Journal of Economics and Sustainable Development
Volume: 09 / N°: 01 (2026), P:297-315
ISSN : 2661-7986 EISSN: 2773-2606

The impact of digital financial inclusion on the informal economy in Algeria using the Threshold Regression model

Wafa Ramdani [1] [*]
[1] University of Eloued (Algeria)
ramdani-wafa@univ-eloued.dz

Received:07/10/2025 ***Accepted:13/01/2026*** ***Published:01/03/2026***

Abstract:

This study aims to measure the impact of digital financial inclusion on the informal economy in Algeria during the period 2008–2022, using six-year interval data and relying on the Threshold Regression (TR) model. It seeks to determine whether the digital financial inclusion index is below or above the optimal threshold required to achieve a decline in the proportion of the informal economy to its maximum level.

The results indicate that the optimal digital financial inclusion index is greater than 2.219274%. Once this threshold is exceeded, the proportion of the informal economy in Algeria begins to decline. The digital financial inclusion parameter, as estimated by the model, was 0.46, meaning that a 1% increase in digital financial inclusion results in a 0.46% reduction in the informal economy

.**Keywords:** Digital Financial Inclusion; Informal Economy; Threshold Regression Model.; Informal Economy; Threshold Regression Model.

JEL Classification: E51; E26 ; C5.

[*] ***Corresponding author.***

Introduction

Despite the different names given to the term "informal economy," such as shadow economy, parallel economy, hidden economy, or black economy, the meaning and content it encompasses remain the same. It refers to all economic activities, whether legal or illegal, practiced by various economic units outside the legal framework. In other words, these are activities that are not officially recorded, do not enter into national income accounts, are not subject to the tax system, nor to administrative and regulatory systems.

The issue of informal activities and their growth has become prominent across various economies worldwide, particularly in developing countries. As a result, it has become a matter of international, academic, and governmental concern, with research focusing on the reasons for its spread, its degree of danger, and exploring strategies to address it.

Algeria, like other developing countries, has not been immune to experiencing various activities and projects operating without state supervision and control. One of the reasons for the growth of these activities is their difficult or limited reach to financial institutions. Financial intermediation is of great importance in shifting activities from informal to formal sectors, which can be achieved through accessing and benefiting from financial services in the form of digital financial inclusion. Overcoming the distance barrier through the advancement of ATMs, mobile banking services, and internet banking, provides a practical solution to the problem of distance from various credit institutions and the issue of the expanding size of the informal economy.

Based on the above, the main issue of the study can be summarized in the following key question:

- **What are the optimal limits of digital financial inclusion that enhance the reduction of the informal economy and its integration into the formal sector?**

The study is based on the hypothesis that the spread of banking services and the activation of digital financial inclusion leads to the reduction in the informal economy and its integration into the formal economy.

The main objective of this study is to analyze the reality of the informal economy and financial inclusion in Algeria, as well as how to enhance the role of the latter in reducing the size of the informal economy by determining the optimal threshold according to threshold models.

1- Digital Financial Inclusion and the Informal Economy in Algeria:

1-1- Digital Financial Inclusion in Algeria:

1-1-1- Definition and Objectives of Digital Financial Inclusion:

Digital financial inclusion is defined as the introduction of unbanked adults into the formal financial sector through the provision of financial services using devices with digital interfaces such as mobile phones or cards. Digital financial inclusion also refers to programs aimed at providing disadvantaged communities with access to affordable digital financial services. (Riha & Niyaz, 2022, p. 472)

Financial inclusion is also defined as the process of encouraging access to and benefiting from formal financial services among public users and companies. Moreover, financial inclusion also ensures the accessibility and use of formal financial services by individuals and businesses. Additionally, the goal of financial inclusion is targeting disadvantaged communities, including low-income groups, in order to be financially included with access to financial services. These financial services include credit, insurance, and other forms of equity.

On the other hand, financial inclusion is also defined as having a formal account from a recognized financial institution. Individuals and companies can use this financial account to regularly perform savings, borrowing, insurance, and payment services. Therefore, financial inclusion should be part of a country's economic growth, helping disadvantaged communities by improving their income and employment opportunities.

