Vol.8 Issue.1 April 2023

RSEP Review of Socio - Economic Perspectives
ISSN: 2149 - 9276
E-ISSN: 2547-9385

The impact of financial technology on financial stability in the MENA zone

Mohamed Kolli[1,•] **& Khadidja Imene Amarouche**[2,∂]
[1] *Ph.D. in Finance, M'hamed Bougara University, Faculty of economics, Boumerdes, Algeria*
[2] *Ph.D. in Finance, M'hamed Bougara University, Faculty of economics, Boumerdes, Algeria*

Article History
Received: 11 December 2022 Revised: 2 March 2023 Accepted: 7 March 2023 Available Online: 1 April 2023

Keywords: Fintech, financial stability, MENA zone, Panel VAR
JEL classification: G21, G28, O33

Citation: Kolli, M. & Amarouche, K.I. (2023). The impact of financial technology on financial stability in the MENA zone, *Review of Socio-Economic Perspectives*, 8(1), 93-106.

Abstract

This article attempts to determine the influence of financial technology (Fintech) on the stability of financial systems in 19 countries of the Middle East and North Africa (MENA) zone; observed over a period of 17 years (2004- 2020). Therefore, our research is based on the panel vector auto regression models (Panel VAR) that are analyzed using the Eviews 12 statistical program. The results show that the fixed effects models are the most significant for estimating the relationship between the fluctuations of financial stability index (FS) and the changes of the explanatory variables selected in our empirical model. At the same time, these results indicate a significant positive relationship between the economic growth (GDPR), the level of financial concentration (BSC) and the volume of banking crises (CPS, LL) on the financial stability index. While, they also confirm the absence of a significant relationship between the dependent variable and financial technology indexes (MPBR, ATM, IU) and the levels of demographic growth (POPG). This may be explained by the fact that the financial systems of the sample countries are mainly traditional and can be attributed to the low level of financial culture of their societies.

1. Introduction

The financial sector is facing recently radical transformations that have led to the emergence of several fintech applications's, which aimed to develop a new financial services and providing them in an easy, fast and inexpensive way, such as: electronic payment systems, blockchain, crowdfunding, cryptocurrency and artificial intelligence systems. With this technological development, digital transformation has become essential to cope with the diversity of remote financial transactions, especially in light of the conditions that most of the financial systems in the world knew with the Covid-19 pandemic. In this context, the MENA zone suffers from a digital paradox, as the region is witnessing a wide use of social media accounts compared to the gross domestic product (GDP) per capita. In addition, the per capita share of using social media in the MENA zone outweighs its counterparts in countries that have the same GDP per capita, however, the level of dependence of the MENA's countries on digital payment systems remains lower than the targeted levels. This disparity in the use of financial technology for social versus economic purposes, characterized the most countries in the MENA zone, which can threat the stability of the financial systems of the region. Accordingly, in this article, we will examine the various repercussions of adopting financial technology on financial stability in a sample of 19 countries in the MENA zone during the period 2004-2020, relying on the panel vector auto regression models (Panel VAR) and the outputs of Eviews 12 statistical program. In order to achieve our research objective, the present paper is organized as follows: The first section develops a review of literature on the subject, the second section presents

• **E-mail:** m.kolli@univ-boumerdes.dz & **ORCID:** https://orcid.org/0000-0002-8486-0459
∂ **E-mail:** k.amarouche@univ-boumerdes.dz & **ORCID:** https://orcid.org/0000-0002-5728-4564
DOI: https://doi.org/10.19275/RSEP151
Article Type: Original Paper

the characteristics of the sample, as well as the specifications of the model to be tested. Finally, in the third section, we interpret the obtained results.

2. Literature review

The use of financial technology is witnessing a wide spread in many countries in recent years, which has accelerated the pace of digital transactions and may put the stability of their financial systems at risk.

2.1. Financial stability

Financial stability plays an important role as one of the main pillars to ensure the macroeconomic stability of countries. In this regard the bank of Korea defines financial stability as a condition in which the financial system can facilitate real economic activities smoothly and is capable of unraveling financial imbalances arising from shocks. The same bank adds that financial stability can also mean a condition in which the three components of the financial system (financial institutions, financial markets and financial infrastructure) are stable where: (Bank of Korea, 2022)

- Stability of financial institutions refers to a condition in which individual financial institutions are sound enough to carry out their financial intermediation function adequately, without assistance from external institutions including the government.
- Stability of financial markets means a condition in which there is no major disruption of market transactions, with no significant deviation of financial asset prices from economic fundamentals, thereby enabling economic agents to raise and operate funds with confidence.
- Stability of financial infrastructure refers to a condition in which the financial system is well structured to ensure smooth operation of market discipline, and both the financial safety net and the payment and settlement system are running effectively.

Furthermore, according to the World Bank a stable financial system is capable of efficiently allocating resources, assessing and managing financial risks, maintaining employment levels close to the economy's natural rate, and eliminating relative price movements of real or financial assets that will affect monetary stability or employment levels. A financial system is in a range of stability when it dissipates financial imbalances that arise endogenously or as a result of significant adverse and unforeseen events. In stability, the system will absorb the shocks primarily via self-corrective mechanisms, preventing adverse events from having a disruptive effect on the real economy or on other financial systems. (World Bank)

Based on what we have presented, we can say that financial stability is a property of a system that allows the detection of various financial imbalances at the level of financial institutions, financial markets and financial infrastructure. It also refers to the effective and efficient use of available resources near to the monetary stability rates. So that, financial stability is about resilience of financial systems to absorb these financial imbalances and correct them in order to prevent negative impact on the overall real economy.

