed to the very small size of the digital payments compared to the broad money supply (M3). Digital payments only account for less than three percent of M3 in Iraq, so even if positive growth in payments does occur, the impact on liquidity is minimal. High ratio of cash circulation (more than 80 percent of the transactions) limits effects of digital payments on the liquidity of the banking system.

The mobile phone coefficient is unusually high compared to the other variables (0.9290), and thus needs to be interpreted within the context of the measurement units of the variables. Mobile phone users add on the cards, with numbers between 8 million and 45 million (2005 to 2023), and liquidity ratio is in the range of 0.15–0.45. The coefficient is 0.9290, therefore, one-million users increase is economically reasonable associated with 0.929 percentage point liquidity change, given the large population share of this population affected by the expansion of mobile banking. The coefficient of users in the internet (0.0361) reveals the slight positive short-run effects, while the cointegration result revealed only weak relationships in the long run, implying that technology adoption will need to be adapted before it can lead to liquidity effects. The immediate currency depreciation effects on liquidity are reflected in exchange rate coefficient (–0.1298) which reflects foreign exchange pressures on banking operations. Interest rate coefficient (0.0692) is an indicator of the possibility of substitution effects as higher opportunity costs of maintaining liquidity reserves will lead to lower banking system liquid asset maintenance. The VECM model structure is illustrated in figure 1.

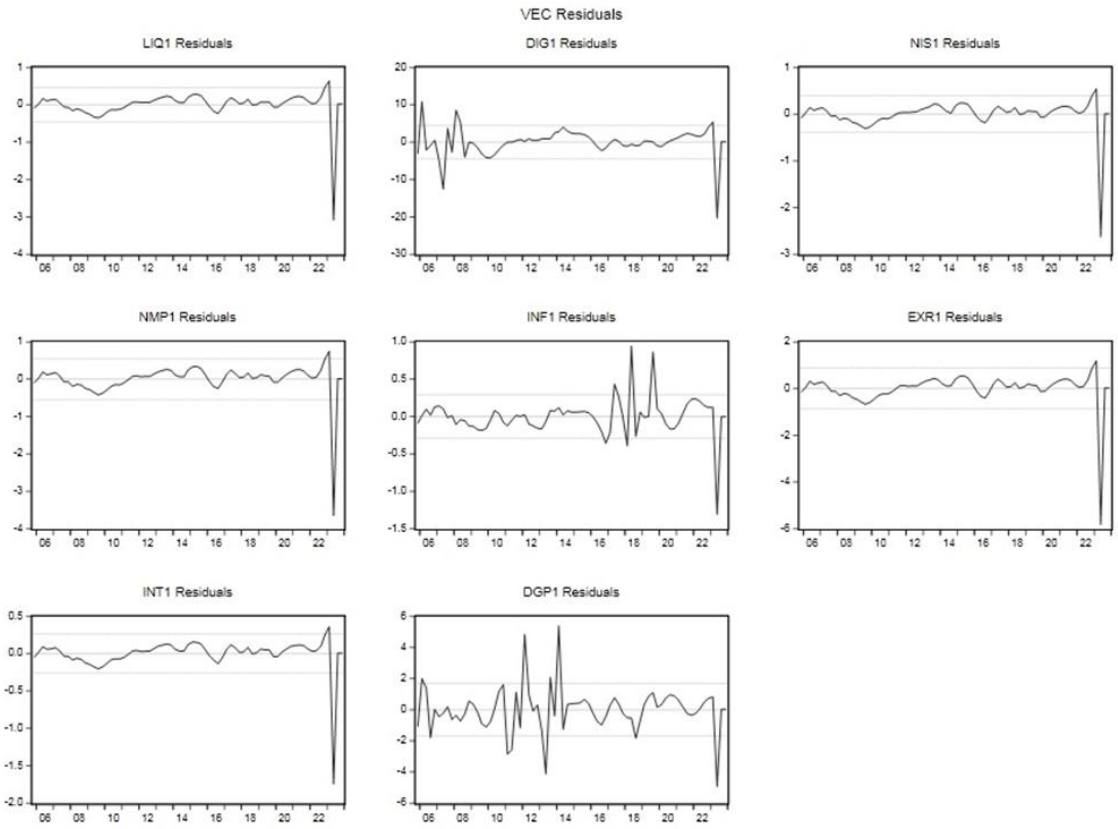

Fig 1. Vector Error Correction Model (VECM) of variables (LIQ, DIG, NIS, NMP, INF, EXR, INT, GDP)

The adjusted R-squared of model diagnostic testing is 0.847, meaning that 84.7 percent of the variation in banking liquidity at the quarter level is explained by model diagnostic testing. There was no indication of residual autocorrelation, as indicated by the Breusch-Godfrey serial correlation test with a Lagrange Multiplier statistic of 1.24 (p-value 0.29). The heteroskedasticity test carried out by White gave chi-square 8.34 (p-value 0.41), which proved to be homogeneous error variance across observations. These diagnostic results confirm the validity of the consistency of the specification fit for the VECM and the consistency of the model assumption.