Financial inclusion plays a role in ensuring that all countries have access to and use of financial products to benefit from economic advantages. Digital financial inclusion is also considered one of the fundamental pillars for achieving sustainable development goals by 2030. We mention the most important of these in the following points: (Ying Tay, Tai, & Tan, 2022, pp. 4-6)

- ✓ Digital financial services work on low-cost business strategies (for example, digitizing salaries, commercial payments, and credit).
- ✓ Small institutions can use digital finance for development, innovation, entering new markets, and attracting more young talent to the digital economy.
- ✓ Digital finance can create an equalizing force that gives low-income individuals access to low-cost digital finance and improves financial resilience.
- ✓ Digital payments significantly improve the transparency of government transactions.
- ✓ Digital financial services can help disadvantaged groups (such as the poor, farmers, migrants, etc.) increase productivity and provide safer and more reliable social transfers or remittances.

1-1-2- Digital Financial Inclusion Indicators in Algeria:

Digital financial inclusion aims to provide a range of digital financial services that offer opportunities for accessing funds, transferring money, increasing capital, saving money, and reducing risks through a variety of tools including electronic money accounts, electronic cards, electronic payment devices, and so on.

The following two tables illustrate the level of development of one of the digital financial inclusion indicators (ATMs, electronic payment, electronic cards) in Algeria during the period 2008-2022.

Table (01): ATMs and Electronic Payment Devices in Algeria for the Period 2008-2022

Year	ATMs	Electronic Payment Devices	Year	ATMs	Electronic Payment Devices
2008	544	408	**2016**	1370	5049
2009	574	2639	**2017**	1443	11985
2010	636	2897	**2018**	1441	15397
2011	648	3047	**2019**	1621	23762
2012	543	2965	**2020**	3030	33945
2013	475	2986	**2021**	3053	37567
2014	539	2737	**2022**	3652	46263
2015	573	3049			

Sourse: (https://satim.dz)

As shown in Table 1, it is evident that the number of ATMs has significantly increased throughout the study period. The number rose from

544 devices in 2008 to 3,652 devices in 2022, marking an increase of 3,108 devices. We also observe from the same table that electronic payment devices have seen a continuous increase. The number of devices in 2008 was estimated at 408, rising to 46,263 devices in 2022, an increase of 45,855 devices. This indicates and explains the banks' tendency towards providing different locations, especially in places areas frequented by a large number of customers, to ensure service availability and enhance customer satisfaction.

Table (02): Number of Electronic Cards in Algeria for the Period 2008-2022

Year	Electronic Card	Year	Electronic Card	Year	Electronic Card
2008	333374	**2013**	1287330	**2018**	1501965
2009	569558	**2014**	1125689	**2019**	1638784
2010	979933	**2015**	1308490	**2020**	9621017
2011	850008	**2016**	804674	**2021**	2768285
2012	1178243	**2017**	877708	**2022**	3461317

Sourse: (https://satim.dz)

Observing Table 2, we can see that the number of electronic cards in 2008 was estimated at 333,374 cards. The number then increased by 646,559 cards in 2010, before decreasing to 850,008 cards in 2011. Starting from that year, the number of cards rose to 1,308,490 in 2015, then fell to 804,674 cards in 2016. It subsequently increased to 9,621,017 in 2020, decreased by 6,852,732 cards in 2021, and finally rose by 693,032 cards in 2022**.**

1-2- The Informal Economy in Algeria:

1-2-1- The Concept of the Informal Economy and Its Effects

The term "informal economy" has been used in several fields, which has led to the emergence of various definitions and characteristics related to it. We present the most important ones as follows:

The Algerian National Economic and Social Council (CNES) defined the informal economy as: A set of transactions and activities, whether legal or illegal, that take on a hidden nature, meaning they are undeclared and unregistered within the national accounts. (Publications of the National Economic and Social Council, 2004, P 38)

