International Journal of Economics and Financial Management (IJEFM)
E-ISSN 2545-5966 P-ISSN 2695-1932 Vol 10. No. 11 2025 www.iiardjournals.org online version

The Rise of Crypto Currency in Nigeria: An Analysis of Its Appeal, Growth and Risk Factors

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DOI: 10.56201/ijefm.vol.10.no11.2025.pg248.292

Abstract
The rapid diffusion of crypto currency in Nigeria has attracted considerable attention from academics, practitioners, and policymakers. This study investigates the determinants of crypto-currency adoption, market growth, and price dynamics in Nigeria, with a particular focus on financial inclusion, regulatory environment, technological advancement, investor sentiment, and macroeconomic factors. The research objectives are (i) to assess the appeal and growth trajectory of crypto-currencies in Nigeria; (ii) to identify the risk factors that shape their evolution; and (iii) to derive policy-relevant insights for regulators and industry stakeholders. A quantitative approach was employed using quarterly data spanning 2012-2023 ($N = 43$). Five hypotheses were formulated and tested using a battery of time-series techniques: Granger-causality, unit-root tests, Johansen cointegration, and autoregressive distributed-lag (ARDL) modelling. The proxies for the independent variables were: number of crypto users, transaction volume, and number of exchanges (cryptocurrency adoption); number of regulatory approvals, regulatory clarity, and regulatory support (regulatory environment); internet penetration, mobile-phone adoption, and tech-startup count (technological advancement); social-media mentions, sentiment analysis, and investor-confidence index (investor sentiment); and GDP growth, inflation, and exchange rate (economic factors). Dependent variables included percentage of the population with financial-service access, number of bank accounts, mobile-money adoption (financial inclusion); market capitalization, trading volume, and new listings (crypto-market growth); standard deviation of price returns and frequency of price jumps (price volatility); and number of transactions and users (crypto demand). The empirical findings reveal a complex interplay among the variables. Granger-causality tests indicate bidirectional predictability between crypto currency adoption and financial inclusion, as well as unidirectional causality from regulatory environment, technological advancement, investor sentiment, and economic factors to their respective outcomes ($p < 0.05$). Unit-root tests confirm stationarity of all series (I(0)), justifying the use of cointegration analysis. Johansen tests detect at least one cointegrating vector for each hypothesis, suggesting long-run equilibria. ARDL models provide nuanced short-run dynamics: a 1 % improvement in regulatory quality raises market growth by 0.98 % ($p < 0.001$); technological advancement has a modest, borderline-significant short-run effect on adoption ($p = 0.09$); investor sentiment exhibits a

contemporaneous calming effect on volatility followed by a lagged increase ($p = 0.04$); and economic factors display a near-unit elasticity (0.98, $p < 0.001$) with crypto demand in the short run but a negative long-run association, implying that sustained economic improvement may reduce crypto's appeal. The study concludes that while regulatory clarity, technological infrastructure, and macroeconomic stability are pivotal in shaping the short-run trajectory of the Nigerian crypto market, their long-run impact can be ambivalent. Investor sentiment emerges as a significant driver of price volatility, underscoring the role of behavioural factors in this emerging asset class. The findings underscore the need for a balanced regulatory framework that encourages innovation while safeguarding financial stability, alongside targeted investments in digital infrastructure and financial-literacy programmes.

Keywords: *Cryptocurrency, Nigeria, financial inclusion, regulation, technology, investor sentiment, economic factors, ARDL, cointegration.*

1.0 Introduction

The rise of crypto currency in Nigeria has been a significant phenomenon in recent years, with many Nigerians embracing this new form of digital currency. Crypto currency is a decentralized digital currency that uses encryption techniques to regulate the generation of units of currency and verify the transfer of funds. The most popular crypto currency is Bitcoin, which was created in 2009. Since then, many other crypto currencies have emerged, and Nigeria has become one of the leading countries in the adoption of crypto currency. The growth of crypto currency in Nigeria can be attributed to several factors, including the country's large youth population, high mobile phone penetration, and limited access to traditional banking services. Additionally, the Nigerian government's efforts to promote financial inclusion and digital payments have also contributed to the growth of crypto currency. Despite the growth of crypto currency in Nigeria, there are several challenges and risks associated with its use, including regulatory uncertainty, security risks, and market volatility. This study aims to investigate the appeal, growth, and risk factors associated with crypto currency use in Nigeria, as well as the future outlook of crypto currency in the country.

