Digital Finance as an Impetus for Financial Sector Growth and its Impact on Banking Stability in the GCC Countries during 2016-2022.

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Abstract

In continuation of the findings of previous studies on the relationship between digital finance and financial stability, especially in emerging economies, this study came to research the relationship between digital finance through digital payment technology and banking stability. In the Gulf Cooperation Council countries, digital finance was measured by (total digital payments as a percentage of GDP, number of ATMs per 100,000 people, debit card penetration rate index), and measuring banking stability with (z-score index), using the cross-sectional data model (The econometric Model of Panel Data) The results indicated that there is a positive relationship between the digital payment indicators and the banking stability index, through the presence of a positive, statistically significant and moral relationship between the total digital payments, the prevalence of debit cards, and the number of ATMs per 100,000 people—banking stability index in the GCC countries.

Keywords: Digital finance, financial technology, digital commerce, banking stability
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1. Introduction:

Recent years have seen a wave of technology-driven innovations, which in turn, led to the reshaping of the traditional banking industry, especially since the onset of the COVID-19 pandemic. According to Research Forester, there has been a significant 69% increase in contactless transactions since January 2020. (Reuter 2020) Meanwhile, global investments in financial technology have risen from $19 billion in 2013 to nearly $165 billion in the first half of 2022, (Businness Wire 2021) with expectations of a 20.1% compound annual growth rate in the global digital payment market by 2024. Moreover, in the US market, a McKinsey report (Manyika & All, 2016) stated that 82% of the society uses digital payments in 2022, compared to 78% in 2021 and 72% five years ago.

These Modern financial technologies consists of a considerable number of innovative solutions to address challenges in delivering financial services. Digital finance, in particular, has revolutionized how financial services are delivered and consumed. Mobile financial transactions, online payment systems, and other contactless financial services have stronglyattracted millions of users worldwide

and become a preferred choice for consumers.According to the digital transformation report of 2021,(Digital Financial Services, 2021) the sum of money traded across the world through digital finance will exceed $13 trillion by 2024. This is due to what digital finance provides by enabling the financially excluded and marginalized to make or receive payments and transfers using digital devices such as mobile phones, debit cards, and point-of-sale terminals … with ease, speed, and lower costs compared to traditional financial services. This shift has led banks to venture into the digital payment sector to align with consumer trends and reach a broader customer base, especially in areas without physical bank branches. As a result, it contributes to creating innovative opportunities to enhance financial inclusion and economic development.

GCCcountries, which constitute an important economic bloc with massive oil wealth and emerging financial markets, have not remained isolated from the wave of financial digitization. Over the years, they have steadily diversified their economies, reducing their reliance on oil revenues and strengthening other sectors, especially the financial sector. The increasing preference for digital payments among Gulf residents is driven by a combination of mature digital infrastructure, widespread smartphone usage, and supportive government policies. This has placed GCC countries at the forefront of adopting digital finance systems.

For instance, according to data published by the UAE Ministry of Economy on June 4th, 2022, the UAE leads the Middle East and North Africa in financial technology, with a value of around $2.5 billion in 2022. According to a report by Mordor Intelligence, the UAE's digital payment is poised for a compound annual growth rate of 12% by 2027, with 144 Fintech companies operating in the UAE by 2022. Additionally, the UAE is home to about one-third of Fintech startups in the Middle East according to Bloomberg. Saudi Arabia also made substantial investments in the digital finance, reaching approximately $350 million in 2021, and financial sector development is a significant part of 2030 Vision.

1.1. Research Problem:

While financial technology has become a necessity, its economic and financial impacts remain unclear. Integrating digital financial services into the financial systems of GCC countries raises crucial questions about the stability of banking services, given the significance of the banking sector in these economies. Digital payments offer efficiency, speed, and broader financial inclusion, but they also carry potential risks to banking system stability. Thus, our main research question is whether there is a statistically significant relationship between digital payment indicators and banking stability in GCC countries.

This main question leads to four sub-questions:

1. Is there a statistically significant relationship between the total digital payments indicator and the banking stability indicator in GCC countries?
2. Is there a statistically significant relationship between the number of ATMs per 100,000 people and the banking stability indicator in GCC countries?
3. Is there a statistically significant relationship between the debit card penetration indicator and the banking stability indicator in GCC countries?

1.2. Study Hypotheses:

To address the research problem and sub-questions, the following hypotheses were formulated:

Main Hypothesis:

- There is a statistically significant relationship between digital payment indicators and banking stability in GCC countries.

Subordinate Hypotheses:

- There is a statistically significant relationship between the total digital payments indicator and banking stability in GCC countries.
- There is a statistically significant relationship between the number of ATMs per 100,000 people and banking stability in GCC countries.
- There is a statistically significant relationship between the debit card penetration indicator and banking stability in GCC countries.

1.3 Importance of the Study:

In the GCC region, where financial and banking institutions form the backbone of the economic system, understanding the impact of this digital transformation on banking stability is vital. The study's significance lies in several aspects:

- Understanding the reality of digital finance in GCC countries, including its key indicators and analysis.
- Providing a comprehensive, scientifically informed framework that highlights the economic efficiency of digital finance in enhancing banking stability, focusing on digital finance as a vital yet understudied topic in academic and research institutions.

1.4 Study Objectives:

The study aims to:

- Investigate digital finance as an impetus for financial sector development in GCC countries and highlight the relationship between its indicators and banking stability.
- Assess the relationship between the total digital transactions indicator and banking stability.
- Explore the impact of debit card penetration on banking stability.
- Examine the potential influence of ATM density on bank stability in the region.

1.5 Study Methodology:

To comprehensively explore all facets of the study, relying on the curriculum-descriptive and analytical by studying the concept of digital finance and the services it provides, the most important drivers of its emergence, then an analysis of its reality and development during the study period (2016-2022)This is based on various data, statistics, figures, and illustrative tables. As for researching the relationship between the study variables we used (Panel Data). This is because it considers the impact of time change and differences in cross-sectional series data simultaneously, which is precisely what we need to accomplish in this study.

2. Previous Studies:

At a time when online financial services, electronic payments, digital currencies, and mobile wallet payments have become indispensable within financial systems, their economic and financial impacts remain largely unknown. This digital transformation in financial services can potentially boost bank efficiency and improve their performance, thereby increasing banking stability. However, it can also introduce new risks that may affect financial stability(Bank of England, 2019).

Despite the importance of digital finance, studies related to the impact of this financial technology on banking services and the overall economy and the relationship between digital finance and banking stability are limited. Among the few studies that shed light on this topic are:

- A study by Inese Mavlutova, Aivars Spilbergs, and others (2023) titled "Digital Transformation as a Driver of the Financial Sector Sustainable Development: An Impact on Financial Inclusion and Operational Efficiency."

This study aimed to explore how digital transformation, particularly digital payments, contributes to sustainable development in the financial sector through financial inclusion and operational efficiency.

Data from 26 European Union countries for the years 2014, 2017, and 2021 were analyzed to determine the relationship between financial inclusion density and its dynamics using three hypotheses. The study employed statistical methods like correlation and regression analysis and expert interviews to verify research results. The authors found significant progress in the density of digital payments in the financial sector of the European Union. They also established a positive relationship between the density of digital payments and financial inclusion, as well as financial institution efficiency.

