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The Impact of Fintech on Financial Inclusion in North Africa: Evidence From Method of Moments Quantile Regression

Brahim SELKA [1,*], Rahima BENAINI [2]

[1] University Centre of Maghnia, Laboratory LEPPESE, (Algeria) (Selkabrahim@hotmail.com)
[2] University Centre of Maghnia, Laboratory LEPPESE, (Algeria) (Benainirahima2021@gmail.com)

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Summary: Our study analyze the influence of Fintech on financial inclusion in nations located in North Africa (Algeria, Tunisia, and Morocco) between 2004 and 2022. Employing the Method of Moments Quantile Regression (MM-QR) framework, we analyze the relationship between Fintech adoption (proxied by ATMs per 100,000 adults) and financial inclusion (represented by branches of commercial banks for every 100,000 adults), incorporating control variables like fixed telephone subscriptions and primary school enrollment. The results of our study indicate a clear and statistically significant positive correlation between Fintech and financial inclusion. The coefficient for Fintech exhibits a decreasing trend across quantiles, in areas where there is little availability to conventional banking services. Additionally, fixed telephone subscriptions display a significant impact on financial inclusion in middle quantiles and remains insignificant for all other quantile. Conversely, primary school enrollment demonstrates a positive and increasing association across all levels of quantiles, highlighting its crucial role in fostering financial literacy and inclusion.

Keywords: Fintech; Financial Inclusion; Quantile Regression, North Africa.

Jel Classification Codes : G23 ; G21 ; C21

* Corresponding author.

I- Introduction :

In order to improve financial stability, social and economic well-being, and equality, developing countries put a lot of weight on financial inclusion in their economic strategies. Financial services generally facilitate individuals and businesses in effectively planning for various aspects, including both long-term objectives and sudden needs. Financial services like loans and insurance are more likely to be used by people who have bank accounts, to initiate and grow companies, allocate resources towards either health or education, handle risk, and start over after a financial shock, all of which can make their lives better in the long term. According to (Demir et al., 2022), financial inclusion has a vital role in minimizing gaps in income through fintech, particularly in higher-income nations, across all quantile levels. The World Bank declared that financial inclusion (FI) refers to the act of providing affordable and practical financial products and services that satisfy the requirements of individuals and organizations. These services and products may include insurance, credit, transactions, and payments and must be provided in a responsible and durable way. In 2018, the International Monetary Fund (IMF) and the World Bank Group introduced the Bali FinTech Agenda (BFA), which defines FinTech as "technological advancements that can revolutionize the delivery of financial services, leading to the creation of innovative business models, applications, processes, and products." (Demirguc-Kunt et al., 2014) discovered that developing economies have a lower level of accessibility to formal financial services in comparison to high-income countries. Based on the identical statistical data, the region of the Middle East and North Africa (MENA) has the largest proportion of working-age persons who do not have access to banking services. This is followed by South Asia and sub-Saharan Africa. Increasing financial inclusion also means giving as many adults of working age as possible access to high-quality, low-cost financial services.

Leaders in the fields of monetary, financial, and economic matters understood the value of financial inclusion after the global financial crisis. It is important for all groups to be able to receive all financial services without any kinds of discrimination. In addition to helping the economy grow, this protects consumers' finances and keeps society stable on a number of levels, including the financial, social, and political. Access to financing makes it possible for all kinds of businesses to invest and for individuals to spend money and build up savings over time. This not only creates more jobs but also raises the standard of living. People and businesses also need to be able to get financing in order to safeguard themselves from unexpected events and effectively manage uncertainty.

Fintech has the capacity to improve the speed, cost-effectiveness, security, transparency, and inclusivity of financial services, particularly for the significant portion of the population that does not engage with traditional banking institutions. However, the rapid expansion of financial technology services and new firms poses a significant risk that requires protection. It is imperative to implement comprehensive measures to ensure the security, performance, and durability of financial sector.