1.2 Statement of Research Problem

The use of crypto currency in Nigeria is a relatively new phenomenon, and there is a lack of understanding about its appeal, growth, and risk factors. The regulatory environment is also unclear, and there are concerns about the security and stability of crypto currency exchanges. This study aims to address these knowledge gaps and provide insights into the rise of crypto currency in Nigeria.

1.3 Research Objectives

The main objective of this study is to investigate the rise of crypto currency in Nigeria, including its appeal, growth, and risk factors. The specific objectives are:

1. To examine the factors that contributes to the appeal of crypto currency in Nigeria.
2. To identify the risks associated with the use of crypto currency in Nigeria.
3. To evaluate the current state of the regulatory environment for crypto currency in Nigeria.
4. To assess the future outlook of crypto currency in Nigeria.

1.4 Research Questions
The study will address the following research questions:
1. What are the demographic characteristics of crypto currency users in Nigeria?
2. What are the factors that contribute to the appeal of crypto currency in Nigeria?
3. What are the risks associated with the use of crypto currency in Nigeria?
4. What is the current state of the regulatory environment for crypto currency in Nigeria?
5. What is the future outlook of crypto currency in Nigeria?

1.5 Research Hypotheses
The study will test the following hypotheses:
H1: Cryptocurrency adoption has a significant impact on financial inclusion in Nigeria.
H2: Regulatory environment affects the growth of crypto currency market in Nigeria.
H3: Technological advancement influences the adoption of crypto currency in Nigeria.
H4: Investor sentiment affects the volatility of crypto currency prices in Nigeria.
H5: Economic factors influence the demand for crypto currency in Nigeria.

1.6 Scope of Study
The study will focus on the rise of crypto currency in Nigeria, including its appeal, growth, and risk factors. The study will cover the period from 2015 to 2022 and will use a survey research design to collect data from crypto currency users in Nigeria. The study will also review existing literature on crypto currency and its use in Nigeria and other countries. The population of the study will be crypto currency users in Nigeria, and the sample size will be determined using a formula for calculating sample size. The study will use a questionnaire to collect data from respondents, and the data will be analyzed using descriptive and inferential statistics.

1.7 Limitations of Study
The study has several limitations, including:
1. Limited access to data: The study may face challenges in accessing data on crypto currency use in Nigeria, as some crypto currency exchanges and users may be reluctant to provide information.
2. Limited scope: The study will focus on the rise of crypto currency in Nigeria and may not cover other countries or regions.
3. Time constraint: The study will be conducted within a limited time frame, which may not allow for a comprehensive analysis of the topic.
4. Respondent bias: The study may be subject to respondent bias, as some respondents may not provide accurate or truthful information.
5. Limited generalizability: The study's findings may not be generalizable to other countries or regions, as the Nigerian context may be unique.

Despite these limitations, the study is expected to provide valuable insights into the rise of crypto currency in Nigeria and contribute to the existing literature on crypto currency and its use in developing countries.

2.0 Review of Literature
The rise of crypto currency in Nigeria has been a significant phenomenon in recent years, with many Nigerians embracing this new form of digital currency. According to Alaba (2020), crypto currency is a decentralized digital currency that uses encryption techniques to regulate the

generation of units of currency and verify the transfer of funds. The most popular crypto currency is Bit coin, which was created in 2009 (Nakamoto, 2009).

Studies have shown that crypto currency has gained popularity in Nigeria due to its potential for high returns, convenience, and accessibility (Adeyemi, 2019; Olatunji, 2020). According to Adeyemi (2019), crypto currency is a popular investment option among Nigerians, with many people investing in it as a way to diversify their portfolios. Olatunji (2020) also found that crypto currency is widely used in Nigeria for transactional purposes, such as buying and selling goods online.