- A study by Rahmatina Awaliah Kasri and others (2022) titled "Digital Payment and Banking Stability in Emerging Economy with Duel Banking System."

- This study aims to study the effect of Digital payment on banking stability in Indonesia, using the vector error correction model (VECM) and vector autoregressive (VAR) models were used to investigate the relationship. Monthly data for 42 Indonesian

banks were used from December 2013 to July 2021 to estimate the relationship between digital payments and banking stability in emerging economies with a dual banking system using a VAR model. Researchers measured digital payments as a percentage of the Gross Domestic Product, while Z-Score was used as a proxy for banking stability. Various control variables, including consumer confidence, inflation rate, money supply growth, and the size of Islamic banks in the dual banking system, were included in the regression equation. The study found a cointegrating relationship between the digital payment penetration rate and Z-Score, indicating a long-term positive association between digital payments and banking stability, particularly in Islamic banking

- A study by Hasanul Banna and Md Rabiul Alam (2021) titled "Is Digital Financial Inclusion Good for Bank Stability and Sustainable Economic Development? Evidence from Emerging Asia."

This study addressed whether digital finance can contribute to financial stability by promoting sustainable economic growth. It aimed to investigate the impact of Digital Financial Inclusion (DFI) on banking stability by enhancing sustainable economic development using an unbalanced panel dataset consisting of 574 banks from seven emerging Asian countries during the period 2011-2018. The results indicated that digital financial inclusion contributes to banking stability.

- Study by Aamir Aijaz Syed and others (2021) titled "Assessing the Role of Digital Finance on Shadow Economy and Financial Instability: An Empirical Analysis of Selected South Asian Countries."

The study aimed to evaluate the role of digital finance on Financial instability in countries witch classified as shadow economies: An empirical analysis of three selected countries in South Asia: India, Bangladesh, and Pakistan, During the period 2004-2018, using estimation methods(CUP-FM)And(CUP-BC)To measure the above relationship which ar Effective technical for treatment Issues of homogeneity and serial interdependence, and small sample data and that through two models, the first measures the impact of digital finance on the shadow economy and the second studies the relationship between digital finance and financial stability. The percentage of mobile money transactions of GDP and the number of ATMs per 100,000 population were used. To measure digital finance, while the non-performing loan ratio (NPL) (GDP, and bank credit to deposit ratio (BCDR)As indicators To measure financial stability. The per capita indicator gross domestic product measures the shadow economy. Control variables like GDP, unemployment, industrial productivity, and foreign direct investment were included. The study concluded that the excessive use of mobile financial transactions and ATMs in emerging countries increases financial instability in the long run by raising the percentage of non-performing loans and the banking credit to deposit ratio. Moreover, the study noted that the increased use of mobile and internet transactions, as well as debit and credit card usage, elevates individuals' spending rates. On the other hand, long-term increases in digital finance help reduce shadow economy growth in the selected sample of countries.

- Study by Asep Risman and others (2020) titled "The Impact of Digital Finance on Financial Stability."

This study aimed to investigate the impact of digital finance on financial stability using a panel data model, with a sample of 120 Indonesian banks over ten years from 2010 to 2019. Digital finance was measured based on each bank's annual digital transaction values, while banking stability was measured using the loan availability ratio. Market and systemic risks were also included as a percentage of total financial derivatives to total assets. The results revealed a positive impact of digital finance on financial stability by increasing banks' ability to provide financing, as reflected in the loan availability ratio contributing to growth. However, the positive impact of digital finance on financial stability lies in reducing systematic risks, especially with an increase in digital payments

as a major component of digital finance, while also supporting automatic banking finance growth.

Overall, these studies suggest that digital payments can improve banking services, stimulate economic activities, and contribute to an increase in Gross Domestic Product. There are fewer studies evaluating their impact on financial and banking safety in both advanced and emerging economies. Most studies have reached limited conclusions regarding the relationship between digital financial transactions and banking stability.

The current study contributes to the existing literature on digital finance in several ways. Firstly, it investigates the impact of digital finance on banking stability in Gulf Cooperation Council countries, addressing a research gap found in prior studies concerning the relationship between digital finance and financial system stability. Secondly, our study introduces a new model within the context of financial technology and digital finance, aligning with the Sustainable Development Goal for 2030 by evaluating the consequences of digital finance on banking stability in emerging countries, which will substantially enhance the literature on digital finance. Also, the study sample was carefully chosen because the countries included in the stady are taking strict measures to improve digital financial inclusion through digital technologies. Therefore, choosing the sample also contributes to the novelty of the study, and thus, in addition to previous studies on the subject, the results will be helpful for the Gulf Cooperation Council countries to understand and develop appropriate policies for expanding digital finance technologies.

3. The Theoretical Background of Digital Finance and Banking Stability

Under this title, we delve into the concept of digital finance, its key techniques, observation, and evolution in the Arab Gulf.

3.1 Concept of Digital Finance

The financial industries have been affected radically over the past few years due to Internet technologies, Which led to the emergence of the concept of digital finance, which is providing financial services over the Internet, Wherever the users have access to financial services without restrictions of time or place ,which makes it easier for a bank solvency conducting banking activities electronically and quickly moving to various other digital finance platforms makes retaining existing customers and attracting new ones a crucial issue for digital finance service providers to remain competitive. With advances in mobile technologies, cloud computing, and big data, it is expected that digital finance continues to grow and expand into different areas of the financial industry in the future.

Numerous definitions of digital finance have been proposed. In this context, digital finance encompasses all electronic banking services, online intermediation, and insurance services. In broader terms, it comprises any financial services conducted online, such as online payments and mortgage services (Farid Zakaria & Tayyeb, 2016, p. 491). It has been defined as the digital services that revolve around financial information, including financial planning, advice, financial investments, and interactions between banks and their clients (Nageswara, 2018, p. 144).

According to Rui (2022, p. 3), digital finance can be defined as financial services provided through mobile phones, computers, and internet-connected credit cards. This type of finance has witnessed rapid growth in recent decades due to the ease of use and the widespread availability of the internet worldwide, along with its lower costs compared to traditional financial methods.

Similarly, a report by McKinsey defines digital finance as financial services offered through mobile phones, the internet, or cards, encompassing a wide range of new financial products, financial operations, and programs related to finance, as well as new forms of interaction with providers of financial technology platforms and innovative financial service providers(Terhi & Pierre, 2013).

Furthermore, accordingly, through the previous definitions, we conclude a more comprehensive definition of the concept of digital finance as the use of all financial services provided by digital methods that enhance the capabilities of organizations and individuals to access all credit facilities,

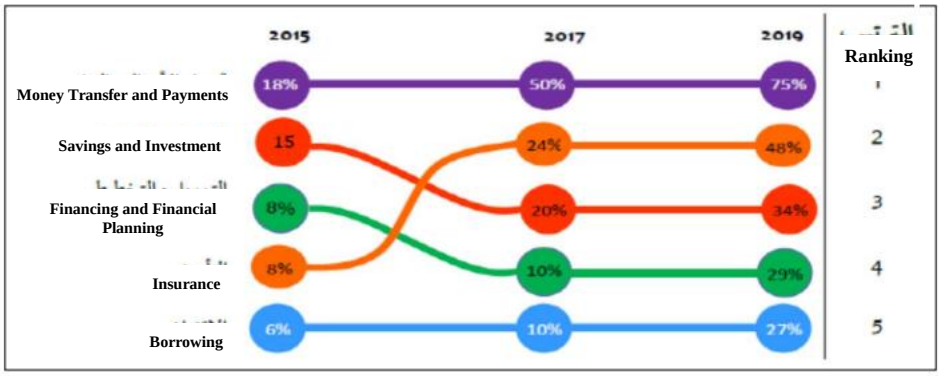
savings, and financial payments via the Internet and reduce the time and cost for the provider and recipient of services.