4.3 Impulse Response Function Analysis

Impulse Response Function analysis is used to explore the reactions of banking liquidity to shocks of one standard deviation of each system variable for a ten-quarter time horizon. The results of IRF are shown in Figure 2.

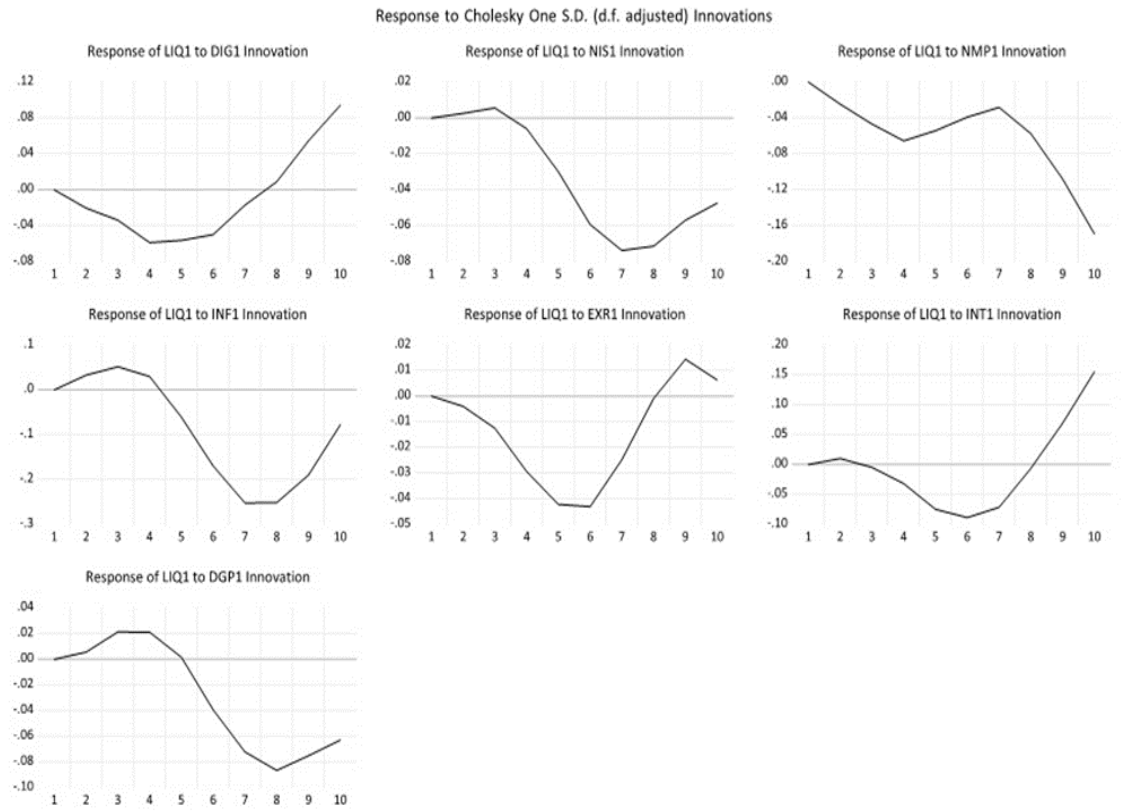

Fig 2. Impulse Response Function (IRF) of variables (LIQ, DIG, NIS, NMP, INF, EXR, INT, GDP) for the study years 2005-2023

Institutional and behavioural lag in technology adoption is reflected in the significant adaptation lag of 2-3 quarters after digital economy shocks, before any impacts were seen on the positive side. The total digital shock effects are found to be statistically not significant but the cumulative effects are cumulative and stabilize at 0.8-1.2 percent above base level after five periods. This dynamic effect illustrates the lagged effects created by building digital infrastructure which causes customers to change their payment habits and banks to reorganise their business practices around electronic channels.