2.2. Financial technology

Financial technology (fintech) as a concept is derived from the combination of two words: finance and technology, where fintech in its broad sense refer to the application of technology for providing financial services and products in the different areas of finance such as: banking, payments, data analysis, capital markets and financial management. While, in a more precise sense, we can say that there is no standard definition of fintech, but most of researches associate it with information technology and innovation in the financial sector. Thereby, fintech is identified as a technology that applies information technology in the financial world and consists of new technological solutions that will even initiate a revolutionary transformation in the world of finance. (Nakashima, 2018, pp.61-66) On the other hand, according to the financial standard board, fintech is a technological financial innovation that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions and the provision of financial services. (Basel committee on banking supervision, 2018)

Fintech's origin can be traced back to the early 1990s, when Citigroup established the "Financial Services Technology Consortium" as a project to facilitate technological cooperation efforts. But, it was only in 2014 that the sector started to attract the increased attention of regulators, industry and consumers (Anyfantaki, 2016) and it refers now to a large and rapidly growing industry representing by 105,3 billion dollars as a global investment in fintech around the word for 2020. For more detailed, the next table records the volume of global fintech investments around the word for the period of 2014-2020:

Table 1. Global fintech investments for the period of 2014-2020

Years	2014	2015	2016	2017	2018	2019	2020
Global investments (Billion dollars)	51,2	64,9	73,7	54,4	141	135,7	105,3
Deals	1628	2123	2173	2629	3145	2693	2861

Source: pulse of fintech reports, KPMG, 2019, 2020 et 2021.

From this table and according to KPMG's fintech reports for the years 2019, 2020 and 2021, we can observe the fluctuation in total global fintech investments during the period of 2014-2020, Sometimes it increased, especially in 2015, 2016 and 2018, due to the strong activity of financial innovations witnessed by various countries of the world, and at other times it decreased, especially in 2017,2019 and 2020, due to the decline in the volume of internet lending and in merger deals and big data. However, in total, they achieved rapid growth in the past six years, as their value increased by 105,67% in the year 2020 compared to 2014, when the volume of global investment in fintech companies has reached 105,3 billion dollars in 2020 compared to 51,2 billion dollars in 2014. The same reports indicated that the year 2020 witnessed the conclusion of 2861 versus 1628 deals in 2014, noting that the geographical diversity of venture capital funded for financial technology investments contributed significantly to enhancing the volume of deals. It is expected that the volume of investments and the number of transactions in the field of financial technology will increase in the coming years, despite the increasing geopolitical uncertainty and trade concerns, which may place a greater burden on investment in financial technology.

2.3. Financial technology influence on financial stability: benefits and risks

With the vast literature dedicated to financial technology and stability separately and with the important growth in global fintech investments around the word, at this time the question arises on the impact of this technological development on the stability of the financial sector in shade of limited literature on whether or not financial technology can strengthen or weaken the financial systems, which most of them has treated this matter trough analytical researches that concerned risks and benefits of financial technology on the financial sector's stability. Thereby, fintech can offer many opportunities for governments, from making their financial systems more efficient and competitive to broadening access to financial services for the under-served populations. However, it can also pose potential risks to consumers and investors and, more broadly, to financial stability and integrity.

2.3.1. Benefits of fintech on financial stability

Fintech can enhance the financial stability through many ways which are summarized in financial stability board report's (2017) as following: (Financial stability board, 2017)

- Decentralisation and diversification: fintech may lead to greater decentralisation and diversification in a number of areas. In lending, technological advances, such as big data processing and automation of loan originations, have reduced barriers to entry. Some business models in this space may also be benefiting from lighter regulation associated with the unbundling of lending from deposits. Another example would be robo-advice, where smaller firms can operate alongside bigger firms given relatively low barriers to entry, including fixed costs.
- Efficiency in operations: innovations in financial services have the potential to lead to greater efficiencies. In fact, adoption of productivity enhancing technologies, such as robo-advice, regulatory technology or applications of technology that streamlines back-office functions, could strengthen business models of incumbent financial institutions. Machine learning and artificial intelligence could facilitate improvements in decision-making processes, by improving the models that financial institutions and investors use. At the same time, the business models of marketplace lenders and robo-advisors have less need for a physical presence than banks, and the use of algorithms to assess creditworthiness and investment opportunities appears to allow platforms to operate with relatively low costs. Fintech lending platforms could also reduce search and transaction costs and lead to better allocation of capital.
- Transparency : increased uses of fintech's applications could reduce information asymmetries in many areas of fintech and enables risks to be more accurately assessed and better priced.
- Access to, and convenience of financial services: the spread of financial transactions within the framwork of fintech improved access to a range of financial services across all of the economic functions for regions where there are a large unbanked population. In this case, the share of cell phone ownership equals or exceeds the share of the population with access to a bank account, particularly in rural areas with little or no access to physical banks. Thereby, Mobile banking allows consumers to quickly and efficiently obtain credit and make purchases. More generally, robo-advisory services increase access to wealth management for households who could not access similar traditional asset management services.

Meanwhile, (Lu et al., 2022) add that financial technology is beneficial for financial stability in term of:

- Risk transfer and diversification, which could stimulate the diversified development of financial institutions' businesses, improve fund allocation and operation efficiency of financial institutions. As a result, it could effectively optimize the financial market system, improve the market's capability to defend and deal with risks and crises, reduce the likelihood of systematic financial crisis and strengthen the stability of economic growth.

- Achieving coordinated development with technological innovation systems via the technicalization of new industries, thereby achieving the goal of stabilizing the macro-economy.
- Encouraging diversification of commercial banks' business and customers and reduce bad loan ratios and systematic risks.

2.3.2. Risks of fintech on financial stability

Compared to finteck's benefits of financial stability, fintech development could produce serious negative effects on financial stability. According to the financial stability board fintech undermines financial stability through two main categories of risks : micro-financial risks and macro-financial risks, where micro-financial risks occur from financial and operational sources and are those that make individual firms, financial market infrastructures or sectors particularly vulnerable to shocks. Thereby, the crystallisation of such risks could have a systemic impact on the financial system if it triggers firm or sector-wide distress, with possible knock-on implications for either the provision of critical functions or services, or systemically important markets or counterparties. They include Maturity mismatch, Liquidity mismatch, Leverage, Governance or process control, Cyber risks, Third-party reliance, Legal or regulatory risk and Business risk of critical financial market infrastructures. As for, macro-financial risks are system-wide vulnerabilities that can amplify shocks to the financial system and therefore raise the likelihood of financial instability. These risks are largely related to the interactions between firms, investors and clients that can create important transmission channels. They regroup contagion, procyclicality, excess volatility, and entities that are systemically important. (Financial stability board, 2017) Against this background, we will center our interest now to explicit the implications of each type of risks on financial stability in the subsequent table:

Table 2. Influence of micro and macro financial risks on financial stability

Micro-financial risk	
Type of risk	**It's link to financial stability**
Maturity mismatch	Appears when a loan is extended for a longer period than the financing is contracted for, creating rollover risk. Systemic impacts could arise if the sector provides critical functions or services.
Liquidity mismatch	Arises when assets and liabilities have different liquidity characteristics, resulting in "run risk" and the need to liquidate quickly relatively illiquid assets, disrupting markets.
Leverage	Higher leverage suggests less equity available to absorb any losses materialising from the realisation of market, credit, or other risks. Potentially exposes systemically important counterparties to losses.
Governance or process control	Poor governance or process control can lead to increased risk of direct disruption in the provision of financial services or critical infrastructure.
Cyber risks	The susceptibility of financial activity to cyber-attack is likely to be higher the more the systems of different institutions are connected.
Third-party reliance	Systemic risks may arise when systemically important institutions or markets are dependent on the same third parties.
Legal or regulatory risk	Legal risk may be greater when activities are evolving, or where regulatory arbitrage is sought.
Business risk of critical financial market infrastructures	Financial market infrastructures may be sensitive to external factors that could adversely impact its balance sheet, and, consequently, lead to a withdrawal of financial services, impairing its function as a critical infrastructure.
Macro-financial risk	
Type of risk	**It's link to financial stability**
Contagion	The distress experienced by a single financial institution or sector can be transmitted to other institutions or sectors – owing either to direct exposures between them, or commonalities that lead to a general loss of confidence in those institutions or sectors.
Procyclicality	Market participants can act in a way that exacerbates the degree and impact of fluctuations in economic growth and market prices over the short and/or long term. Examples include: the excess provision of credit by banks during upswings in the economy, and the extreme degree of deleveraging that tends to take place once the economy turns into a downswing; the low pricing of risk in financial markets during good

	times, and the high risk premium demanded by investors during bad times.
Excess volatility	The financial system can overreact to the news. This can lead to adverse outcomes if, for example, any such overreaction creates solvency or liquidity problems that can spiral through the financial system, impairing the functioning of asset and credit markets. This is most likely to occur when there is homogeneity of business models or common exposures.
Systemic importance	Entities that are viewed as being systemically important (or too highly connected to fail) may amplify risks through moral hazard. For example, they may be more inclined to take on excessive risk, given that the downside to doing so may be limited by the implicit guarantee of public support. Predatory pricing of services could also stifle competition ("the winner takes all"), reducing the likelihood of other service providers stepping in when the entity suffers distress.

Source: Financial stability board. (2017)

Additionally, in order to support the above analyze, (Lu Shen, Guohua He and Huan Yan, 2022) affirm that fintech development could lead to more financial turmoil in times of disorderly and excessive innovation. Thus, technological enterprise, due to its inherent instability, may increase the credit risks of financial institutions, whereas the mobility and conductivity of these risks would make financial systematic risks escalate. Furthermore, information asymmetry of the market as well as the high uncertainly of technological enterprises' sustainable profitability, financial institutions lead to an inaccurate evaluation of asset quality what would entrain industrial default risks and economic turbulence. As the same time, the imbalance of functional structure in the development of technological finance could be manifested as an imperfect loan model of policy- which is mainly direct loans that would worsen the risks of currency mobility within banks. (Lu et al., 2022)

Finally, it is important to point out that the research of Lu Shen, Guohua He and Huan Yan (2022) who has tried to modeling the impact of technological finance on financial stability based on the panel data of 30 Chinese provinces (including autonomous regions and municipalities) between 2005 and 2017. The analysis of results demonstrated that, in the eastern region, technological finance has an obvious negative shock effect on financial stability within a short period, but the effect gradually dwindles as time goes by. While neither western nor middle regions have displayed an obvious shock impact on financial stability. Such regional difference suggests that financial stability is related to the level of regional development and the nature of trade. In fact, enterprises in the middle and western regions in China are mostly of the traditional industry, with relatively little financial investment into the technological enterprises. Therefore, the risk, thus incurred would not affect the region's overall financial system much. On the contrary, the eastern region is keen on technological innovation, with much financial investment on enterprises of technological innovation, which leaded to the escalating financial risks in the region. (Lu et al., 2022)

3. Data, specification of the empirical model and methodology

The study's sample consists of annual observations of 19 countries in the MENA zone, during the period 2004-2020. Where this sample was chosen based on the availability and consistency of data for all the variables restrained in our empirical model. The data was taken from the World Development Indicators (WDI) database supplied by the World Bank, in addition to the Bankscope international banking database. It concerns the countries listed in the table below.

Table 3. Sample countries

Algeria	Georgia	Malta	Saudi Arabia
Armenia	Iraq	Mauritania	Tunisia
Azerbaijan	Jordan	Morocco	Turkey
Cyprus	Kuwait	Oman	United Arab Emirates
Egypt	Lebanon	Qatar	

Source: Author's based on the availability of information required in the MENA zone

These countries will be adopted in our empirical study to estimate and analyze the impact of financial technology use's on their financial stability, where the Z-score index provided by Bankscope database has been considered as a measure of the financial and banking stability variable, which is used to measure financial stability on a large scale in the financial and economic literature and is considered an unbiased indicator to measure the

financial activities risk's of banks, especially Ahamed and Mallick (2019) and Banna et al. (2021). Therefore, the *z*-score index is determined through the following formula:

$$Z - score_{it} = \frac{ROA_{it} + EQA_{it}}{\sigma(ROA)_{it}}$$

Here, ROA_{it}, EQA_{it} and $\sigma(ROA)_{it}$ means the return on average assets, the equity to asset ratio, and the standard deviation of the return on average assets of the bank 'i' in the year 't' respectively. If banks 'profitability is normally distributed, the inverse proxy of Z-score can be considered as the bank's probability of insolvency. Thereby, higher returns and capitalisation would increase bank stability, while volatile returns would decrease the stability of banks. (Ahamed and Mallick, 2019)

In terms of the study model, a modified approach is adopted for the proposed models in the works of Mohd Daud et al. (2022) and Feghali et al. (2021) to analyze the impact of financial technology on financial stability, taking account of several explanatory variables such as levels of financial concentration, banking crises, financial inclusion, economic growth and population size. Thus, the study model can be formulated as follows:

$$FS_{i,t} = \beta_0 + \beta_1 GDPR_{i,t} + \beta_2 MPBR_{i,t} + \beta_3 ATM_{i,t} + \beta_4 IU_{i,t} + \beta_5 BSC_{i,t} + \beta_6 CPS_{i,t} + \beta_7 LL_{i,t} + \beta_8 POPG_{i,t} + \gamma_i + \varepsilon_{i,t}$$