3.2 Digital Finance Techniques

Digital finance techniques come in various types. The primary stage includes payment services, lending, crowdfunding platforms, direct lending networks, and electronic payment solutions. In recent times, new trends reflecting the sector's evolution toward international money transfers, wealth management, and digital insurance have emerged, as depicted in the figure below (Harraq, 2023, p. 66).

[

Figure No. (1) Areas of use of new financial technologies]



Source: Global FinTech Adoption Index 2019, 2019 EYGM Limit, P 10
In:https://wiredspace.wits.ac.za/items/28a601f2-4447-4412-817d-

3.2.1 Blockchain Technology: Blockchain technology offers a new environment for databases that enables users to securely participate in a shared database and update it even in the absence of mutual trust. Blockchain stands out because it isn't controlled by a single entity, and it can be programmed to store various information, including smart contracts, crowdfunding, supply chain verification, identity and intellectual property management, as well as file storage (Peterson & Ozili, 2018).

3.2.2 Cryptocurrencies: Cryptocurrencies are a type of digital currency that uses encryption to ensure security and privacy. They operate independently of any central authority and do not follow any value guidance of traditional currencies. Most cryptocurrencies are managed through distributed ledger networks that record and verify transactions across a network of contracts (Pitchbook, 2019, p. 2).

3.2.3 Electronic Settlement Systems "Payment - Transfer": This involves accounting ledgers that record asset ownership. The settlement process includes updating the records of transferred asset ownership. The general ledger is updated by recording the payment or transfer from the sender to the recipient, reducing the sender's balance and increasing the recipient's balance to reduce payment obligations between them (Garrick & Michel, 2017, p. 13).

3.2.4 Lending Services: These services connect funders with customers seeking financing, such as retail companies and small to medium-sized enterprises. Prominent examples include direct lending and crowdfunding platforms (Khadija, 2018, p. 3).

3.2.5 Wealth Management "Financial Portfolios": Digital finance companies assist promising project owners in managing their financial portfolios and assets. They provide advice and consultations regarding portfolio composition and may manage and deploy them in successful projects to increase revenue and profits (Harraq, 2023, p. 67).

3.2.6 Digital Insurance: Digital insurance represents a transformation of traditional insurance services into digital services aimed at achieving efficiency and speed through process automation using modern technologies to ensure the accuracy of procedures and reduce error rates in industrial, commercial, and service sectors (Khadija, 2018, p. 4).

3.3. Motives for the Shift Towards Digital Finance

There are various motives driving individuals, businesses, and governments towards digital

finance, including :(Jacob & Andree, 2018, p. 367)

First Motive: The rapid growth of various technological advancements in new business models that challenge the modern financial services' constraints. Among the most prominent dynamic technologies in modern financial services are the Internet, cloud computing, robots, Distributed Ledger Technologies (DLTs) also known as blockchain, virtual currencies like Bitcoin, biometrics, artificial intelligence, advanced analytics, and advanced identity management methods. These technologies have the power to disrupt the landscape as they allow entry into business models that require minimal investment. For example, cloud computing enables participants or competitors to start businesses with almost no capital expenditures. This exemplifies a broader trend of obtaining resources and assets through real-time payment models, which rely on advances in digital communication.

Second Motive:The changing customer preferences, it has lost today they prefer to conduct their business transactions on digital platforms such as:

(Google, Amazon, Facebook, Apple, etc.), where they consider them servicesSatisfying digital services are free, personal, and easy to use; this new situation poses a challenge to everyone involved in developing business models that can monetize customer information**;**

Third Motive: The COVID-19 pandemic as and the reason for social distancing, isolation, and lockdowns imposed by pandemic-19 and the inability of individuals to go to banks and financial institutions act at the same time, more people have moved towards relying on modern digital finance technologies have led to the improvement and ease of use of the applications of these technologies and its safety individuals seeking to obtain it, Which led to a decline in the share of banks and traditional financial institutions. Therefore, the outbreak of the Covid-19 epidemic had a positive impact on the digital lending platform market. Credit institutions and banks, in particular, have worked to enhance their digital banking offerings to better meet the needs of their customers in the wake of the outbreak epidemic

Fourth Motive: Deprived large market segments connected with small and medium-sized enterprises who mostly represent individuals without bank accounts. In summary, emerging business models benefit from new technologies, changes in population demographics, the effects of robust networking, regulatory changes, and deprived market segments. While these developments are still relatively recent, there is a consensus among experts and market participants that they will have significant impacts on the digital financial services industry, allowing companies to access digital finance.

3.4.Assessing the State of Digital Finance in the Gulf Cooperation Council (GCC) Countries:

Digital finance is on the rise globally, driven by the widespread availability of mobile devices and the internet. As a result, many countries are investing in digital finance infrastructure to expand their citizens' access to financial services. The global health concerns arising from the COVID-19 pandemic in 2019 and 2020 prompted an unexpected shift towards remote work in GCC countries, similar to the rest of the world. Strict public safety measures forced people to engage through e-commerce platforms, online learning, and financial technology services. This solidified digital information exchange methods in consumer behavior deeply. The demand for digital services and applications did not decline even after the pandemic, as people increasingly avoided the use of physical cash, resulting in a surge in digital payments in theGCC countries.

3.4.1. Factors Contributing to the Spread of Digital Finance in GCC Countries:

The Gulf Cooperation Council (GCC) countries, including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates, have experienced a significant transformation in the adoption and development of digital banking solutions. This transformative journey has been fueled by a set of social, economic, and strategic impetus policy. (CCN Economy 2023)