Given the information provided, the research problem can be formulated as follows: How does financial technology affect financial inclusion in North Africa?

We suppose that a significant and positive association has been observed between financial technology and financial inclusion in North Africa.

The objective of this paper is to quantify the impact of fintech on financial inclusion in North Africa using robust econometric methods. This involves analyzing historical data to identify patterns and correlations between fintech and financial inclusion.

II– Literature review:

After examining the relevant studies, it was discovered that while the majority of researchers acknowledge the positive impact, some present evidence to the contrary. In a recent study, (Legowo, et al., 2021) found that the partnership between traditional banks and fintech companies has the potential to enhance financial inclusion. In addition, a study conducted by (Fouad & El Rahman, 2018), data from MENA nations was analyzed and it was discovered that the presence of ATMs has had a beneficial impact on both the promotion of financial inclusion and the stimulation of economic growth. In a comprehensive analysis, (Khalaf & Wadi, 2023) established a clear connection between Fintech and financial inclusion. They quantified Fintech by looking at the

number of ATMs per 100,000 population, and defined financial inclusion based on the percentage of residents with various sorts of accounts at formal financial institutions.

But, surprisingly, (Tidjani, 2021) came to the conclusion that it's still not clear how Fintech affects financial inclusion. This is because Fintech solutions aren't fully developed yet, and it's not clear what they will be in the future. However, people who can't use banks in MENA countries must use them. (Allen, 2021) comes to the conclusion that Arab countries are still behind many other countries in the world when it comes to implementing financial inclusion. This is because they can't provide many official financial services to people who can't access them. The study also says that digital technology can help make these countries more financially inclusive.

Some North African countries have recently started to keep up with the fast growth of financial technology. This is because it is a fast-growing field that offers great business opportunities and helps the region's economy grow. Technology companies also come up with new ways for the financial sector to run its businesses more efficiently and effectively. It is our hope that our study will add something important to the body of research on Fintech and financial inclusion, especially in North African countries that have problems with inequality and poor access to financial services.

III– Methods and Materials:

This study samples three North African countries, Algeria, Tunisia, and Morocco, from 2004 to 2022. We chose this specific country because to its higher prevalence of financial exclusion, and our objective was to investigate the potential of fintech to reduce these gaps in exclusion.

The impact of fintech is not a singular, one-dimensional phenomenon. It varies across countries, depending on their population, education level, and fixed telephone subscriptions. A simple linear relationship between fintech and financial inclusion would be a disservice to the complexities.

Hence, the present study employs the methods of moments quantile regression with fixed effect (MM-QR), as introduced by (Machado & Silva, 2019), to examine potential variations in the impact of fintech on financial inclusion across different quantiles. This strategy enables us to obtain a comprehensive understanding of the conditional distribution in contrast to the ordinary least squares (OLS) technique.

This study looks at how financial technology affects financial inclusion. Financial inclusion (FINI) is the dependent variable represented by commercial bank branches per 100,000 adults. The independent variables are Fintech (FINT) proxied by ATMs per 100,000 adults, fixed telephone subscriptions (FIXTEL) and primary school enrollment (SCH). The variables were all converted to their natural logarithmic form to eliminate any possibility of heteroscedasticity issues and to enhance the significance of the analysis, as formulated below:

$$InFINI_{it} = f(InFINT_{it}, InFIXTEL_{it}, InSCH_{it}) \quad (01)$$

$$InFINI_{it} = \alpha 0_i + \alpha 1_i\, InFINT_{it} + \alpha 2_i\, InFIXTEL_{it} + \alpha 3_i\, InSCH_{it} + \varepsilon_{it} \quad (02)$$

In Equations (1) and (2), the variable i represents the country index, ranging from 1 to N, where N is the total number of countries. t = 1, 2, 3, ..., T represents time, while $\alpha 0_i$ denotes the fixed effects specific to each country. The variables $\alpha 1_i$, $\alpha 2_i$, and $\alpha 3_i$ represent the elasticities of financial inclusion in relation to fintech, fixed telephone subscriptions, and primary school enrollment, respectively. The word ε_{it} denotes the error term, which is assumed to be independent and normally distributed.