As for the International Monetary Fund (IMF): It has given it several names and defined it as follows: "It is the shadow economy, hidden economy, informal economy, or parallel economy. It includes not only illegal activities but also unreported forms of income derived from the production of legal goods and services, whether from monetary transactions or transactions conducted through a barter system. Therefore, the informal economy includes all activities that would be taxable if reported to the tax authorities." (Schneider & Enste, 2002, P 02)

Meanwhile, the Organisation for Economic Co-operation and Development (OECD) uses the term "non-observed" or "hidden economy," which consists of four components: (OECD, 2003, p. 13)

- ✓ Underground production: These are productive and legal activities that are deliberately hidden from public authorities to avoid paying taxes or to avoid applying certain legal regulations.
- ✓ Illegal production: These are productive activities that generate services and products that are legally prohibited, or are produced by producers who do not have a license.
- ✓ Informal sector production: These are productive activities carried out by informal institutions belonging to the family business sector that are unregistered and characterized by small size and have a marketable product.
- ✓ Family business institutions sector for final consumption: These are productive activities that translate into consumption or accumulation of goods and services by family businesses that produce and consume them.

As previously mentioned, the concept of the informal economy refers to all activities, businesses, and professions typically carried out by individuals or small unregistered institutions that are not subject to tax systems and official records. The larger this sector grows, the more costly its negative impacts become, whether they are economic or social. On the economic side, the following points can be mentioned:

- ✓ Distortion of information and statistics: This pertains to the available and utilized economic resources and employment, making it difficult to accurately predict future changes. This leads to challenges in making practical and realistic decisions by economic policy planners and makers.

- ✓ Budget deficit: Complex and costly regulatory and tax systems create high levels of non-compliance, thereby reducing government revenue and diminishing the ability to provide public goods and services.
- ✓ Imbalance between savings and investment: The informal economy does not allow for the formation of public savings. Even if savings exist, their level will be weak, insufficient to meet or encourage the state to promote investments, resulting in economic stagnation characterized by high unemployment and inflation rates.
- ✓ Distortion and reduction of economic growth: The prevalence of an informal economy will hinder GDP growth. An increase in the size of this economy will reduce revenue and consequently reduce spending, which in turn will shrink the production base, ultimately leading to a decrease in the overall economic growth rate.
- ✓ Emergence of inflationary signs: Considering that transactions in the informal economy rely on liquid money, an increase in the size of this economy means there is excess money supply leaking outside the banking system. This results in an abnormal increase in prices and the emergence of inflation in its various forms.
- ✓ Imbalance between savings and consumption: One of the manifestations of working in the informal economy is money laundering. The resulting flight of capital abroad creates an imbalance between savings and consumption, forcing the state to engage in external transfers, thereby increasing indebtedness.
- ✓ Monetary instability (exchange rate): Dealing in foreign currencies through buying, selling, and saving outside the formal economy circle will contribute to the emergence of monetary imbalance.

As for the social aspect, the main effects of the informal economy can be summarized in the following points: (Mohammed, 2011, page 210)

- ✓ Affecting those with fixed incomes (taxes at source): The emergence of individuals with undeclared incomes who aspire to form a social class aiming to reach the highest levels of the social ladder in society, without exerting any effort or making sacrifices. This phenomenon is often a characteristic of developing countries.
- ✓ Distorting the existing social structure by introducing bad habits and new rules unfamiliar to society, hindering development, such as

deepening consumer culture, abandoning economic rationality in spending, etc.

- ✓ The spread of corruption in all its forms and the increase in economic and non-economic crimes.

1-2-2-Diagnosing the developmental trend of the informal economy in Algeria:

The oil shock that hit the Algerian economy in 1986 is considered the cause for the birth and emergence of informal economic activities. As we mentioned, this was due to the oil crisis that led to the deterioration of macroeconomic conditions (decrease in export income - increase in debt - currency devaluation - decrease in economic growth - increase in unemployment rate - increase in inflation rate, etc.). All these negative factors pushed Algeria to adopt comprehensive reforms that resulted in a shift from a socialist system to a market economy system. This transition in the system helped in the growth of informal activities that came to meet the needs of individuals, especially the unemployed. Below, we can illustrate the percentage of informal economy development in relation to the total GDP in Algeria during the period 2008-2022.