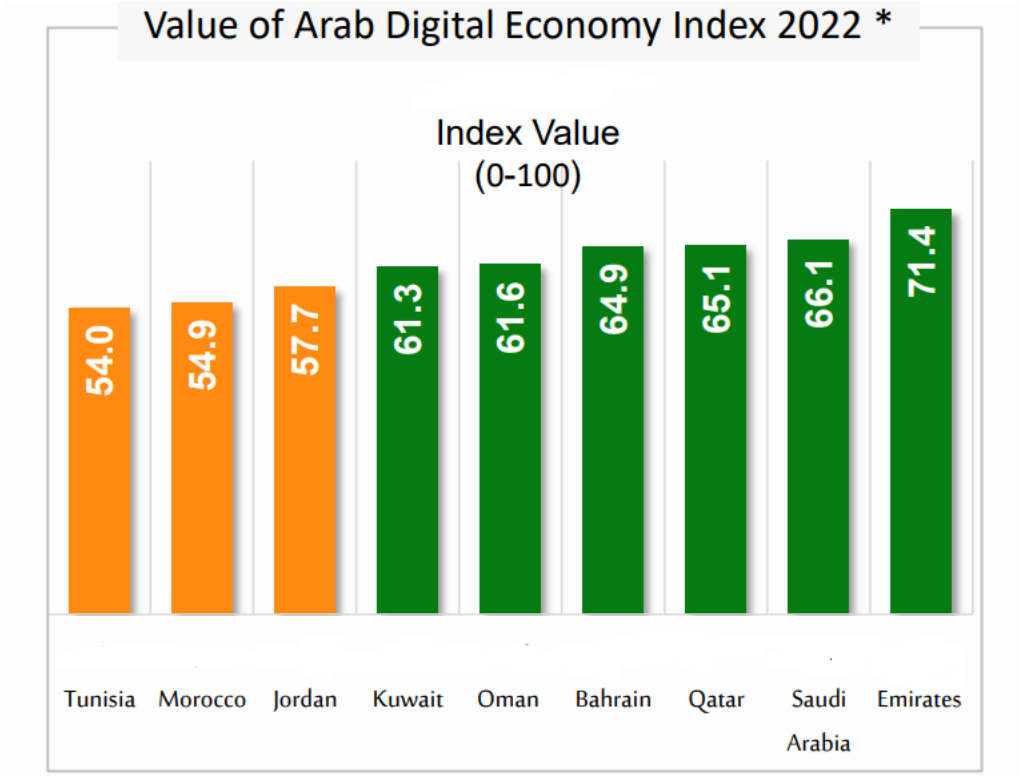
First: Youthful Population - GCC countries have a significantly young population. For instance, as of 2021, more than 60% of Saudi Arabia's population was under 30 years old. This younger generation, often referred to as digital natives, has been exposed to digital technologies from an early age. As a result, they naturally gravitate towards digital solutions, including digital banking. Their expectations for speed, convenience, and ease of use have prompted banks to innovate.

Second: High Smartphone Penetration - The widespread availability of smartphones in GCC countries has been a massive impetus for digital financial services. Nations like the United Arab Emirates and Qatar consistently rank among the countries with the highest smartphone penetration rates globally. This widespread access has allowed financial institutions to offer mobile banking apps and other digital banking tools, as the majority of the population already possesses the essential device needed to access these platforms.

Third: Favorable Government Initiatives - Recognizing the potential of the digital economy, governments across the GCC have launched ambitious initiatives aimed at promoting digital transformation. For example, Saudi Arabia's Vision 2030 seeks to diversify the nation's economy away from oil, with digital transformation as a core pillar. Under this vision, efforts have been directed towards promoting digital payments with the goal of achieving 70% non-cash transactions by 2030. The United Arab Emirates' National Innovation Strategy aims to make the UAE one of the world's most innovative countries, with a strong focus on technology and digital infrastructure.

Thanks to these factors, all GCC countries lead the pack among the top-performing countries in the 2022 Arab Digital Economy Index released by the Arab Federation for Digital Economy. The United Arab Emirates ranked first with 71.4 points, followed by Saudi Arabia with 71.66 points, Qatar at third place with 65.1 points, Bahrain at 64.9 points, Oman at 61.6 points, and Kuwait at sixth place with 61.3 points. The report also highlighted the increasing expenditure on modern technological solutions by GCC countries as they seek to build economies based on digital innovations. Recent statistics indicate that the UAE's spending on information and communication technology is expected to reach $23 billion, compared to $9 billion in Qatar and $10.1 billion in Kuwait by 2022 as it it’s shown in this figure:

[Figure 02 : Value of Arab Digital Economy Index for 2022]



Source : Arab Digital Economy in https://arab-digital-economy.org/ae_arab-digital-economy-index

3.4.2 Prominent Digital Payment Platforms in the Gulf Cooperation Council (GCC) Countries

As digital finance gains ground in the Gulf Cooperation Council (GCC) countries, several platforms have emerged, showcasing the region's ability to adapt to global financial advancements. Notable among these companies are STCPay, BenefitPay, and Beam, each offering a unique blend of features tailored to meet the specific needs and preferences of their markets(George, Sheinal, & Kishan, 2017).

First: STCPay Platform (Saudi Arabia): The Saudi Telecom Company introduced the STCPay service, which rapidly evolved into one of the leading mobile wallet services in the kingdom. It aligns with the Saudi government's Vision 2030 goal of promoting non-cash transactions. In addition to peer-to-peer transfers and bill payments, STCPay also facilitates cross-border money transfers, a crucial feature for a country with a significant expatriate population. Its instant transaction capabilities make it an attractive choice for residents and businesses alike.

Second: BenefitPay Platform (Bahrain): BenefitPay is a mobile payment app developed and launched by BENEFIT, the national network for ATMs and point-of-sale terminals in Bahrain. Since its inception, BenefitPay has played a pivotal role in advancing the digital financial landscape in Bahrain. It enables users to make digital payments easily and securely using their smartphones.

Third: Beam Platform (United Arab Emirates): Beam is a digital payment service in the United Arab Emirates, developed to streamline digital payments. Users can link their credit or debit cards to the Beam app on their smartphones and use them for cashless payments at a wide range of stores and other facilities in a secure and convenient manner.

Beam initially started as a loyalty rewards program in the United Arab Emirates but swiftly transformed into a comprehensive digital wallet, reflecting the rapid tech-driven transformation in the country.

3.4.3 Fintech Companies in GCC Countries

The financial technology (fintech) market has expanded in the GCC and the Middle East as a

whole due to strategic initiatives aimed at achieving full digital transformation and diversifying economies away from reliance on oil revenues. In recent years, the United Arab Emirates, Qatar, and Saudi Arabia have witnessed substantial growth and adoption of fintech in the Middle East. GCC countries are increasingly becoming vital hubs for technology startups, significant investments in fintech, and a focus on open banking services. The UAE, in particular, is concentrating its fintech efforts on establishing an open banking system in the country by the end of 2023. Additionally, Saudi Arabia's digital banking sector is driven by robust regulatory initiatives, as it plays a significant role in the Vision 2030 strategy, aimed at modernizing the Saudi economy and reducing its dependency on oil.The figure below illustrates the growth of fintech investment values in the Middle East(George, Sheinal, & Kishan, 2017).

[Figure 03 : Total Global Investement activity (VC, PE and M&A) in Fintech 2017-Q2 2020]

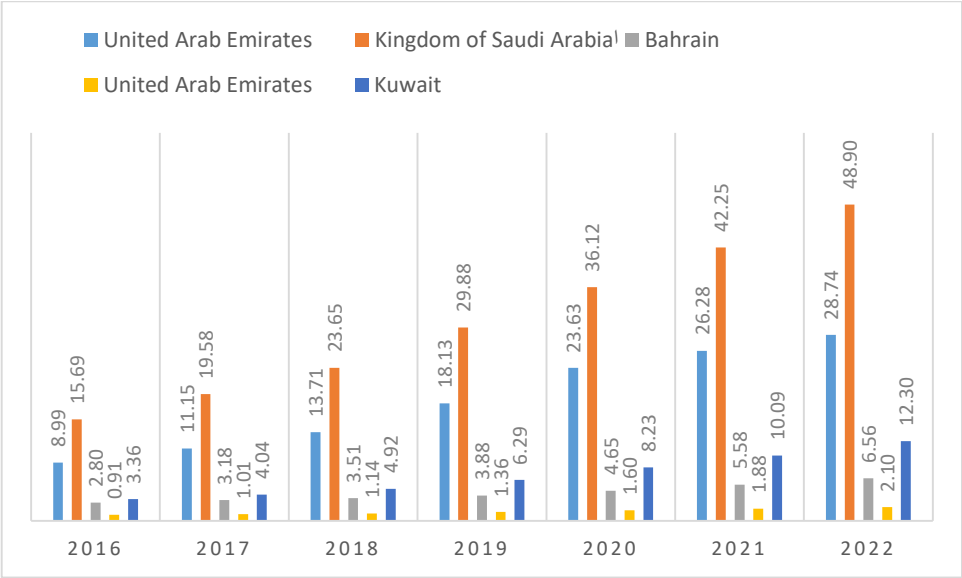
Source :https://www.consultancy-me.com/news/3050/investor-appetite-in-middle-easts-fintech-sector-remains-strong