Where:

FS represents the financial stability index using the Z-score, **GDPR** indicates the economic growth index which represents the macroeconomic variables that affect the financial sector of countries, **MPBR, ATM and IU** represents the financial technology indexes, **BSC** represents financial concentration, **CPS and LL** indicates banking crises indexes that are opposite to financial stability. Finally **POPG** is the level of demographic growth of the sample countries which reflects the extent of access to financial technology services. Accordingly, the next table presents indications and measurements of variables used in this research:

Table 4. Indication and measurement of the variables

Variables	Type	Indication	Measurement	Data Sources
FS		Financial stability	BANK Z-SCORE	Bankscope
GDPR	Macro	GDP growth rate	(ΔGDP/Current GDP) *100	World Bank Data (WBD)
MPBR	Fintech	Mobile Phone Banking (MPB)	Mobile cellular subscriptions (per 100 people)	World Bank Data (WBD)
ATM	Fintech	Automated Teller Machines (ATM)	Automated teller machines (ATMs) (per 100,000 adults)	World Bank Data (WBD)
IU	Fintech	Internet Use	Individuals using the Internet (% of population)	World Bank Data (WBD)
BSC	Concentration	Banking system concentration	Bank concentration: percent of bank assets held by top three banks	Bankscope
CPS	Banking Crises	Credit to Private Sector to GDP (CPS/ GDP)	The ratio of domestic credit to private sectors to Gross Domestic Product	World Bank Data (WBD)
LL	Banking Crises	Liquid Liability to GDP (LL/GDP)	The ratio of liquid liability to Gross Domestic Product	World Bank Data (WBD)
POPG	Control	Population	Population growth (annual %)	World Bank Data (WBD)

Source: Author's compilation based on theoretical and empirical literature review

As for the econometric study, we adopted in our research the panel data models, considering that our sample includes observations of variables related to 19 countries in the MENA zone during the period 2004-2020. Then, based on statistical test results explained later, the panel vector autoregression models (Panel VAR) have been selected. The data was processed and analyzed statistically using the Eviews 12 statistical program. In this regard, the economic theoretical literature shows that the (Panel Var) models are relatively recent in use compared to the vector autoregression (Var) models where many researchers rely on (Panel Var) models in their empirical studies. We mention, for example, the study of Carstensen et al. (2009), which analyzed the effects of structural factors on the transmission of monetary policy to the mortgage markets in the countries of the Organization for Economic Cooperation and Development (OCDE), In addition to the study of Beetsma and Guiliadori (2011); and Lane and Benetrix (2010), who have adopted in their works (Panel Var) models in order to analyze the transmission of shocks of public expenditures. (Ramde, 2018, p.15) Thus, the descriptive statistics for empirical variables are indicated in the next table:

Table 5. Descriptive statistics of the variables

Variables	Mean	Maximum	Minimum	Std. Dev.	Jarque-Bera	Observations
FS	21.34599	70.97000	0.910000	12.47278	381.1116	323
GDPR	4.123782	53.38179	-25.9077	6.231676	3490.089	323
MPBR	102.0485	212.6390	2.181362	41.42712	0.036439	323
ATM	35.51723	90.89000	0.700000	22.79876	13.76863	323
IU	46.28446	100.0000	0.481470	28.42984	17.26906	323
BSC	70.97851	100.0000	37.10000	18.00314	21.20852	323
CPS	59.17380	255.3103	1.266927	45.01738	559.9268	323
LL	78.34526	256.8967	3.304430	60.25284	121.7676	323
POPG	2.528021	17.51221	-0.88818	2.860814	1521.275	323

Source: Author's calculations using Eviews 12.

The above table shows the descriptive statistics of the variables used in the study, where the average value of the financial stability (FS) index was about 21.35, with an important standard deviation of 12.47. It can be explained by the presence of a large variation across the countries of the MENA zone in terms of the level of banking stability. As for the standard deviations of financial technology indicators (MPBR, ATM, IU), they were large compared to their averages, with values of 41.43, 22.80 and 28.43, respectively. This may be due to the great disparity between the MENA countries in terms of technological progress.

At the same time, these descriptive statistics can be presented in the following figure:

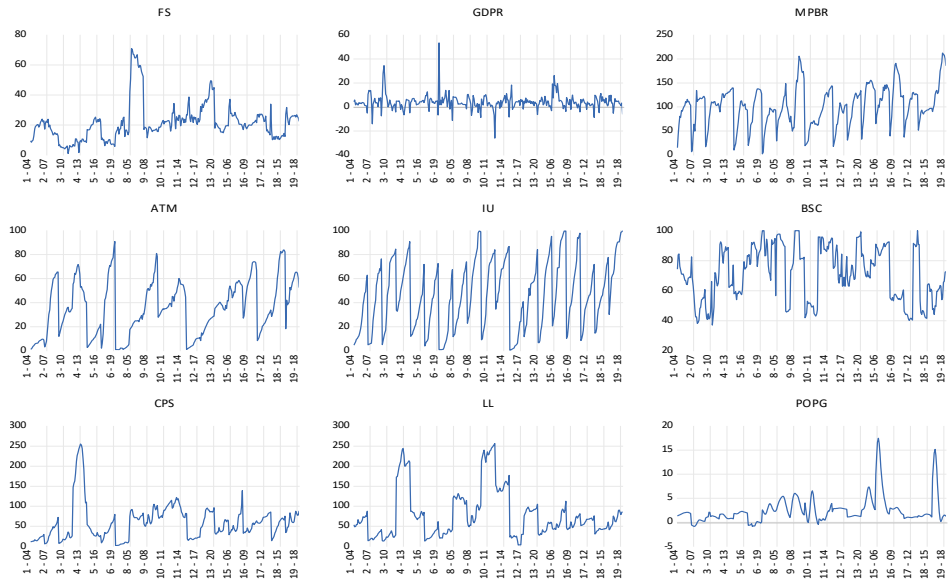

Figure 1: Panel time series of the variables

Source: Author's calculations using Eviews 12.