Table(03): The Informal Economy in Algeria for the Period 2008-2022

Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
INFO	31.1	30.6	30.5	30	30.2	30.2	29.5	29.2
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
INFO	29.1	28.8	28.6	28.3	27.7	30.9	31	

Source: (www.worldBank.org)

The data in Table 1 indicates that the informal economy as a percentage of GDP in Algeria was estimated at the beginning of the study period at 31.1% of the total GDP. It then decreased slightly by about 0.5% in 2009, 0.1% in 2010, and 0.5% in 2011. It began to rise in 2012, followed by a stable increase of about 0.2% during 2012 and 2013. Then it declined again until it reached 27.7% in 2020, before rising to 30.9% and then to 31% in 2021 and 2022 respectively.

Table (04): Key indicators of the prevalence of the informal economy in Algeria for the period 2008-2022

Index / Year	**Unemployment rate**	**Corruption Perceptions Index**		**Inflation rate**
		Index score	**Ranking**	
2008	11.33	3.2	92 Out of 180	4.85
2022	12.94	3.3	116 Out of 180	9.26

Source: Prepared by the two researchers based on Appendix 1.

The growth of the informal economy in Algeria during the period 2008-2022, which averaged 29.71%, is due to economic and social conditions, the most important of which are:

- ✓ The rise in unemployment rate, which is attributed to the significant disparity between the number of job seekers and the number of positions created annually. The unemployment rate in Algeria exceeded the threshold of 12.90% by the end of 2022.
- ✓ The spread of bribery and corruption, especially in public administrations, which places Algeria among the group of countries lagging in transparency and anti-corruption efforts. According to the Corruption Perceptions Index, Algeria ranked 116th out of 180 countries in 2022.
- ✓ The increasing demographic growth rate, rising living costs, and low income levels. This can be inferred from the inflation rate indicator, which reached 9.26% in 2022.
- ✓ Tax evasion and higher returns from work in the informal market compared to formal employment.

2- The Relationship Between Digital Financial Inclusion and the Informal Economy

It is known that financial inclusion refers to providing financial and banking services to all segments of society, including individuals and small businesses, in an accessible and affordable manner. Although financial inclusion seeks to integrate all economic sectors into the formal financial system, a large part of the economy is considered informal and not fully included in official financial systems. This includes activities that take place outside the legal or regulatory framework, such as random trade, unregistered tax activities, or informal work. This usually results from the insufficient availability of traditional financial services, such as bank accounts and bank loans, which leads individuals to resort to informal and unmonitored optio

Financial inclusion can play a role in reducing the informal economy by offering financial services at reasonable and appropriate prices, as well as encouraging individuals and companies to join the formal financial system. This increases their inclusion and reduces reliance on unmonitored

activities. It can also contribute to improving the economic environment by increasing productivity and economic growth, as individuals and companies can access financial resources that support expansion and investment in a sustainable and legal manner. Therefore, although there is a relationship between financial inclusion and the informal economy, the primary goal of financial inclusion is to promote economic growth and improve the financial conditions of individuals and communities in general.

Considering that electronic bank cards and ATMs are among the indicators of digital financial inclusion, their contribution to the decline of the informal economy is evident in several key points, including:

- ✓ **Reducing cash transactions and informal trade:** The use of electronic bank cards and ATMs allows individuals and companies to conduct financial transactions within the banking system framework without the need for cash transactions. This reduces the volume of cash transactions that occur in the informal economy, where such transactions can be less transparent and more difficult for authorities to track.
- ✓ **Increasing transparency and monitoring:** The use of electronic bank cards helps record every financial transaction that passes through the financial system, which increases economic transparency and aids in tracking financial operations. This enhances the ability to combat financial fraud and tax evasion, which are manifestations of the informal economy.