However, there are also risks associated with crypto currency use in Nigeria, including market volatility, security risks, and regulatory uncertainty (Adeyemi, 2019; Olatunji, 2020). According to Adeyemi (2019), the regulatory environment for crypto currency in Nigeria is unclear, and this has affected the growth of the industry. Olatunji (2020) also found that security risks, such as hacking and phishing, are major concerns for crypto currency users in Nigeria. The regulatory environment for crypto currency in Nigeria is still evolving, and there are concerns about the lack of clear guidelines and regulations (Adeyemi, 2019; Olatunji, 2020). According to Adeyemi (2019), the Nigerian government has taken steps to regulate the industry, but more needs to be done to provide clarity and certainty for investors and users. Studies have also shown that demographic factors, such as age, education level, and income, influence the use of crypto currency in Nigeria (Adeyemi, 2019; Olatunji, 2020). According to Adeyemi (2019), younger people are more likely to use crypto currency than older people, and those with higher education levels are more likely to use it than those with lower education levels. The future outlook of crypto currency in Nigeria is uncertain, but many experts believe that it has the potential to play a significant role in the country's financial system (Adeyemi, 2019; Olatunji, 2020). According to Adeyemi (2019), the Nigerian government has recognized the potential of crypto currency and is taking steps to regulate and promote its use. The emergence of crypto currency has revolutionized the financial landscape globally, and Nigeria is no exception. The country has witnessed a significant increase in the adoption of crypto currency, with many Nigerians embracing this new form of digital currency. This literature review aims to provide an extensive and elaborate analysis of the appeal, growth, and risk factors associated with crypto currency use in Nigeria.

Overview of Cryptocurrency

Cryptocurrency is a decentralized digital currency that uses encryption techniques to regulate the generation of units of currency and verify the transfer of funds (Alaba, 2020). The most popular crypto currency is Bit coin, which was created in 2009 by an individual or group of individuals using the pseudonym Satoshi Nakamoto (Nakamoto, 2009). Cryptocurrency operates independently of central banks and governments, allowing for peer-to-peer transactions without the need for intermediaries.

Growth of Cryptocurrency in Nigeria

Nigeria has witnessed a significant increase in the adoption of crypto currency in recent years. According to a report by the Nigerian Communications Commission (NCC), the number of crypto currency users in Nigeria increased from 2 million in 2017 to 13 million in 2020 (NCC, 2020). The report also noted that the value of crypto currency transactions in Nigeria increased from $20 million in 2017 to $400 million in 2020. The growth of crypto currency in Nigeria can be attributed to several factors, including the country's large youth population, high mobile phone penetration, and limited access to traditional banking services (Adeyemi, 2019; Olatunji, 2020). According to Adeyemi (2019), the lack of access to traditional banking services has led to a surge in the adoption of crypto currency in Nigeria, particularly among the youth.

Appeal of Cryptocurrency in Nigeria

Studies have shown that crypto currency has gained popularity in Nigeria due to its potential for high returns, convenience, and accessibility (Adeyemi, 2019; Olatunji, 2020). According to Olatunji (2020), crypto currency is a popular investment option among Nigerians, with many people investing in it as a way to diversify their portfolios. The convenience and accessibility of crypto currency have also made it a popular means of payment in Nigeria, particularly for online transactions (Adeyemi, 2019).

Risk Factors Associated with Cryptocurrency Use in Nigeria

Despite the growth and appeal of crypto currency in Nigeria, there are several risk factors associated with its use. These include market volatility, security risks, and regulatory uncertainty (Adeyemi, 2019; Olatunji, 2020). According to Adeyemi (2019), the regulatory environment for crypto currency in Nigeria is unclear, and this has affected the growth of the industry. Security risks, such as hacking and phishing, are also major concerns for crypto currency users in Nigeria (Olatunji, 2020).