4. Estimated model

After specifying the econometric model to be estimated using multiple regression methods on panel data applied to the statistical program (Eviews 12). Our results concerning the various tests and regressions carried out are reported as follows:

4.1. Panel Unit Root tests

Panel unit root tests outperform individual time-series tests, as they include both sectional and temporal informational content, which leads to more accurate results compared to individual time-series stability tests. But on the other hand, the panel data witnesses a fundamental problem related to the association between units or individuals, where it is possible to distinguish between two generations of tests; the first generation is characterized by the independence between the units, while the second generation includes the link between the units. (Hurlin and Mignon, 2005, p.256). In this regard, the results issued from the Im, Pesaran, Shin (IPS) test are better than those provided by other time-series stability tests for the panel data, as Hurlin & Mignon (2005) demonstrated that is the most consistent test for small size samples (T<30). (Hurlin and Mignon, 2005, pp.266-270)

The current study used four basic types of panel unit root tests, which are: Levin-Lin-Chu (LLC) test, Im, Pesaran, Shin (IPS) test, (ADF-Fisher) test, and (ADF-Fisher test). PP-Fisher). The results in Table 6 demonstrate that the Panel time series of the MENA zone, whether related to the financial stability index (FS), or those related to independent variables (GDPR, MPBR, ATM, IU, BSC, CPS, LL, POPG), is unstable at the 5% level of significance, while the results of the unit root tests showed that all these variables became stable at first-degree differences, even at 1% significance level I(1).This means that it is very likely that there will be a cointegration between the financial stability index (FS) on the one hand, and the financial, economic and social variables representing financial technology indicators on the other (GDPR, MPBR, ATM, IU, BSC, CPS, LL, POPG). These results are reported in the next table:

Table 6. Panel unit root test results

Variables	LLC		IPS		ADF-Fisher		PP-Fisher	
	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
Individual Intercept								
FS	-4.262	-16.67***	-4.081	-15.02***	80.341	236.14***	71.499	274.36***
GDPR	-3.279	-9.963***	-2.211	-11.76***	74.794	189.81***	72.684	253.25***
MPBR	-9.135	-7.459***	-5.563	-4.895***	98.486	92.248***	158.37	95.748***
ATM	-2.457	-4.788***	-0.360	-4.507***	54.083	91.429***	49.138	122.87***
IU	0.358	-7.954***	6.342	-6.916***	17.849	123.30***	30.332	143.67***
BSC	0.466	-10.67***	0.797	-8.442***	29.385	142.03***	33.843	161.27***
CPS	1.405	-0.298	2.510	-6.226***	34.598	105.26***	276.61	123.21***
LL	2.252	-7.964***	3.902	-6.363***	19.351	109.64***	14.000	105.70***
POPG	-5.830	-6.233***	-4.431	-5.812***	96.394	133.73***	22.817	44.207
Individual Intercept and Trend								
FS	-7.364	-15.93***	-5.395	-13.47***	97.383	197.40***	93.466	240.14***
GDPR	4.694	-8.780***	-3.973	-9.239***	82.464	144.55***	66.781	209.80***
MPBR	-1.828	-9.143***	2.776	-6.287***	29.155	106.06***	54.143	135.61***
ATM	3.134	-9.238***	4.760	-6.332***	17.164	104.05***	17.259	116.50***
IU	0.187	-8.382***	1.918	-7.056***	36.271	116.29***	31.878	140.61***
BSC	-2.047	-10.08***	0.439	-6.017***	30.612	109.66***	33.159	145.28***
CPS	4.926	-0.201	-1.409	-4.634***	56.841	86.134***	57.046	105.57***
LL	-1.819	-6.205***	-0.652	-4.404***	47.137	82.899***	24.300	75.286***
POPG	12.886	-25.09***	5.550	-17.16***	11.039	222.54***	27.406	30.379
None								
FS	0.064	-19.77***			30.302	340.40***	29.968	353.48***
GDPR	-7.002	-17.65***			115.01	295.68***	111.76	311.19***
MPBR	2.036	-8.709***			14.622	140.08***	6.000	158.37***
ATM	5.795	-6.060***			12.622	104.10***	5.034	147.61***
IU	11.273	-2.562***			1.689	42.799***	0.259	85.063***
BSC	0.730	-14.74***			19.810	240.20***	22.334	245.04***
CPS	5.264	-8.619***			14.602	128.17***	26.577	141.12***
LL	3.959	-10.74***			7.381	166.53***	6.146	154.33***
POPG	-3.919	-7.555***			147.88	133.53***	40.049	94.162***

Note: ∗, ∗∗and ∗∗∗ represent, respectively, passing 10%, 5%, and 1% significance level test.
Source: Author's calculations using Eviews 12.

4.2. Panel Cointegration test

There are several panel cointegration tests, such as pedroni test, Kao test and Fisher test, however, in the current research, the Kao test has been preferred as it gives more effective results for panel data with a weak time dimension (T<30). (Hurlin and Mignon, 2007, p.256) The results showed that there is no cointegration, at a significant level of 5%, between the fluctuations in the financial stability index (FS) and the economic growth index (GDPR), the financial technology indexes (MPBR, ATM, IU), the financial concentration index (BSC), the banking crises indexes (CPS, LL) and the demographic growth index (POPG). These results mean also that there are no long-term equilibrium relationships between changes in the financial stability index (FS) and the other external variables, including the changes taking place in the financial technology determinants in the MENA zone. In this case, (panel Var) models are most suitable for estimating the relationship between financial technology and the financial stability index. These cointegration results are presented in the table below:

Table 7. Panel cointegration test results

Modele	FS=f(GDPR, MPBR, ATM, IU, BSC, CPS, LL, POPG)	
Kao Cointegration Test	t-Statistic	Probability
	-1.519306	0.0643*
Decision	No cointegration	
The appropriate Model	Panel Var Model	

Note: ∗, ∗∗and ∗∗∗ represent, respectively, passing 10%, 5%, and 1% significance level test.

Source: Author's calculations using Eviews 12.