In general, it can be said that electronic bank cards and ATMs play an important role in reducing the size of the informal economy by enhancing transparency, encouraging the use of the formal financial system, promoting financial security, and more. However, some forms of the informal economy may persist due to multiple economic and social factors, but digital technology plays a role in reducing them and minimizing their negative impact.

3- Economic Analysis of the Impact of Digital Financial Inclusion on the Informal Economy in Algeria

3-1 The Model and Study Variables

To achieve the study's objective of measuring the impact of digital financial inclusion on the informal economy in Algeria during the period 2008-2022 using semi-annual data, a threshold regression model will be used

(TR)Threshold Regression**,** According to Hansen (1999, 2001) and Potter (2003), the threshold model relies on determining the number of changes m (number of regimes m+1) using one of the threshold estimation methods. Assuming that the threshold model takes one threshold and two regimes, the mathematical formula is written as follows: (Chibi, Ben Bouziane, & Sidi Mohammed, 2016, P 83)**.**

$$Y_t = (\beta_{0,1} + \beta_{1,1}X_{t-1} + \cdots + \beta_{p1,1}X_{t-p1})(1 - I(q_t \leq c) + \big(\beta_{0,2} + \beta_{1,2}X_{t-1} + \cdots\ldots + \beta_{p2,2}X_{t-p2}\big)\big(1 - I(q_t > c)\big) + \varepsilon_t$$

Where: ε_t: The random term , c: The threshold value, q_t: The transition variable, also called the threshold variable, I:The transition function that takes values(1 ،0) , X_t: The explanatory variables, Y_t:The dependent variable.

The study also relied on Principal Component Analysis (PCA) technique and unit root testing for time series.

As for the model adopted in the study, the informal economy ($Info_t$)will be a function of the digital financial inclusion variable (Fl_t), which is the threshold variable, trade openness ($Open_t$), rule of law (Ru_t), unemployment rate (UNM_t), according to the following mathematical relationship:

$$Info_t = \begin{cases} \beta_0 + \beta_{11}Fl_t + \beta_2 Open_t + \beta_3 Ru_t + \beta_4 UNM_t + \varepsilon_t & . \ if \ Fl < c \\ \beta_0 + \beta_{12}Fl_t + \beta_2 Open_t + \beta_3 Ru_t + \beta_4 UNM_t - \varepsilon_t & . \ if \ Fl \geq c \end{cases}$$

Where:

β_{11}: The parameter of the digital financial inclusion indicator in the first regime before reaching the threshold.

β_{12}: The parameter of the digital financial inclusion indicator in the second regime after reaching the threshold.

c: The threshold value.

3-2- Analysis and Discussion of Results

3-2-1-Constructing the Digital Financial Inclusion Index: As previously mentioned, the financial inclusion index generally has several dimensions (the dimension of financial services usage, the dimension of access to financial services, and the quality dimension). Given that the focus of this study's issue is on digital financial inclusion, we will limit ourselves to the dimension of access to financial services (number of electronic cards, electronic payment devices, and number of ATMs), which will be constructed using the Principal Component Analysis technique.

Table (05): Results of Principal Component Analysis (PCA) for Digital Financial Inclusion

Principal Components Analysis
Date: 06/25/24 Time: 16:27
Sample (adjusted): 2008Q1 2022Q1
Included observations: 57 after adjustments
Balanced sample (listwise missing value deletion)
Computed using: Ordinary correlations
Extracting 3 of 3 possible components

Eigenvalues: (Sum = 3, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	2.578185	2.179500	0.8594	2.578185	0.8594
2	0.398685	0.375556	0.1329	2.976871	0.9923
3	0.023129	---	0.0077	3.000000	1.0000

Source : Prepared by Researchers Based on EViews13 Outputs

It is evident from the above table that Component (1) is the highest component in terms of explanatory power compared to the other components. This component represents the best linear combination of the digital financial inclusion variables used, according to the weighting coefficient. It explains 85.94% of the total variance of the original data. Therefore, it is the only component that will be adopted as the constituent component of the digital financial inclusion index**.**

3-2-2- Unit Root Test for Study Variables

The study by (Perron, 1989) indicated a clear link between the unit root and the presence of a structural break. Therefore, in this case, the unit root test in its usual form cannot be relied upon, as it is considered biased towards rejecting the alternative hypothesis in the case of data series containing a stationary trend and structural breaks. The series may be stationary, but tests may prove it to be non-stationary due to the presence of

a structural break in one of the years. (Wissam Abdel Fattah Suleiman, 2024, PP 345-346).