3.5 Analysis of the State of Digital Finance in the Gulf Cooperation Council (GCC) Countries

3.5.1. Evolution of Total Digital Payments in the GCC Countries from 2016 to 2022

The GCC countries have witnessed rapid growth in total digital payments primarily driven by their young population, high smartphone penetration rates, and government initiatives that promote digital finance in the region. The following figure illustrates the trend in the total value of digital payments in the GCC countries from 2016 to 2022.

[Figure 4: Total Value of Digital Payments in the GCC Countries from 2016 to 2022]



Source: Compiled by researchers using data from [Statista](https://www.statista.com/outlook/dmo/fintech/digital-payments/worldwide)

In: https://www.statista.com/outlook/dmo/fintech/digital-payments/worldwide

The chart depicts continuous growth in the total value of digital payments over the years in all GCC countries, reflecting technological transformation and increased adoption of digital payment solutions. Notably, Saudi Arabia and the United Arab Emirates have experienced the fastest growth among the GCC countries, which can be attributed to their larger economies and faster absorption of digital payment technology.

There was a significant acceleration in digital payments, particularly during the period from 2019 to 2020, driven by the COVID-19 pandemic, which necessitated contactless digital payments. However, in comparison to Saudi Arabia and the United Arab Emirates, Bahrain, Qatar, and Kuwait have shown lower levels of adoption of digital payments. This may be due to differences in technological adoption and the maturity of digital infrastructure in these countries.

In summary, the data points to sustainable growth and increasing adoption of digital financial technology in the GCC region over the past six years.

3.5.2 Evolution of the Number of Mobile Payment Transactions in the GCC Countries from 2016 to 2022

The Arabian Gulf region has seen a tangible shift in consumer behavior towards the use of digital financial services. This shift opens up opportunities for financial service providers to offer innovative services and make a significant impact on the market. A recent study conducted by McKinsey on urban consumers in the United Arab Emirates and the Kingdom of Saudi Arabia revealed that at least 80% of consumers in these countries prefer to conduct their banking activities through mobile phones and tablets. They visit branches and contact customer service hotlines only for specific and more complex needs. The table below illustrates the evolution of the number of mobile payment transactions in the GCC countries from 2016 to 2022.

Table 01: Evolution of the Number of Mobile Payment Transactions in the GCC Countries from 2016 to 2022

Countries / Years	Kuwait	Bahrain	Qatar	Kingdom of Saudi Arabia	United Arab Emirates
2016	1,88	0,73	1,05	18,53	16,13
2017	2,13	0,80	1,26	22,66	20,26
2018	2,33	0,85	1,61	24,17	21,77
2019	2,44	0,96	1,70	26,18	23,78
2020	2,54	1,00	1,84	29,07	26,67
2021	2,63	1,05	1,97	31,66	29,26
2022	2,72	1,07	2,09	33,60	31,20

Source: Prepared by the researchers based on data extracted from the website: Statista. https://www.statista.com/outlook/dmo/fintech/digital-payments/worldwide

The data in the table above indicates continuous growth in the number of mobile payment transactions in all GCC countries. This signifies an increasing adoption of mobile payment technology and a significant shift towards digital solutions. As usual, the United Arab Emirates and the Kingdom of Saudi Arabia lead the GCC countries in terms of the highest number of mobile financial transactions. Following them are Qatar,

Bahrain, and Kuwait, which are also experiencing growth in mobile payment transactions, albeit at a slower pace.

It appears that there was a notable acceleration in the increase of mobile financial transactions by Gulf Arab residents, especially between 2019 and 2020. This period coincided with the peak of the COVID-19 pandemic, which led to a rapid digital transformation. This pushed people towards using mobile payment technology more extensively.

In conclusion, the data indicates sustainable growth in the adoption of mobile payment technology in the GCC region. It also demonstrates how economic conditions and exceptional circumstances, such as the COVID-19 pandemic, can influence the adoption of digital financial technology.

4. Empirical Study of the Relationship between Digital Finance and Banking Stability in GCC Countries

4.1 Methodology and Data

In order to investigate the relationship between digital finance and banking stabilityIn the GCC countries, we started by selecting indicatorstomeasurementDigital financeBanking stability, andfromthenUse econometric techniquesBy applying the longitudinal cross-sectional data model (The econometric Model of Data Panel), and the study was conducted on the GCC countries, which are (Bahrain, Kuwait, Oman, Qatar, the Kingdom of Saudi Arabia, and the United Arab Emirates) during the period: 2016-2022, with the State of the Sultanate of Oman excluded from the study due to the unavailability of its digital payment data.

4.1.1 Data and Digital Finance Measurement Indicators

When measuring digital or electronic payments, we relied on variables used by Shang et al. (2019), who attempted to analyze digital payments globally. In their study, the digital payment rate is not measured based on the absolute value of electronic retail payment transactions. Instead, we utilized the digital payment transaction percentage of the Gross Domestic Product (GDP). This allows us to calculate the digital payment adoption rate by dividing the value of digital payment transactions by the GDP. The second indicator was the number of ATMs per 100,000 people, while the third indicator was the debit card penetration rate, which is widely used in studies to measure digital payments.

4.1.2 Data and Banking Stability Measurement Indicators

In recent years, there have been significant efforts to develop indicators for measuring financial stability as a measure of financial sector soundness. Three common methods are used to develop financial stability indicators. In situations where the banking sector dominates the financial system (as is the case in GCC countries), financial stability is typically measured using the Z-score, which represents the bank's ability to cover its yield volatility.

Practically, a financial stability measurement usually includes indicators such as Capital Adequacy Ratio (CAR), Return on Assets (ROA), and Equity-to-Debt Ratio (E/D). Capital Adequacy Ratio is often considered an indicator of bank fragility that determines the ability of public budgets to absorb shocks (Scholtens et al., 2010). Non-Performing Loans (NPL) can also be used as an indicator of financial fragility because they reflect the borrowers' repayment ability and the bank's ability to generate revenues while maintaining strength.

In this study, we use banking stability as an alternative to financial stability, given the dominance of the banking sector in GCC countries' financial systems. Therefore, we use the Z-score as an indicator of banking stability, which can capture the risks of bank insolvency and assess the capital and assets retained by banks to cover their yield volatility. In this context, a higher Z-score indicates higher stability in the banking industry. A bank with a high Z-score suggests that the bank enjoys high stability, and vice versa.

Data was collected from sources, including the World Bank database, International Monetary Fund database, central banks' reports and bulletins for the study countries, as well as private data platforms (ICT database, Statista, Global Economy).