$InFINI_{it}$ denotes log of financial inclusion, $InFINT_{it}$ is the log of financial technology, $InFIXTEL_{it}$ is the log of fixed telephone subscriptions and $InSCH_{it}$ is the log of primary school enrollment.

To investigate the effects of financial technology, fixed telephone subscriptions, and primary school enrollment on financial inclusion, we used panel quantile regression, which was first used in this work (Koenker & Bassett, 1978). This approach, which is more robust than usual regression techniques that prioritize the average impact such as ordinary least squares, provides clearer visualizations of the impact of the independent variables by allowing the slopes of the regression line to fluctuate throughout different quantiles of the dependent variable.

However, quantile regression with single effects has many limitations, such as inability to account for potential unobserved variability among people. Thus, we used the moments quantile regression (MM-QR) with fixed effect methodology. This method allows for the calculation of conditional quantiles by merging estimations of the location and scale functions, which are derived using conditional means. Unlike (Koenker, 2004) and (Canay , 2011), the MM-QR not only changes the position but also enables the individual impacts to influence the general distribution, as well as the location and scale, of the dependent variable Y (FINI). In addition, when estimating quantile regression with individual effects and endogenous explanatory factors, MM-QR becomes extremely important.

Models of location-scale variants include the MM-QR, which calculates the conditional quantiles of a dependent variable (Y) based on a set of variables (X) that influence its distribution. Y is defined by the following formula:

$$Yit = \alpha i + Xit\,'\,\beta + (\delta i + Zit\,'\,\gamma)\,Uit \qquad (03)$$

The probability, P $\{\delta i + Zit' \quad \gamma > 0\}$, is equal to 1. The parameters α, β', δ, and γ' are unknown and need to be determined.

(αi, δi), where i ranges from 1 to n, reflect the fixed effects for each individual. Z consists of a k-vector that includes defined components of X. The given components are differentiable transformations denoted by Zl, where l ranges from 1 to k. Each transformation Zl is a function of X, by: $Zl = Zl\,(X),\ l=1,\ldots..,k \qquad (04)$

The variables Xit and Uit are independent and have the same probability distribution for any fixed i and across time (t). According to Machado and Silva (2019), Uit are at a right angle to Xit and are modified to achieve the present time criteria without strict exogeneity. The conditional quantile $Qy\,(\tau|x)$ of the dependent variable Y, as described in Equation (3), is stated as follows:

$$Qy\,(\tau|Xit) = (\alpha i + \delta i\; q(\tau)) + Xit'\,\beta + Zit\,'\,\gamma\; q(\tau) \qquad (05)$$

where Xit' includes the independent variables. The symbol $Qy\,(\tau|Xit)$ represents the quantile distribution of the dependent variable Yit, given the specific values of the explanatory variables Xit. The fixed effect of quantile τ for individual i is determined by the scalar coefficient αi (τ), which is equal to the sum of αi and δi multiplied by q(τ).

The individual effects, as opposed to the conventional least-square fixed effect, do not exhibit intercept shift. Given that they are time-invariant parameters, it is acceptable for the heterogeneous impacts to vary throughout the quantiles of the dependent variable. The estimation of q(τ) is derived from the subsequent optimization issue:

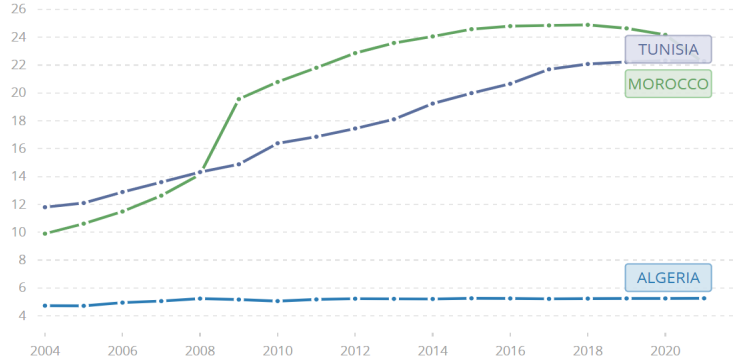
$$Minq = \sum i \sum t\; \rho\tau\,(\text{Rit} - (\delta i + Zit\,'\,\gamma)\; q\;) \qquad (6)$$

The equation Rit = Yit - $(\alpha i + Xit\,' \quad \beta)$ represents the difference between Yit and the sum of αi and $Xit\,' \quad \beta$. The function ρτ (A)= (τ-1) AI {A ≤ 0} + τ AI {A > 0} is a function used for verification.

IV- Results and discussion :

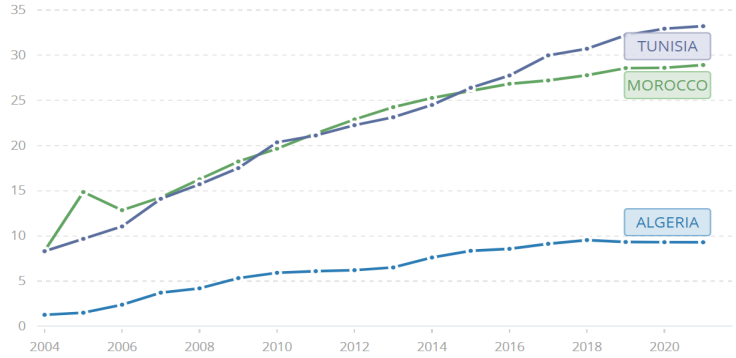
IV.1. Graphs:

Figure (1): Commercial bank branches (per 100,000 adults) - Algeria, Morocco, Tunisia



The source: The World Bank Data

Figure (2): Automated teller machines (ATMs) (per 100,000 adults) - Algeria, Morocco, Tunisia



The source: The World Bank Data

IV.2. Data

Table (1) : Variable Description

Variable	Definition	Source
FINI	Financial inclusion represented by commercial bank branches per 100,000 adults	International Monetary Fund Data
FINT	Financial technology proxied by ATMs per 100,000 adults	International Monetary Fund Data
FIXTEL	Fixed telephone subscriptions	International Monetary Fund Data
SCH	Primary school enrollment	International Monetary Fund Data

The source : By Authors

Table (2) : Descriptive statistics

Variable	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-berra	N
LNFINI	2.48	2.65	3.22	1.55	0.64	-0.36	1.43	7.07 (0.029)	57
LNFINT	2.60	2.79	3.48	0.24	0.78	-1.04	3.76	11.74 (0.002)	57
LNFIXTEL	2.17	2.18	2.67	1.41	0.28	-0.72	3.14	4.97 (0.082)	57
LNSCH	4.68	4.68	4.73	4.64	0.02	0.21	1.74	4.22 (0.121)	57

The source : Author's own computation

According to the data in Table 2, the skewness values for three variables (FINI, FINT, and FIXTEL) are negative and significantly different from zero, indicating a strong leftward skewness. The skewness value for the variable SCH is positive and likewise significantly different from zero. The kurtosis values deviate significantly from three, indicating that using OLS estimation would be unreliable, while adopting quantile regression would be more appropriate and resilient for this investigation.