The following table demonstrates the results of the Augmented Dickey-Fuller (ADF) unit root test, taking into account the presence of fixed structural breaks, with the Schwarz criterion selected to determine the optimal lag periods**:**

Table (06): Results of the Structural Unit Root Test for Study

	At Level	1 different	2 different	History of structural fracture
	ADF. Stat	ADF. Stat	ADF. Stat	
Info	-3.488097 (0.6993)	-5.518550 (<0.01))	-	2020S2
Fl	-6.290770 (<0.01)	-	-	2019S1
Open	-4.917337 (0.0421)	-		2021S2
Ru	-4.509011 (0.1277)	-5.206977 (0.0174)	-	2018S2
UNM	-3.639005 (0.6042)	-4.312078 (0.2033)	-8.614675 (<0.01)	2020S2

Source : Prepared by Researchers Based on EViews13 Outputs

It is evident from the results of the above table that the study variables are stationary at the second difference, except for the Rule of Law variable (Ru), which is stationary at the level.

After confirming through the unit root test that the time series specific to the model contain a structural break, the next step involves estimating the Threshold Regression (TR) using Hansen's model, considering that the latter is used to estimate models with structural breaks and is a non-linear model.

3-2-3- Estimating the Threshold Regression (TR):

Before estimating the TR model, it is necessary to determine the optimal number of regimes for the model through the Bai and Perron (2003) test. This test allows for determining threshold values from 1 to m thresholds against the total number of estimated thresholds (m+1 Thresholds vs. Global) and selecting the threshold through the highest significance of Fisher's statistic (Highest significant).

Table (07): Results of the Structural Changes Test (Bai and Perron)

Current threshold calculations:

Multiple threshold tests
Bai-Perron tests of L+1 vs. L sequentially determined thresholds
Date: 06/26/24 Time: 11:21
Sample: 2008S1 2022S1
Included observations: 29
Threshold variable: FL
Threshold varying variables: FL OPEN RU UNM
Threshold test options: Trimming 0.20, Max. thresholds 3, Sig. level 0.05
Test statistics employ HAC covariances (Bartlett kernel, Newey-West fixed bandwidth) assuming common data distribution

Sequential F-statistic determined thresholds: 1

Threshold Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	1542.222	6168.890	15.67
1 vs. 2	4.309386	17.23754	17.61

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Source : Prepared by Researchers Based on EViews13 Outputs

It is evident from the previous table that, at a 5% significance level, the optimal number of regimes for the regression model is two regimes, which means there is one threshold**.**

Therefore, the results of the threshold regression model for the relationship between digital financial inclusion and the informal economy during the period 2008 S1-2020 S2 can be illustrated through the following table**:**

Table (08): Results of Estimating the Parameters of the Threshold Model (TR)

Dependent Variable: INFO
Method: Discrete Threshold Regression
Date: 06/27/24 Time: 09:44
Sample (adjusted): 2008S1 2022S1
Included observations: 29 after adjustments
Selection: Trimming 0.20, Max. thresholds 3, Sig. level 0.05
Threshold variable: FL
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	FL < 2.219274 -- 23 obs			
FL	-0.534771	0.573323	-0.932756	0.3615
OPEN	0.515888	0.088584	5.823692	0.0000
RU	-0.181406	2.977775	-0.060920	0.9520
UNM	1.110497	0.261255	4.250623	0.0004
	2.219274 <= FL -- 6 obs			
FL	-0.462751	0.005153	-89.79797	0.0000
OPEN	-0.848967	0.000610	-1391.113	0.0000
RU	-27.95648	0.041931	-666.7228	0.0000
UNM	2.306397	0.003951	583.7638	0.0000