4.3. Panel VAR lag order selection criteria

Under several criteria adopted in determining the optimal number of delays for the estimated model, such as Akaike information criterion-AIC, Schwarz information criterion-SC and Hannan–Quinn information criterion-HQ. We will use the Schwarz Information Standard (SC) like the Miller & al (2011) study to identify the optimum delays for the estimated models. (Ramde, 2018, p.23) Therfore, we note from the results shown in the table below that the optimal number of delays for the study model is two years (Lag*=2) which is the same number of delays also for the Hannan–Quinn information criterion-HQ.

Table 8. Lag selection optimal results

Lag	AIC	SC	HQ
0	73.86374	73.99161	73.91522
1	50.44690	51.72562	50.96172
2	48.84712	51.27670*	49.82529*
3	48.59014*	52.17056	50.03164
4	48.81079	53.54207	50.71564

Note: AIC—Akaike information criterion, SC—Schwarz information criterion, HQ—Hannan–Quinn information criterion. * signifies optimal lag length.

Source: Author's calculations using Eviews 12.

4.4. Panel VAR model

The Panel VAR methodology requires, at a first stage, the estimation of both fixed effects models (FEM) and random effects models (REM). In a second stage, the comparison between these two models will be done using the Hausman test, although the results of the standard analysis often indicate that the fixed effects models are the most appropriate for panel data across countries (Greene, 2012, pp.419-420). In this context, the Hausman's test results were similar to the literature of econometric, and confirm that the fixed effects models are the most suitable for estimating the relationship between the fluctuations of financial stability index (FS) and the changes in each economic growth index (GDPR), financial technology indicators (MPBR, ATM, IU), financial concentration index (BSC), banking crisis indicators (CPS, LL) and demographic growth index (POPG) in the MENA zone. These results are summarized in the table below:

Table 9. Estimated Panel Var coefficients

Variable	Fixed Effects Models (MG Estimation)		Random Effects Models (PMG Estimation)	
	Coefficient	Prob.	Coefficient	Prob.
C	3.893162*	0.0973	-0.069981	0.9442
FS(-1)	0.587568***	0.0000	0.890853***	0.0000
FS(-2)	-0.082472	0.1805	0.073672	0.1933
GDPR(-1)	0.096512**	0.0269	0.064066	0.1180
GDPR(-2)	-0.005127	0.8891	-0.048185	0.1730
MPBR(-1)	-0.002465	0.8955	0.000722	0.9667
MPBR(-2)	0.008272	0.6533	-0.001189	0.9436
ATM(-1)	0.001267	0.9853	-0.042102	0.4646
ATM(-2)	-0.025297	0.7001	0.025957	0.6691
IU(-1)	-0.028199	0.5523	-0.016148	0.7255
IU(-2)	0.011751	0.8022	0.012319	0.7872
BSC(-1)	0.054312**	0.0344	0.049445**	0.0385
BSC(-2)	0.009997	0.6979	-0.029536	0.2162
CPS(-1)	-0.038177	0.1195	-0.010174	0.6553
CPS(-2)	0.059896**	0.0187	0.013006	0.5607
LL(-1)	0.044292	0.1647	0.033037	0.2596
LL(-2)	-0.026822	0.4212	-0.030712	0.3036
POPG(-1)	-0.126055	0.6286	-0.472066*	0.0601
POPG(-2)	0.212127	0.4123	0.417704*	0.0866
R-squared	0.957501		0.939934	
Adjusted R-squared	0.951331		0.935869	
F-statistic	155.2048***	0.000000	231.2463***	0.000000
Prob(F-statistic)		0.000000		
Hausman Test	*Chi*2=102.509***		0.0000	
Wald Test	*F-statistic*=1.939**		0.0178	
	*Chi*2=31.025**		0.0134	

Note: ∗, ∗∗and ∗∗∗ represent, respectively, passing 10%, 5%, and 1% significance level test.

Source: Author's calculations using Eviews 12.

At the same time, the results of Fisher's test for fixed effects models (FME) in the above table prove the significance of the model as a whole at the level of significance of 1% and the quality of the model estimated statistically, where the coefficient of determination reached 95.75%. The results demonstrate also the existence of a positive and statistically significant relationship relating to the effect of fluctuations in the financial stability index for the previous period (t-1) and its current values in the MENA zone at a significant level of 1%, which explains the dynamic of the time relationship in the short term between the movements of the financial stability index and its past fluctuations, and corresponds to the economic and financial literature, where the general trend of the real values of macroeconomic and financial variables does not change in the short term, unlike the nominal variables. On the other hand, the significance of the impact of the rest variables that determine the effect of financial technology on financial stability varied in the short term, as the results showed the existence of a short-term significant relationship between changes in the financial stability index and each of the fluctuations in the economic growth index for the previous period. (GDPR(-1)), fluctuations in the financial concentration index for the previous period (BSC(-1)), variations in the volume of credits granted to the private sector for the past two years (CPS(-2)), in addition to the absence of a statistically significant relationship between the levels of financial stability for MENA zone and financial technology indicators (MPBR, ATM, IU).

As for the significance and relationship of the independent variables to the dependent variable, the results of estimating the fixed effects models (FME) showed a significant positive relationship between economic growth (GDPR), the level of financial concentration (BSC) and the volume of loans granted to the private sector (CPS), on the one hand, and the financial stability index (FS), on the other hand; This contradicts many studies in this field, as this can be explained in the MENA zone due to the traditional activity of the financial and banking systems, in addition to the weak financial competition between banks and the increase in banking concentration, which relates the performance level of the banking system using the Z-Score scale to the activity, profitability and stability of major banks, that are mostly public or governmental banks. As these banks are not private, they are looking primarily at reducing levels of risk rather than maximizing the level of profitability, which reflects

the focus of their activity around less profitable and less risky operations, what affect positively the financial stability index.

In addition, the same results confirm the absence of a significant relationship between the level of financial stability and financial technology indicators. This could be due to the occurence that the financial and banking systems in the MENA zone are mostly traditional, which limits their ability to offer financial and banking services that include the use of financial technology techniques due to the weak digital infrastructure, which reflects the shrinking volume of electronic financial and banking operations in the MENA zone compared to other regions of the world. This non-proliferation of financial technology in the banking systems of the MENA zone can be explained by the low level of financial culture of their societies, that affects negatively the level of financial inclusion in the region. These results can also be confirmed by the absence of significant relation for the levels of demographic growth and the financial stability index, meaning that the increase in the population does not reflect the increase in their access and intensification of their use of financial technology services in particular and financial and banking services in general.