Table (3) : Correlation matrix - VIF

	LNFINI	LNFINT	LNFIXTEL	LNSCH	VIF	1/VIF
LNFINI	1.000				-	-
LNFINT	0.888	1.000			1.34	0.744
LNFIXTEL	-0.0357	0.0425	1.000		1.16	0.860
LNSCH	-0.4639	-0.4871	-0.3448	1.000	1.52	0.657
Mean	-	-	-	-	1.34	-

The source : Author's own computation

Table 3 displays the correlation coefficients between the variables and the results of the variance inflation factor. The VIF test findings demonstrate that there is no multicollinearity among the independent variables, as the average value of 1.34 is below the limit of 5. The VIF results confirm our perspective that FINT, FIXTEL, and SCH should be included in the same model.

Table (4) : Slope homogeneity test

Test	Delta	P-value
The test of Pesaran and Yamagata		
Δ	8.512	0.000
Δ adj	9.917	0.000
The test of Blomquist and Westerlund		
Δ	2.407	0.016
Δ adj	2.804	0.005

The source : Author's own computation

Before moving forward, we need to perform a key test to verify whether the Slope homogeneity hypothesis holds true for the data. Two tests will be used: the (Pesaran & Yamagata, 2008) test, and (Blomquist & Westerlund, 2013) test. According to Table 4, the data clearly show the rejection of the null hypothesis of uniformity in the slope across different nations. Hence, it is crucial to take into account the limitations imposed by variability on the slope to guarantee reliable outcomes in estimating techniques.

Table (5) : Cross-section dependence tests

Variables	BP	PS	BCS	PE
LNFINI	43.389***	16.489***	16.405***	6.583***
LNFINT	52.821***	20.339***	20.256***	7.267***
LNFIXTEL	4.690	0.690	0.606	0.608
LNSCH	10.225**	2.949***	2.866***	-1.956**

The source : Author's own computation

*** , ** denotes the rejection of the null hypothesis at 1% and 5%.

The (Breusch & Pagan, 1980) (BP) test, the (Pesaran , 2004) (PS) test, the (Pesaran, 2007) (PE) test, and the Bias corrected scaled LM (BCS) test from (Baltagi, et al., 2012) are the four tests we use. The findings show that the "no cross-sectional dependence" null hypothesis is not true for three variables: SCH, FINT, and FINI. This strongly supports the idea that any shock impacting one of these variables in one nation will also have an impact on the same variable in other countries.

IV.3. MM-QR results and discussion

Table (6) : The findings of the MMQR approach

Quantiles	LNFINT	LNFIXTEL	LNSCH
0.10	0.414***	0.294	4.582**
0.25	0.379***	0.269*	4.770***
0.50	0.303***	0.216*	5.174***
0.75	0.205**	0.147	5.702***
0.90	0.157	0.113	5.958**

***, **, and * indicate significance at the 1, 5, and 10%

The results of MM-QR at various quantiles are presented in table 6, the coefficient related to FINT is positive, significant and gradually decreased from 0.1 to 0.75 quantiles and remains insignificant for the last quantile. The positive coefficient for fintech indicates that as the number of ATMs (fintech proxy) increases, the number of bank branches (financial inclusion proxy) also rises. This aligns with the expectation that fintech can be a stepping stone towards formal financial services. The coefficient's decline from the 0.1 to 0.75 quantiles suggests a diminishing marginal effect. This means the initial increase in ATMs has a stronger impact on financial inclusion in areas

with initially low access to bank branches (lower quantiles). In these areas, ATMs might be a crucial first step for people who previously lacked convenient financial services. The coefficient becoming insignificant in the last quantile suggests that for areas with already high branch density (top of the distribution), additional ATMs may not significantly increase overall financial inclusion, these areas might already have sufficient access to traditional banking services, making ATMs less impactful.