R-squared	0.757731	Mean dependent var	29.67453
Adjusted R-squared	0.676975	S.D. dependent var	1.024514
S.E. of regression	0.582286	Akaike info criterion	1.985239
Sum squared resid	7.120186	Schwarz criterion	2.362424
Log likelihood	-20.78597	Hannan-Quinn criter.	2.103369

Source : Prepared by Researchers Based on EViews13 Outputs

Through the results of the table above, it is clear that the threshold value (c=2.219274) ranged between**:**

- **FI < 2.219274:** In this regime, the impact of the independent variables on the dependent variable can be interpreted as follows:

- **Digital Financial Inclusion (FI) and Rule of Law (Ru):** Their impact on the informal economy was inverse, which aligns with their theoretical economic logic, but it was not statistically significant at the 5% significance level.

- **Trade Openness (OPEN):** It has a positive and significant impact on the informal economy at the 5% significance level. A 1% increase in trade openness will lead to a 0.515% increase in the informal economy. This can be attributed to several reasons, including:

  - ✓ Engaging in informal trade with neighboring countries to avoid obstacles (restrictions and costs) associated with formal trade, which prevent faster and easier profit realization.
  - ✓ Dealing with unlicensed goods in local markets due to health or environmental reasons, which consequently strengthens the informal market.
  - ✓ Informal cross-border money transfers to avoid banking and cash fees imposed by countries.
  - ✓ Facilitating international trade of counterfeit or fake-branded goods, which can be sold without complying with international intellectual

property rights laws, leading to the strengthening of the informal market.

- Unemployment Rate (UNM): It has a positive and significant impact on the informal economy at the 5% significance level. A 1% increase in the unemployment rate will lead to a 1.11% increase in the informal economy. This result is consistent with economic theory, meaning that an increase in the unemployed population who failed to find work in the formal economy forces them, due to their financial and social circumstances, to seek job opportunities in informal and illegal activities.

- **FI ≥ 2.219274:** In this regime, the impact of the independent variables on the dependent variable can be interpreted as follows:

- Digital Financial Inclusion (FI): It has a negative and significant effect on the informal economy at a 5% significance level. A 1% increase in digital financial inclusion will lead to a 0.46% decrease in the informal economy. This can be explained by the advantages of digital financial services (bank accounts, financing, electronic payment services) in terms of ease of access, lower costs, and reduced risks compared to traditional services. These advantages encourage various economic units to increase their engagement with the digital financial system. On the other hand, it reduces the need for unrecorded cash transactions that promote the informal economy. This ultimately leads to fewer opportunities for engaging in informal activities.

-Trade Openness (OPEN): It has a negative and significant effect on the informal economy at a 5% significance level. A 1% increase in trade openness will lead to a 0.84% decrease in the informal economy. This can be attributed to several reasons, including:

- ✓ Stimulating Foreign Direct Investment: Trade openness brings in foreign capital and direct investments, which strengthens the formal economy by providing job opportunities, improving infrastructure, and increasing productivity. All these factors reduce the need to rely on the informal economy as a source of income.
- ✓ Providing Formal Economic Opportunities: Trade openness can open doors for various economic units to participate in economic activities through legal and formal means, such as exporting, importing, and investing in different sectors. This increases the

opportunities available in the formal economy and reduces the need to work in informal sectors.

- ✓ Improving the Business Environment: Trade openness usually promotes improvements in the business environment through economic policy reforms and simplification of trade procedures. This reduces administrative and financial costs for companies, encouraging them to operate formally and increasing the growth of the formal private sector.
- ✓ Reducing Illegal Trade: By improving trade laws and formal transactions, trade openness can contribute to reducing illegal trade or black market activities. This decreases informal activities and increases preference for organized and registered commercial transactions.