4.5. Panel Causality test

With regard to short-term relationships, the results of the Panel Causality Tests using the Pairwise Dumitrescu Hurlin test, confirm the existence of a significant causal relationship, at the level of significance 1%, in one direction for economic growth index (GDPR), financial technology indexes (MPBR, ATM, IU), financial Concentration index (BSC), banking crisis indicators (CPS, LL) and demographic growth index (POPG) towards the financial stability index (FS). On the other hand, the results showed that there was no causal relationship in the reverse trend from the financial stability index towards the financial technology indexes (MPBR, ATM, IU); which is consistent with the various studies and theoretical literature on the subject. The results are provided in the next table:

Table 10. Panel Causality test results

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
GDPR does not homogeneously cause FS	3.77264	1.71878	0.0857
FS does not homogeneously cause GDPR	2.53676	0.04964	0.9604
MPBR does not homogeneously cause FS	6.18271	4.97371	7.E-07
FS does not homogeneously cause MPBR	2.81824	0.42980	0.6673
ATM does not homogeneously cause FS	8.00941	7.44076	1.E-13
FS does not homogeneously cause ATM	2.69112	0.25812	0.7963
IU does not homogeneously cause FS	7.67415	6.98798	3.E-12
FS does not homogeneously cause IU	2.66463	0.22234	0.8241
BSC does not homogeneously cause FS	6.30997	5.14558	3.E-07
FS does not homogeneously cause BSC	4.84282	3.16411	0.0016
CPS does not homogeneously cause FS	4.65682	2.91290	0.0036
FS does not homogeneously cause CPS	6.67254	5.63525	2.E-08
LL does not homogeneously cause FS	4.03352	2.07110	0.0383
FS does not homogeneously cause LL	3.12359	0.84220	0.3997
POPG does not homogeneously cause FS	8.96359	8.72943	0.0000
FS does not homogeneously cause POPG	8.74856	8.43902	0.0000

Note: ∗, ∗∗and ∗∗∗ represent, respectively, passing 10%, 5%, and 1% significance level test.
Source: Author's calculations using Eviews 12.

4.6. Robustness Test:

In order to test the strength of the previous results, we will analyze the effects of the occurrence of structural shocks in the dependent variables on financial stability index, so that the shock analysis depends on two main dimensions. The first dimension includes the analysis of impulse response functions, IRFs) and the second dimension consist of the analysis of variance (Forecast-error variance decomposition, FEVDs), which reflects the relative importance of an independent variable in explaining the variance of prediction errors for the dependent variable.

Thus, according to the estimates of the 10-year immediate response functions (IRFs), shown in Figure 2 below, a single positive structural shock in the components of the financial stability index (FS), amounting to 1%, has a positive impact in the short term on the crisis index itself, with very weak impact complications that do not exceed 3% in the first year after the shock, while the impact of the shock decreases in the long term to settle at levels ranging from 2 to 2.5%. The results also showed the weakness of the shocks that occur in the rest of variables, including the indexes of financial technology on financial stability index in the MENA zone, whether in the short or long term.

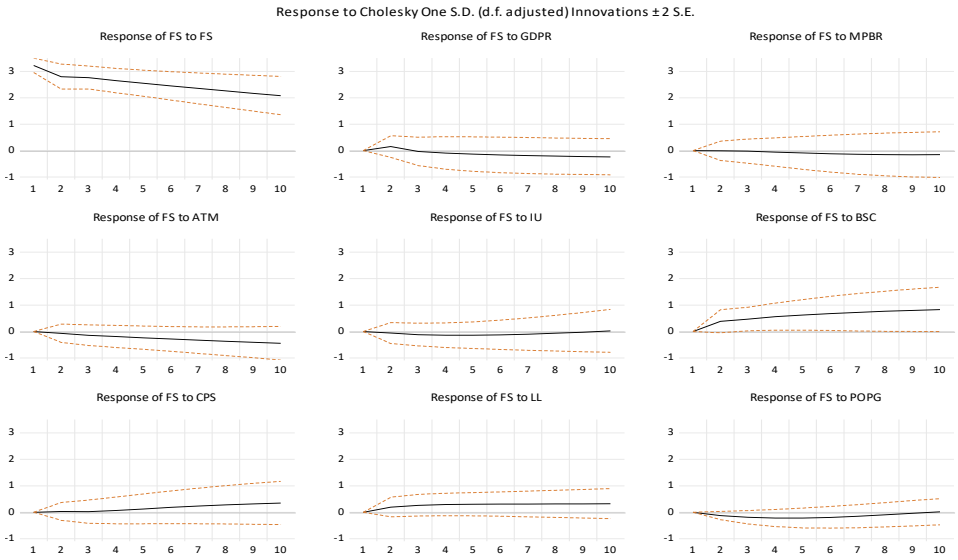

Figure 2: Pulse response graphs

Source: Author's calculations using Eviews 12.

The results of variance analysis's (FEVDs) summarized in Table 11 below indicate that the shocks that most explain the index of financial stability in the MENA zone in the short term are shocks that occur in the components of the index itself by more than 98%, while the remaining percentages of fluctuations are explained through the shocks that occur in the independent variables, including the financial technology indexes. The results also show that the explanation of shocks that occur in the components of the index itself in the medium and long term has decreased to varying rates, reaching the lowest of 90% in the last year, where the diminishing role of shocks that appear in the components of the indicator necessarily leads to an increase in the role of shocks that occur in the other independent variables of these fluctuations, especially the financial concentration index, however, the contribution of financial technology indicators in explaining these changes remains weak in the medium and long terms. This supports the results of the assessment reached previously.