Table 02: Study Variable Descriptions

Variables	Role	Source
Digital Finance		
Total digital payments	Measures the total value and frequency of transactions conducted through digital channels within a year. Provides an overview of the extent to which people are adopting digital financial technologies.	ICT database ,Statista
Number of ATMs per 100,000 People	Measures the availability of ATMs in the region and how accessible they are to people.	FMI database + Global Economy
Debit Card Penetration Rate	Represents the percentage of people who own and regularly use debit cards for daily transactions.	World Bank database
Banking Stability		
Z-SCORE	Measures the stability of banks and their ability to withstand financial crises. It provides an insight into the health of the bank and its capacity to cope with challenges.	Platform: Global Economy + reports of the central banks of the concerned countries

Source: Prepared by the researchers

4.1.3.Study model

Based on the study variables and sample, the study model will be a cross-sectional data model(Panel Data),whereThe panel data combines both time series and cross-sectional data, and is divided into three available models: a pooled regression model(FEM), fixed effects model (PRM) and finally random effects model (FEM). There are several advantages to using panel models, as they: enable the heterogeneity of individuals to be controlled. Providing more information, more variance, less multicollinearity between variables, a greater degree of freedom and more efficiency. This is because time series models often suffer from multicollinearity. It also enables the measurement and identification of effects that are difficult to detect in cross-sectional or time series data. (Baltagi, 2008, pp. 4-8)

To determine the optimal model among the three models, we perform two stages. The first is the comparison between the aggregate regression model and the fixed effects model, while the second stage is the comparison between the fixed and random effects model.

The first stage: In this stage, it is checked whether or not there are differences between countries or between time periods. A model with a secant for each country is chosen against the hypothesis of the model with a common secant, where:

$$H_0 = \mu_0 + \mu_1 + \cdots + \mu_n \ ,$$
$$H_0 = \gamma_0 + \gamma_1 + \cdots + \gamma_n$$

Whereas, the null hypothesis test is based on Fisher's statistic according to the following formula:

$$F = \frac{(R^2_{FEM} - R^2_{PM})/(N-1)}{(1 - R^2_{FEM})/(NT - N - K)}$$

Where it represents:k: number of estimated parameters.

R^2_{FEM}: Coefficient of determination for the fixed effects model.

R^2_{PM}: Coefficient of determination for the clustered regression model (co-categorical model).
The second stage: When the first stage is completed and the fixed effects model appears to be the appropriate model, we then compare it with the random effects model using a test.Hausman based on the following hypotheses:
H0: The random effects model is the appropriate model.
H1: The fixed effects model is the appropriate model.
This test determines the estimators of the two models so that they represent the null hypothesis that the random-effects estimator is consistent and efficient, versus the alternative hypothesis that the random-effects estimator is inconsistent. (Ratigh and Ratia, 2014, pp. 157-159).
In this research we will studyThe impact of digital finance on banking stability in the Gulf Cooperation Council countries (the United Arab Emirates, Kuwait, Qatar, the Kingdom of Saudi Arabia, and Bahrain)(N=(5), during the period (T=7) 2016-2022, so the total number of views reaches 35 views.

4.1.4. Model Specification

Based on previous studies and theoretical considerations, we have identified the explanatory variables related to digital finance that influence banking stability. In order to explore the relationship between these explanatory variables and the dependent variable, we tested the following hypotheses:

H0: There is no statistically significant relationship between the Digital Payment Transaction Index and the Banking Stability Index (z-score).
H1: There is a statistically significant relationship between the Digital Payment Transaction Index and the Banking Stability Index (z-score).
H0: There is no statistically significant relationship between the Number of ATMs per 100,000 adults and the Banking Stability Index (z-score).
H1:There is a statistically significant relationship between the Number of ATMs per 100,000 adults and the Banking Stability Index (z-score).
H0: There is no statistically significant relationship between the Debit Card Penetration Rate and the Banking Stability Index (z-score).
H1: There is a statistically significant relationship between the Debit Card Penetration Rate and the Banking Stability Index (z-score).

We analyzed this relationship using panel data and formulated the econometric model as follows:

$$\boldsymbol{Z-score_t = cons + DP_t + ATM_t + DC_t + \delta_t + \eta_i + \varepsilon_{it}}$$

Where:
$\boldsymbol{Z-score_t}$: Banking stability index
$\boldsymbol{DP_t}$: Digital payment transaction percentage of GDP
$\boldsymbol{ATM_t}$: Number of ATM per 100,000 adults
$\boldsymbol{DC_t}$:Debit card penetration rate
$\boldsymbol{\delta_t}$: is the unobserved time-invariant specific effects
$\boldsymbol{\eta_i}$: captures a common deterministic trend
$\boldsymbol{\varepsilon_{it}}$: is a random disturbance assumedto be normal, and identically distributed with$E(\varepsilon_{it}) = 0$;Var $(\varepsilon_{it}) = \sigma^2 \succ 0$.

Table 03: Descriptive Statistics Results:

variables	Obs	Mean	Std.Dev	Min	Max
Z-score	35	18.4051	5.9125	7.43	26.54
DP	35	16389.08	2045.37	910.8	72210
ATM	35	58.5457	15.1987	29.91	81.21
DC	35	59.3342	13.7268	27	77.4

The table above provides descriptive statistics for all the variables used in this study from January 2016 to December 2022. It shows that banking stability in the Gulf Cooperation Council (GCC) countries is relatively good, with an average value of 18.40. The highest recorded value was 26.54. However, during

the COVID-19 pandemic, banking stability in the Gulf region improved significantly.

4.2. Model Estimation Based on Panel Data

We estimated three panel data models: the Pooled Regression Model (PME), the Fixed Effects Model (FEM), and the Random Effects Model (REM). The following table presents the estimation results using STATA 15.

Table 04: Results of Panel Model Estimation (PME), Fixed Effects Model (FEM), and Random Effects Model (REM)

Explanatory Variables	Estimation models		
	Panel Model Estimation (PME)	Fixed Effects Model (FEM)	Random Effects Model (REM)
DP	0.0000997**	0.0000257	0.0000716**
ATM	0.3019***	0.1081**	0.1779***
DC	0.1063	-0.1464**	-0.0825
Constant	-7.2143	20.3417***	11.7086**
$R^2(squared)$	0.7231	0.2694	0.5578
F (statistic)	26.99	3.24	21.04
Prob-F	0.0000	0.0000	0.0001
Number of obs	35	35	35

Source: Prepared by the research team based on the STATA 15 findings (Appendix 2)
* significant at 10% level, ** significant at 5% level, *** significant at 1% level

The results of the coefficients for the independent variables showed overall significance. The F-stat test results in the table indicate that the estimated pooled regression model is statistically acceptable at a 5% significance level. Furthermore, the R-squared (squared) values in the estimated models appear to be good, meaning that the model has a high explanatory capacity of more than 72% for the variations in the dependent variable (banking stability), especially in the pooled regression model.

4.3Model Comparison Tests:

4.3.1.Parm Test:

We will use the constrained F-test to compare the aggregate model and the fixed-effects model, and the results in the table were as follows:

Table 05: Parm Test

F.stata	p-value
3.43	0.1296

Source: Prepared by the research team based on the STATA 15 findings (Appendix 3)
We notice from the results in the table above that the F.stata test was not statistically significant at a 5% level. Therefore, it can be said that the aggregate model is better than the fixed-effects model.