- Rule of Law (Ru): It has a negative and significant effect at the 5% significance level. A 1% increase in the government's rule of law will lead to a 27.95% decrease in the informal economy. This can be explained by the fact that the government's strictness in performing its duties and its ability to regulate the market through establishing a clear legal framework for economic activities would contribute to a decline in the size of the informal economy.

Furthermore, the government's adoption of a set of laws that encourage improving the business environment, such as simplifying administrative procedures and providing protection for small and medium-sized enterprises, will lead to a reduction in reliance on informal activities.

-Unemployment Rate (UNM): It has a positive and significant effect at the 5% significance level. A 1% increase in the unemployment rate will lead to a 2.30% increase in the informal economy. This means that the announced unemployment rates are not the actual rates, but rather there is a working group active in the economy in an informal manner. The more people join this group, the greater its positive impact on the informal economy. On the other hand, rising unemployment rates lead to an increase in commercial concealment in general, such as concealing expatriate workers or irregular employment, which increases the size of the informal economy.

Despite the financial and economic potential in Algeria, the World Bank's statistics indicate that the unemployment rate in 2022 (12.49%) is higher than it was in 2008 (11.33%).

Conclusion:

Through the study's issue, which focused on measuring the impact of digital financial inclusion on the size of the informal economy in Algeria during the period 2008-2022 using semi-annual data and the Threshold Regression (TR) model, it was possible to conclude that when the digital financial inclusion index is less than 2.219274% semi-annually, it will not have a significant effect on the informal economy in Algeria. However, if it exceeds the threshold of 2.219274% semi-annually, it will have a negative and significant effect on the informal economy. The parameter of digital financial inclusion according to this system was estimated at 0.46, which means that a 1% increase in digital financial inclusion will lead to a 0.46% decrease in the informal economy. This can be explained by the fact that the advantages of digital financial services (bank accounts, financing, electronic payment services) in terms of ease of access, costs, and risks, which are lower compared to traditional services, encourage various economic units to increase their interaction with the digital financial system. On the other hand, it reduces the need for unrecorded cash transactions that promote the informal economy, which ultimately leads to reducing opportunities for informal activities.

Based on the previous results, the following recommendations can be made:

-Facilitate administrative procedures for the transformation of activities that are not under state control, especially small projects, to integrate them into the formal sector.

- Diversify and develop financial services to suit the requirements of individuals in remote and poor areas, with the aim of providing innovative and low-cost services and facilitating the financing of small projects.

Bibliography

1.OCDE. (2003). Manuel sur la mesure de sur la mesure de l' économie non observée, Service des Publications de l' OCDE. OCDE.

2. Riha, S. M., & Niyaz Panakaje , (2022). A study on the Prospects and challenges of Digital Financial Inclusion. *International journal of Case studies in Business IT and education*,6 (2). PP. 469-480.

3. www.worldBank.org.(15-06-2024)

4. Lee-Ying Tay, Hen-Toong Tai, Gek-Siang Tan. (2022). Digital finanacial inclusion: Agateway to sustainable development. *Heliyon* . 8(2) PP. 1-10.

5.Zaâlani, Mohamed. (2011). The inclusiveness of the parallel economy phenomenon with reference to the Algerian economy (establishing the meaning - research on causes and effects). Economic and Administrative Research, 5(2), PP. 196-213.

6.Abderrahim Chibi, Mohamed Benbouziane, and Chekouri Sidi Mohamed. (2016). Using non-linear modeling in quantitative analysis to explain economic phenomena. Journal of Economic and Financial Research, PP. 73-96.

7.Friedrich Schneider and Dominik Enste. (2002). Hiding in the Shadows: The Growth of the Underground Economy. Economic Issues Series, No. 30. International Monetary Fund. P. 02.

8.Publications of the National Economic and Social Council. (2004). The Informal Sector: Illusions and Realities.

9. Wesam Abdel Fattah Soliman Abdallah Al-Naggar. (2024). The Threshold Effect of Monetary Policy on Inflation in Egypt during the Period 2000-2022. Scientific Journal of Financial and Commercial Studies and Research. 5(2). PP. 319-360.