Table 11. Variance decomposition

Period	FS	GDPR	MPBR	ATM	IU	BSC	CPS	LL	POPG
1	100.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	98.71	0.128	0.000	0.023	0.018	0.812	0.004	0.204	0.086
3	97.74	0.093	0.001	0.092	0.064	1.400	0.005	0.404	0.196
4	96.71	0.097	0.010	0.175	0.106	2.015	0.018	0.563	0.294
5	95.71	0.123	0.027	0.280	0.135	2.615	0.054	0.687	0.359
6	94.72	0.162	0.052	0.407	0.149	3.210	0.117	0.789	0.386
7	93.74	0.208	0.079	0.555	0.150	3.800	0.206	0.875	0.382
8	92.75	0.258	0.107	0.723	0.142	4.388	0.316	0.952	0.359
9	91.74	0.3107	0.1336	0.9094	0.1304	4.9719	0.441	1.023	0.330
10	90.7	0.363	0.155	1.112	0.121	5.551	0.574	1.092	0.305

Source: Author's calculations using Eviews 12.

5. Conclusion

The current paper has developed an econometric study using the panel vector auto regression models (Panel Var) to estimate the impact of financial technology on financial stability in the MENA zone. The results showed that factors such as: economic growth, financial concentration and banking crises constitute the most significant variables to explicit the levels of financial stability in the MENA zone compared to the financial technology indexes. This can be attributed to the weak digital infrastructure of banking systems and the marginalization of banking competition in many countries of the zone. While, other factors, such as the lower levels of financial literacy in the societies of the zone, play a crucial role in explaining the decline in the levels of financial inclusion in the MENA zone, which limits its use of financial technology services and ties the financial stability index in the MENA zone to traditional banking activities, rather than banking activities related to the use of financial technology.

Therefore, we can say that financial technology companies in many countries in the MENA zone have witnessed an important development in recent years, especially in the sector of communications and information technology, which has contributed to the improvement in the rates of individuals and companies' use of internet networks. The increase in the number of smart phone users also contributed to the acceleration of electronic payment applications in the MENA zone, in light of the support of the supervisory authorities in terms of electronic signature, cyber security and data protection. However, despite the progress in this field over the past decades, the MENA zone faces many challenges in order to achieve the necessary compatibility between the development of financial technology services to enhance the financial stability and reducing the risks of digital transformation in the region, such as the insufficiency of electronic systems for identifying costumers, the need to develop the regulatory and supervisory environment and facilitate the licensing process in line with the activities of financial technology companies, the low levels of financial culture in some MENA countries, the need to strengthen the capabilities of these companies in the face of cyber attacks that threaten digital financial services, in addition to the increasing reliance on money in some countries in the MENA zone due to the large size of the informal economy.

References

Ahamed, M. M., and Mallick S. K. (2019). Is financial inclusion good for bank stability? International evidence. *Journal of Economic Behavior & Organization*. *157*. 403–427.

Anyfantaki, S. (2016). The evolution of financial technology (F I N T E C H), *Economic Bulletin*. *44*. 47-62.

Bank of Korea. *Definition and Importance of Financial Stability*. Available at: <https://www.bok.or.kr/eng/main/contents.do?menuNo=400037> [Accessed on July 2022].

Bank of international settlements. (2018). *Sound Practices: Implications of fintech developments for banks and bank supervisors*. Basel committee on banking supervision. February.

Banna, H., Hassan, M. K. and Rashid, M. (2021). Fintech-based financial inclusion and bank risk-taking: Evidence from OIC countries. *Journal of International Financial Markets, Institutions & Money*. *75*.

Beetsma, R., and Giuliodori, M. (2011). The effects of government purchases shocks: review and estimates for the EU. *The Economic Journal*. *Vol 121. Issue 550*. February. 4–32.

Bénétrix, A. S., and Lane, P. R. (2010). International differences in fiscal policy during the global crisis. *NBER Working Paper*. *No. 16346*.

Carstensen, K., Hulsewig, O., and Wollmershauser, T. (2009). Monetary policy transmission and house prices: European cross-country evidence. CESifo *Working Paper*. *No*. *2750*.

Cusolito, A. P., Gévaudan, C., Lederman, D., and Wood, C. A. (2021). The Upside of Middle East and North Africa: How Digital Technology Adoption Can Accelerate Growth and Create Jobs. *International Bank for Reconstruction and Development / The World Bank.*

Feghali, K., Mora, N., and Nassif. P. (2021). Financial inclusion, bank market structure, and financial stability: International evidence. *The Quarterly Review of Economics and Finance*. *80*. 236–257.

Financial stability board. (2017). *Financial Stability Implications from FinTech: Supervisory and regulatory issues that merit authorities' attention*. June. 1-65.

Greene, W. (2012). *Econometric Analysis* (Seventh Edition ed.). New York: Pearson Education Limited.

Hurlin, C., and Mignon, V. (2007). Une synthèse des test de cointégration sur données de panel. *Revue Économie et prévision. Vol. 04. N° 180-181*. 241-265.

Hurlin, C., and Mignon, V. (2005). Une Synthèse des Tests de Racine Unitaire sur Données de Panel. *Revue Économie & prévision*. *N° 169-171*, 253-294.

KPMG. (2022). Pulse of Fintech H2'21, January. Available at: <https://home.kpmg/xx/en/home/insights/2022/01/top-fintech-trends-in-h2-2021.html> [Accessed on July 2022].

KPMG. (2021). Pulse of Fintech H2'20, January. Available at: <https://home.kpmg/xx/en/home/campaigns/2021/08/pulse-of-fintech-h2-2020.html> [Accessed on July 2022].

KPMG. (2020). Pulse of Fintech H2 2019, January. Available at: https://assets.kpmg/content/dam/kpmg/xx/pdf/2020/02/pulse-of-fintech-h2-2019.pdf [Accessed on July 2022].

Lu, S., Guohua, H., and Huan, Y. (2022). Research on the impact of technological finance on financial stability: Based on the perspective of high-quality economic growth, *Hindawi Complexity*. January. pp.1-15.

Mohd Daud, S. N., Ahmad, A., Khalid, A., and Azman-Saini. W.N.W. (2022). FinTech and financial stability: Threat or opportunity?. *Finance Research Letters*. *47*.

Nakashima Tokushi. (2018). *Creating credit by making use of mobility with FinTech and IoT*. *IATSS Research*. *42*. 61-66.

Ramde, f. (2018). *Institution, investissements et croissance dans l'UEMOA: une approche panel VAR*. Rīgā. Latvia: Editions universitaires européennes EUE.

World Bank. *Financial stability*. Available at World Bank: <https://www.worldbank.org/en/publication/gfdr/gfdr-2016/background/financial-stability> [Accessed on July 2022].