4.3.2 Breusch and Pagan-LM Test:

This test is used for differentiating between the aggregate model and the random-effects model. The criteria are as follows:
- If the random-effects model is more appropriate, we accept H0.
- If the aggregate model is more appropriate, we accept H1.

Table 06: Breuch and Pagan-LM test

Breuch and Pagan-LM	p-value
15.83	0.0000

Source: Prepared by the research team based on the STATA 15 findings (Appendix 4)

The Chi-bar value was equal to 15.83 and the probability p-value = 0.0000, which means accepting the null hypothesis H0, meaning that the random model is better than the aggregate model.

Hausman test:

After we have done the restricted F test and the Hausman test, the role of the Hausman test comes to differentiate between the fixed effects model and the random effects model, as we show its results in the following table:

Table 07: Hausman test

Hausman	p-value
13.75	0.0033

Source: Prepared by the research team based on the STATA 15 findings (Appendix 5)

From the results of the table above,we notice that the value of the Hausman test statistic was estimated at: 13.75, and the probability value of its p-value was estimated at: 0.0023, i.e. less than 0.05, and from this the null hypothesis is rejected and the alternative hypothesis is accepted, meaning that the fixed effects model is better than the random effects model.

Through analyzing the comparison tests, we conclude that the appropriate model for the study among the three models is the aggregate model.

4.4. Diagnostic Tests for the Model:

The fixed-effects panel model is based on a set of assumptions to ensure the validity of its use in the prediction process and to test the study's hypotheses. These assumptions primarily include testing the multicollinearity between variables and testing the constancy of variance and autocorrelation of errors. We have applied these tests to the fixed-effects model, and below are the results of these tests.

4.4.1 Multicollinearity Test:

Table 08: Multicollinearity test

variable	vif	1/vif
DC	2.80	0.356807
ATM	2.61	0.382779
DP	1.83	0.545839
Mean VIF		2.42

Source: Prepared by the research team based on the STATA 15 findings (Appendix 6)

Based on the results of the VIF test for all variables, we find that the VIF values do not exceed 5, indicating that the model does not suffer from multicollinearity.

4.4.2. Autocorrelation Test:

The Wooldridge test is considered one of the best modern tests for measuring the presence of autocorrelation in the fixed-effects panel model. The results of this test are presented in the table as follows:

Table 09: Wooldridge test

Wooldridge	p-value
0.847	0.4094

Source: Prepared by the research team based on the STATA 15 findings (Appendix 7)

According to the Wooldridge test, the p-value is estimated to be 0.4094, which is greater than 0.05. Therefore, the test results are not statistically significant, indicating the acceptance of the null hypothesis, which suggests no autocorrelation among the residuals in the study model.

4.43. heteroskedisticity test

The Breusch-Pagan/Cook-Weisberg test is used to assess the presence of heteroskedasticity in the fixed-effects panel model. The results of this test are shown in Table 12, indicating whether heteroskedasticity exists in the model.

Table 10:Heteroskedisticity test

Breusch-Pagan / Cook-Weisberg	p-value
0.01	0.9349

Source: Prepared by the research team based on the STATA 15 findings (Appendix 8)

From the table above, we can observe that the Breusch-Pagan/Cook-Weisberg test statistic is 0.01, and the p-value is 0.9349. This p-value is greater than the critical value of 0.05. Therefore, we reject the null hypothesis and accept the alternative hypothesis, indicating that the fixed-effects model is characterized by homoscedasticity, meaning it does not suffer from the problem of heteroskedasticity.

Hence, we can conclude that the Panel Data model does not have any typical issues, such as multicollinearity, autocorrelation of residuals, or heteroskedasticity. Based on the results of the model comparison tests, the preferred model for this study is the aggregate model.

4.5.Estimating of the aggregate model:

After comparing the three models and conducting the aggregate model test, the estimation results for the aggregate model are presented in Table 13:

Table 11: Aggregate Model Estimation Results

Explanatory variables	**Appropriate model**
	Aggregate model
DP	*0.0000997***
ATM	*0.3019****
DC	*0.1063*
Constant	*-7.2143*
$R^2(squared)$	*0.7231*
F (statistic)	*26.99*
Prob-F	*0.0000*
Number of obs	*35*

Source: Prepared by the research team based on the STATA 15 findings (Appendix 2)
* Significant at 10%** Significant at 5%*** Significant at 1%

The table illustrates the standard estimation results for the aggregate regression model, assessing the impact of independent variables related to digital finance on banking stability, represented by the z-score. Based on the results presented in the table, the model equation can be formulated as follows:

$$\boldsymbol{Z - score_t = -7.2143 + 0.00097DP_t + 0.30ATM_t + 0.1032DC_t}$$

4.6Discussion and Analysis of Results:

- **Concerning the independent variable "Total Digital Payments":** Its coefficient and sign were positive, aligning with the model's hypotheses. The coefficient's interpretative value was 0.0009 with significance at 0.023, indicating a high statistical significance. This implies a strong positive relationship: for every one-unit increase in the explanatory variable (Total Digital Payments), the dependent variable (Banking Stability) increases by 0.09%. Consequently, the null hypothesis is rejected in favor of the alternative hypothesis, signifying a statistically significant positive relationship between Total Digital Payments and Banking Stability in the Gulf Cooperation Council countries.
- **For the variable "Number of ATMs per 100,000 people":** The coefficient and sign were positive, supporting the

model's hypotheses. The interpretative value of the coefficient was 0.30 with a highly significant significance level of 0.000. This indicates a strong positive relationship: a one-unit increase in the explanatory variable (Number of ATMs per 100,000 people) leads to a 30% increase in the dependent variable (Banking Stability). The null hypothesis is therefore rejected in favor of the alternative hypothesis, confirming a statistically significant positive relationship between the number of ATMs per 100,000 people and Banking Stability in the Gulf Cooperation Council countries.

- **Regarding the independent variable "Debit Card Penetration Rate":** Its coefficient and sign were positive and in line with the model's hypotheses. The coefficient's interpretative value was 0.1032 at a significance level of 0.012. This signifies a positive relationship: a one-unit increase in the explanatory variable (Debit Card Penetration Rate) results in a 10.32% increase in the dependent variable (Banking Stability). The null hypothesis is rejected in favor of the alternative hypothesis, indicating a statistically significant positive relationship between the Debit Card Penetration Rate and Banking Stability in the Gulf Cooperation Council countries.
- The results above indicate that the model has a very good explanatory power. The coefficient of determination (R-squared) is 0.7231, meaning that 72.31% of the variation in the dependent variable (Banking Stability) is explained by changes in the explanatory variables. The remaining 17.69% can be attributed to other unaccounted factors. Thus, the null hypothesis is rejected in favor of the alternative hypothesis, signifying a statistically significant relationship between digital finance indicators and banking stability.

4.7. Conclusions and Recommendations:

4.7.1. Conclusions:

After collecting and analyzing the data, conducting the necessary tests, and comparing test models, the following conclusions have been derived:

Firstly, there is a strong positive correlation between digital finance indicators and banking stability.

Secondly, there is a statistically significant positive relationship between total digital payments and banking stability in the Gulf Cooperation Council (GCC) countries. This finding aligns with studies by Inese Mavlutova, Aivars Spilbergs, and others (2023) as well as the study by Rahmatina Awaliah Kasri and others (2022). It suggests that as the value of mobile and point-of-sale digital payments increases, financial stability also improves. Digital payments have a long-term positive correlation with banking stability.