The coefficient related to FIXTEL is significant and positive from 0.25 to 0.50 quantiles and remains insignificant for all other quantile. The positive coefficient for fixed telephone subscriptions in the 0.25 to 0.50 quantiles suggests a connection between phone access and increased bank branches in areas with moderate levels of financial inclusion. This could be clarified by the fact that fixed phones might act as a prerequisite for establishing bank branches in these areas. Reliable communication is crucial for secure financial transactions and efficient branch operations. The coefficient becoming insignificant in the lower (below 0.25) and higher (above 0.50) quantiles suggests that fixed telephones have a limited impact on financial inclusion in extremely low or high financial inclusion areas because in areas with very low phone penetration (below 0.25 quantile), even an increase in fixed lines might not be sufficient to trigger widespread bank branch expansion, and in the areas with high financial inclusion, alternative communication channels like mobile phones or internet could be the dominant mode for accessing financial services, rendering fixed lines less crucial.

The coefficient related to SCH is positive, significant and gradually increased from the lower to higher quantiles, the positive coefficient across all quantiles suggests a strong connection between higher primary school enrollment rates and increased financial inclusion, as measured by bank branches. This corresponds with the notion that education is a key part of supporting financial inclusion.

V- Conclusion:

This study explored how various factors influence financial inclusion in North Africa. While fintech was expected to have a positive impact, the research confirmed this, especially in areas with limited bank access. ATMs played a crucial role in these areas, offering a convenient first step towards financial services. Interestingly, the effect of ATMs diminished in regions with existing bank branches.

Key Results:

- Fintech Boosts Inclusion: Fintech strengthens financial inclusion, particularly in areas lacking bank access.
- ATMs Bridge the Gap: ATMs significantly improve inclusion in low-bank areas, offering initial access to financial services.
- Education Matters: Primary school enrollment consistently supports financial inclusion, suggesting education empowers long-term financial engagement.

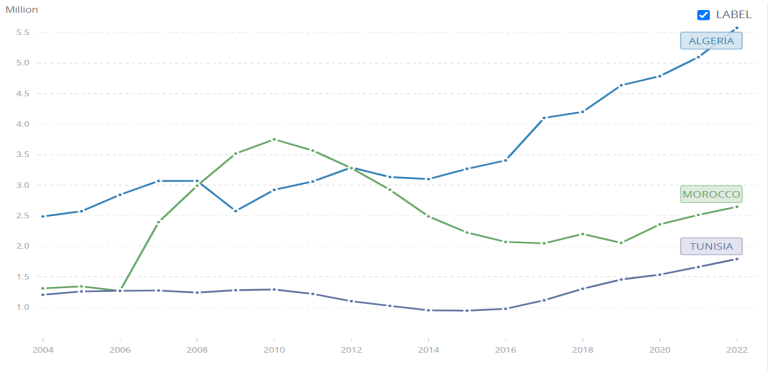
Recommendations:

- Leveraging Existing Infrastructure: Conduct research and pilot programs to assess the feasibility and effectiveness of utilizing existing infrastructure, like post offices, for basic financial services (e.g., account opening, cash deposits/withdrawals, bill payments). This can extend reach in underserved communities lacking traditional bank branches.
- Financial Literacy in Schools: Partner with educational institutions to integrate age-appropriate financial literacy education into school curriculums. Equipping young people with financial knowledge and responsible management skills fosters long-term financial inclusion.
- Mobile Money and Agent Networks: Explore and promote FinTech solutions like mobile money and agent banking networks. These offer convenient access to financial services through mobile phones and local agents, by passing the need for traditional bank branches, particularly relevant in geographically remote areas.
- Digital Identity Solutions: Develop and implement secure digital identity solutions for underserved communities. This can be crucial for accessing financial services online or through mobile apps, which are increasingly used for financial inclusion initiatives.

- Data Privacy and Security: Design and implement FinTech solutions with robust data privacy and security measures. Building trust through secure platforms is critical for encouraging participation in financial services within underserved communities.
- Partner with FinTech startups: Encourage partnerships between traditional financial institutions and FinTech startups. These partnerships can leverage the agility and innovation of FinTech companies to develop and deliver more inclusive financial products and services tailored to the needs of underserved populations.