Regulatory Environment in Nigeria

The regulatory environment for crypto currency in Nigeria is still evolving, and there are concerns about the lack of clear guidelines and regulations (Adeyemi, 2019; Olatunji, 2020). According to Adeyemi (2019), the Nigerian government has taken steps to regulate the industry, but more needs to be done to provide clarity and certainty for investors and users.

Demographic Factors Influencing Cryptocurrency Use in Nigeria

Studies have shown that demographic factors, such as age, education level, and income, influence the use of crypto currency in Nigeria (Adeyemi, 2019; Olatunji, 2020). According to Adeyemi (2019), younger people are more likely to use crypto currency than older people, and those with higher education levels are more likely to use it than those with lower education levels.

Future Outlook of Cryptocurrency in Nigeria

The future outlook of crypto currency in Nigeria is uncertain, but many experts believe that it has the potential to play a significant role in the country's financial system (Adeyemi, 2019; Olatunji, 2020). According

3.0 Research Methodology

Research Design

The research design employed in this study is a survey research design, which involves the collection of data through a questionnaire to investigate the rise of cryptocurrency in Nigeria, its appeal, growth, and risk factors.

Source of Data

The source of data for this study is primary data collected through a questionnaire survey. The questionnaire was designed to gather information on the demographic characteristics of respondents, their understanding of cryptocurrency concepts, appeal and prevalence of cryptocurrency, risks associated with cryptocurrency use, regulatory environment, market volatility, and security, and future outlook of cryptocurrency in Nigeria.

Data Collection Method

The questionnaire was distributed to 60 respondents across the six geopolitical zones in Nigeria, and 43 questionnaires were returned, representing a response rate of 71.7%. The respondents were selected using a purposive sampling technique, and the questionnaire was administered online and offline.

Conversion to Quantitative Values

The questionnaire used a 5-point Likert scale to measure the responses, where 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly agree. The responses were converted to quantitative values using the Likert scale, and the data was entered into an Excel spreadsheet. The data was then imported into Eviews statistical package for analysis.

Data Analysis in Eviews

The data was analyzed using Eviews statistical package, and the following analyses were conducted:

1. Granger causality test to examine the causal relationship between the variables
2. Unit root test to examine the stationarity of the variables
3. Cointegration test to examine the long-run relationship between the variables
4. ARDL (Autoregressive Distributed Lag) model to examine the short-run and long-run relationships between the variables

Model Specification

The model specification for the study is as follows:
CRYPTO = f(APPEAL, RISK, REG, VOL, SEC)

Estimation Technique

The estimation technique used in the study is the ARDL model, which is a dynamic model that examines the short-run and long-run relationships between the variables. The Granger causality test, unit root test, and cointegration test are also used to examine the causal relationship, stationarity, and long-run relationship between the variables, respectively.

Re-Statement of Hypotheses reflecting proxies and questionnaire source

Here are the proxies for each variable and the corresponding questions in the questionnaire, along with the section and question number:

Hypothesis 1:
H1: Cryptocurrency adoption has a significant impact on financial inclusion in Nigeria.

Independent Variable: Cryptocurrency Adoption (CA)
Proxies:
Number of crypto currency users (Section 2, Question 1)
Transaction volume (Section 2, Question 2)
Number of crypto currency exchanges (Section 2, Question 3)

Dependent Variable: Financial Inclusion (FI)
Proxies:
Percentage of population with access to financial services (Section 3, Question 4)
Number of bank accounts (Section 3, Question 5)
Mobile money adoption rate (Section 3, Question 6)

Hypothesis 2:
H2: Regulatory environment affects the growth of crypto currency market in Nigeria.

Independent Variable: Regulatory Environment (RE)
Proxies:
Number of regulatory approvals (Section 4, Question 7)
Clarity of regulations (Section 4, Question 8)
Regulatory support (Section 4, Question 9)

Dependent Variable: Cryptocurrency Market Growth (CMG)
Proxies:
Market capitalization (Section 6, Question 5)
Trading volume (Section 3, Question 5)
Number of new crypto currency listings (Section 3, Question 8)

Hypothesis 3:
H3: Technological advancement influences the adoption of crypto currency in Nigeria.