Thirdly, there is a statistically significant positive relationship between the number of ATMs per 100,000 people and banking stability in the GCC countries. This finding is consistent with a study by Asep Risman and colleagues (2020). The positive impact of digital finance on financial stability is attributed to a reduction in systematic risks as digital payments become a key element of digital finance.

Fourthly, there is a statistically significant positive relationship between the proliferation of debit cards and banking stability in the GCC countries. This finding aligns with a study by Aamir Aijaz Syed and others (2021). Excessive use of debit and credit cards increases individual spending rates. Therefore, in the long term, increased digital finance helps reduce the shadow economy.

4.7.2 Recommendations:

The study's results provide practical insights for policymakers and regulatory authorities in emerging market economies regarding the current development of digital payments, which is not detrimental to banking stability. The "noise" surrounding the digital revolution in financial technology, particularly related to financial stability concerns due to digital breaches, is more short-term than long-term. Therefore, there is a need to take short-term

precautionary measures in addition to policy measures that support development. These can be accomplished through:

- **Offering incentives, such as tax discounts, to emerging technology-focused institutions in the field of financial technology.**
- **Organizing an awareness campaign about the prospects of digital finance. Digital financial services should be provided in a timely manner, leveraging technologies like artificial intelligence and machine learning to enhance banking stability and efficiency. This will foster comprehensive economic growth and encourage people to save more, ultimately leading to sustainable economic growth.**
- **Ensuring digital financial literacy for all and ensuring that people have access to electronic devices with the latest technologies and various applications, coupled with uninterrupted internet connectivity. Insufficient or lacking internet connectivity can deter people from enjoying digital financial services.**
- **Banks should implement updated programs and databases to counteract threats like card cloning, debit and credit card misuse, and cyberattacks. To prevent card cloning, banks can introduce a service for withdrawing money via quick response code scanning using mobile phones, as already operational in European and American countries.**
- **Governments should consider offering incentives such as tax discounts to emerging institutions in the financial technology sector.**

Finally, this study faces certain limitations. For instance, it was not possible to compare the results with other regions and major technology companies due to data unavailability. Future studies could expand to make such comparisons and assess whether banks in GCC countries are actively enhancing digitization and efficiency similar to leading countries in digital finance.

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Appendices

Appendix No. 1

Descriptive statistics table

```
. summarize ZSCORE DP ATM DC
```

Variable	Obs	Mean	Std. Dev.	Min	Max
ZSCORE	35	18.40514	5.912586	7.43	26.54
DP	35	16389.08	20045.37	910.8	72210
ATM	35	58.54571	15.19877	29.91	81.21
DC	35	59.33429	13.72685	27	77.4

Appendix 2

Pooled OLS Model

```
. regress ZSCORE DP ATM DC
```

Source	SS	df	MS	Number of obs	=	35
				F(3, 31)	=	26.99
Model	859.531285	3	286.510428	Prob > F	=	0.0000
Residual	329.063789	31	10.6149609	R-squared	=	0.7231
				Adj R-squared	=	0.6964
Total	1188.59507	34	34.9586787	Root MSE	=	3.2581

ZSCORE	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DP	.0000997	.0000377	2.64	0.013	.0000227	.0001766
ATM	.3019357	.0594206	5.08	0.000	.1807466	.4231249
DC	.1063307	.0681447	1.56	0.129	-.0326514	.2453127
_cons	-7.214303	6.702724	-1.08	0.290	-20.8846	6.455992

FixedEffectsModel

```
. xtreg ZSCORE DP ATM DC , fe

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

R-sq:                                           Obs per group:
     within  = 0.2644                                         min =          7
     between = 0.2697                                         avg =        7.0
     overall = 0.2694                                         max =          7

                                                F(3,27)            =       3.24
corr(u_i, Xb)  = -0.0435                        Prob > F           =     0.0378

------------------------------------------------------------------------------
      ZSCORE |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          DP |   .0000257   .0000375     0.69   0.498    -.0000511    .0001026
         ATM |   .1081434   .0570318     1.90   0.069    -.0088762    .2251631
          DC |  -.1464505   .0742039    -1.97   0.059    -.2987042    .0058033
       _cons |   20.34172   3.248277     6.26   0.000     13.67681    27.00664
-------------+----------------------------------------------------------------
     sigma_u |  5.4497998
     sigma_e |  1.1920497
         rho |   .95434052   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(4, 27) = 51.14                     Prob > F = 0.0000
```

RandomEffectsModel

```
. xtreg ZSCORE DP ATM DC  , re

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

R-sq:                                           Obs per group:
     within  = 0.0419                                         min =          7
     between = 0.5899                                         avg =        7.0
     overall = 0.5578                                         max =          7

                                                Wald chi2(3)       =      21.04
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =     0.0001

------------------------------------------------------------------------------
      ZSCORE |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          DP |   .0000716   .0000314     2.28   0.023       .00001    .0001332
         ATM |   .1779493   .0471548     3.77   0.000     .0855276     .270371
          DC |  -.0825141   .0601322    -1.37   0.170     -.200371    .0353427
       _cons |   11.70864   4.938195     2.37   0.018     2.029958    21.38733
-------------+----------------------------------------------------------------
     sigma_u |  1.1806526
     sigma_e |  1.1920497
         rho |   .49519667   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```


Appendix No. 3

ParmTest

```
. testparm i.time

 ( 1)  2017.time = 0
 ( 2)  2018.time = 0
 ( 3)  2019.time = 0
 ( 4)  2020.time = 0
 ( 5)  2021.time = 0
 ( 6)  2022.time = 0
       Constraint 3 dropped
       Constraint 4 dropped

       F(  4,     4) =    3.43
            Prob > F =    0.1296
```

Appendix No. 4

Breush-Pagan Test

```
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        ZSCORE[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                     |       Var     sd = sqrt(Var)
             ---------+------------------------------
               ZSCORE |    34.95868       5.912586
                    e |    1.420982        1.19205
                    u |    1.393941       1.180653

        Test:   Var(u) = 0
                            chibar2(01) =    15.83
                          Prob > chibar2 =   0.0000
```

Appendix No. 5
Hausman test

```
. hausman rendom fixed

                 ---- Coefficients ----
                |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
                |    rendom       fixed       Difference          S.E.
----------------+----------------------------------------------------------------
             DP |    .0000716    .0000257       .0000459               .
            ATM |    .1779493    .1081434       .0698059               .
             DC |   -.0825141   -.1464505       .0639363               .
----------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from xtreg
           B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       13.75
                Prob>chi2 =      0.0033
                (V_b-V_B is not positive definite)
```

Appendix No. 6

```
. estat vif

    Variable |       VIF       1/VIF
-------------+----------------------
          DC |      2.80    0.356807
         ATM |      2.61    0.382779
          DP |      1.83    0.545839
-------------+----------------------
    Mean VIF |      2.42
```

Appendix No. 7
Wooldridge test for autocorrelation

```
. xtserial ZSCORE DP ATM DC

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,       4) =      0.847
           Prob > F =      0.4094
```

Appendix No. 8
Breush-Pagan/cook-Weisberg test for heteroskedasticity