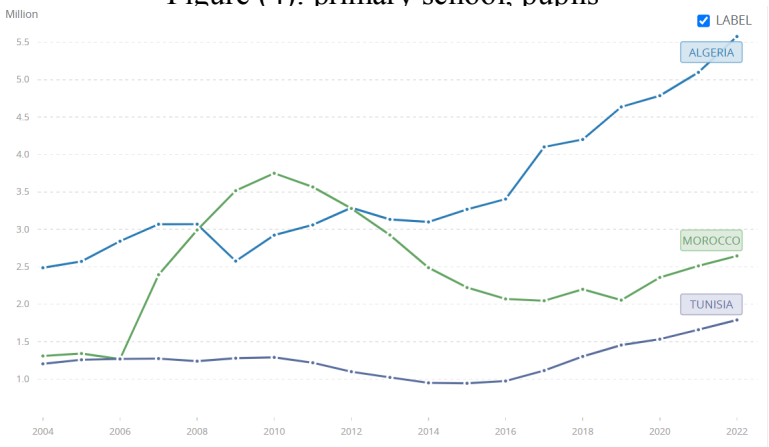
- Appendices:

Figure (3): Fixed telephone subscriptions - Algeria, Morocco, Tunisia



The source: The World Bank Data

Figure (4): primary school, pupils



The source: The World Bank Data

Referrals and references:

Allen, F. (2021). Globalization of Finance and Fintech in the MENA Region. Economic research forum Working Paper(1489).

Baltagi, B., Feng, Q., & Kao, C. (2012). A Lagrange Multiplier test for cross-sectional dependence in a fixed effects panel data model. Journal of Econometrics, 170(1), pp. 164–177.

Blomquist, J., & Westerlund, J. (2013). Testing slope homogeneity in large panels with serial correlation. Economics Letters, 121(3), pp. 374–378.

Breusch, T., & Pagan, A. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. Rev. Econ. Stud, 47(1), p. 239.

Canay , I. (2011). A simple approach to quantile regression for panel data. The Econometrics Journal, 14(03), pp. 368– 386.

Demir, A., Pesqué-Cela, V., Altunbas, Y., & Murinde, V. (2022). Fintech, financial inclusion and income inequality: A quantile regression approach. The European Journal of Finance, 28(1), pp. 86–107.

Demirguc-Kunt, A., Klapper, L., Singer, D., & Oudheusden, P. (2014). Measuring financial inclusion around the world. The Global Findex Database (7255).

Fouad, R., & El Rahman, Y. (2018). Financial inclusion and economic growth MENA region. Scientifc Journal for Economic & Commerce, 48(4), pp. 799–819.

Khalaf, L., & Wadi, R. (2023). Fintech and Financial Inclusion: Evidence from MENA Countries. Technological Sustainability and Business Competitive Advantage . Internet of Things., pp. 185-198.

Koenker, R. (2004). Quantile regression for longitudinal data. Journal of Multivariate Analysis, 91(1), pp. 74-89.

Koenker, R., & Bassett, G. (1978). Regression Quantiles. Econometrica, 46(1), pp. 33-50.

Legowo, M., Subanidja, S., & Sorongan, F. (2021). Fintech and bank: Past, present, and future. Jurnal Teknik Komputer, 7(1), pp. 94–99.

Machado , J., & Silva, J. (2019). Quantiles via moments. Journal of Econometrics, 213(01), pp. 145–173.

Pesaran, M. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. (U. o. Cambridge, Éd.) Working Paper in Economics(0435).

Pesaran, M. (2007). A simple panel unit root test in the presence of cross-section dependence. Journal of applied econometrics, 22(2), pp. 265–312.

Pesaran, M., & Yamagata, T. (2008). Testing slope homogeneity in large panels. Journal of Econometrics, 142(1), pp. 50–93.

Tidjani, C. (2021). COVID-19 and challenges of the fntech industry: A state of the art and outlooks on the North African region. Abaad Iktissadia Review, 11(2), pp. 696–721.

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