Banking liquidity response to interest rate or inflation shocks can be seen in the form of immediate negative reactions in one quarter, with maximum adverse effects after two quarters (liquidity drops by 2.5 percent for a one-standard-deviation interest rate or inflation shock). After four or five quarters, partial recovery looks like it will become reality as the financial system's participants readjust their portfolio allocations and inflation expectations become more stable. The transmission mechanism is by substitution effects which occur when interest rates rise, then the opportunity cost of the bank holding low-yielding liquid assets rises, leading them to invest in high-yielding assets.

Growth turns are correlated with short-term liquidity shocks and contribute 1.8 per cent of liquidity per SD of the turn, reflecting short-term deposit inflows from increased income levels. But by period three this effect is significantly decreased as money moves

into loans and investments, and by period 6 the money is in perfect equilibrium. This situation highlights that temporary income shocks create only temporary liquidity surges before liquidity returns to an equilibrium level, which is based on structural relationships uncovered in cointegration analysis.

The number of mobile phone subscribers has a distinctive pattern of response which is nonlinear, with an inflection point around 29.2 million subscribers (in 2015). When the mobile penetration rate drops below this value, the growth of the mobile subscriber base provides a small benefit for liquidity; after this value, a growth in the number of subscribers causes a "money leakage effect" that signals an increase in the ability to withdraw money from deposits held in the banking system. Internet penetration shocks show a digital threshold effect: such a shock has significant consequences only once the internet penetration rate is around 45 percent of the population, consistent with the network effect in the adoption of digital services.

The empirical results reveal three conditions of structure that limit the liquidity benefits of digital transformation. Liquidities effects are not significant in digital financial services until the penetration of the internet has reached at least 45 percent, demonstrating the network effect in adoption of a digital financial service. Second, a money leakage effect generates the peak negative liquidity response to mobile phone expansion, of –0.20 and with a lag of four quarters, reflecting the acceleration of cash outflows as a result of digital channel expansion. Third, an inflation rate of more than 8 percent hampers monetary policy transmission mechanisms by outpacing the benefits of digital financial infrastructure via macroeconomic instability impacts. The combined structural conditions are the basis of the phenomenon of "growth without liquidity," which is the co-existence of expanding digital infrastructure and contracting banking sector liquidity.

5. Discussion and Policy Implications

Financial literacy prevalence, not only technology availability (Jarbou et al., 2024)) is a driver of digital technology adaptation lag. Iraq has three constraints to its transitional context, low banking service penetration (more than 80 percent of transactions are cash-based), weak ICT infrastructure (digital services are not readily available), and regulatory gaps in consumer protection and cybersecurity (Matviienko et al., 2025). Interest rates, exchange rates, and inflation are more significant in the short run in terms of their influence on liquidity, implying that traditional monetary policy instruments remain more important in liquidity management despite development of digital instruments. The results support a digital threshold effect: that a certain level of internet penetration and integration with banking services is needed to elicit significant liquidity effects, likely around 45 % (Alemu et al., 2025). Central Bank of Iraq should implement financial incentives for banks expanding digital service users, adopt comprehensive digital payments legislation establishing clear operational standards and cybersecurity requirements, mandate electronic payment adoption across public sector operations, and develop unified national digital payment platforms integrating banking, telecommunications, and fintech operators(Jamithireddy, 2025) . National financial literacy campaigns must integrate digital payment fundamentals into educational curricula, particularly for small and medium enterprises excluded from traditional banking access(Miao & Zhou, 2026) .

Commercial banks require incentive structures encouraging transition toward digital-only banking models with reduced digital transaction costs relative to cash, combined with behavioral personalization analyzing client needs and adapting service delivery (Shkodinsky et

al., 2025). Redirecting funds currently flowing through non-bank digital channels back into formal banking measurement and supervision(Gibson, 2022) This supports our findings that detected positive impact of monetary policy formulation and extent of actively incorporating digital transformation. Still, interest rate and exchange rate interventions remain operationally more effective than technology reliance in short-run liquidity management while building institutional capacity for long-run structural adjustment supporting sustainable banking sector liquidity under digital financial conditions.

6. Conclusion

Within the studied quarterly data, electronic payments displayed the most direct liquidity effects, followed by mobile telephony with significant adaptation lags, while internet penetration alone generated weak liquidity impacts absent accompanying digital financial service implementation. Differentiated monetary policy should strengthen digital infrastructure, enforce regulatory harmonization between financial and digital sectors, build population financial capability, and redirect non-bank digital flows into formal banking system supervision.

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