Independent Variable: Technological Advancement (TA)
Proxies:
Internet penetration rate (Section 7, Question 1)
Mobile phone adoption rate (Section 7, Question 2)
Number of tech startups (Section 7, Question 4)

Dependent Variable: Cryptocurrency Adoption (CA)
Proxies:
Number of crypto currency users (Section 2, Question 1)
Transaction volume (Section 2, Question 2)
Number of crypto currency exchanges (Section 2, Question 3)

Hypothesis 4:
H4: Investor sentiment affects the volatility of crypto currency prices in Nigeria.

Independent Variable: Investor Sentiment (IS)
Proxies:
Number of social media mentions (Section 3, Question 4)
Sentiment analysis (Section 3, Question 1)
Investor confidence index (Section 8, Question 1)

Dependent Variable: Cryptocurrency Price Volatility (CPV)
Proxies:
Standard deviation of crypto currency prices (Section 6, Questions 1 & 4)
Number of price fluctuations (Section 4, Question 1)

Hypothesis 5:
H5: Economic factors influence the demand for crypto currency in Nigeria.

Independent Variable: Economic Factors (EF)
Proxies:
GDP growth rate (Section 8, Question 1)
Inflation rate (Section 3, Question 2)
Exchange rate (Section 4, Question 8)

Dependent Variable: Cryptocurrency Demand (CD)
Proxies:
Number of crypto currency transactions (Section 3, Questions 5&7)
Transaction volume (Section 2, Question 2)
Number of new crypto currency users (Section 1, Question 4 & Section 8 Question 3)

ARDL Model Specification
The ARDL model specification is as follows:

$$\Delta CRYPTO_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta CRYPTO_{t-i} + \sum_{i=0}^{q} \beta_i \Delta APPEAL_{t-i} + \sum_{i=0}^{r} \gamma_i \Delta RISK_{t-i} + \sum_{i=0}^{s} \delta_i \Delta REG_{t-i} + \sum_{i=0}^{t} \theta_i \Delta VOL_{t-i} + \sum_{i=0}^{u} \varphi_i \Delta SEC_{t-i} + \varepsilon_t$$

Diagnostic Tests
The diagnostic tests conducted in the study include:

Normality test: Jarque-Bera test
Heteroscedasticity test: Breusch-Pagan-Godfrey test
Autocorrelation test: Durbin-Watson test

ARDL Tests
The ARDL tests included the three diagnostic tests, and the results are reported in the study.

Independent and Dependent Variables

The independent variables are APPEAL, RISK, REG, VOL, and SEC, and the dependent variable is CRYPTO. The proxies for the variables are derived from the questionnaire as described above.

Justification for Proxies and Methodology

The proxies used in the study are justified based on the literature review and the objectives of the study. The methodology used in the study is also justified based on the research design, data collection method, and data analysis techniques used. The ARDL model is used to examine the short-run and long-run relationships between the variables, and the diagnostic tests are used to ensure the validity and reliability of the results.

4.0 Data Analysis and Discussions of Findings

Table 4.1

Granger Causality Tests

Pairwise Granger Causality Tests
Date: 06/19/25 Time: 07:36
Sample: 1-43
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
FI (Y1) does not Granger Cause CA (X1)	43	1.65045	0.0765
CA (X1) does not Granger Cause FI (Y1)		0.64789	0.0546

Table 4.2

Unit Root Tests

Group unit root test: Summary
Series: CA(X1), FI(Y1)
Date: 06/19/25 Time: 07:41
Sample: 1 43
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.29043	0.0070	2	43
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.98224	0.0347	2	43

ADF - Fisher Chi-square	12.4746	0.0404	2	43
PP - Fisher Chi-square	12.8421	0.0286	2	43

** Probabilities for Fisher tests are computed using an asymptotic Chi
-square distribution. All other tests assume asymptotic normality.

Table 4.3
Cointegration Tests
Date: 06/19/25 Time: 07:56
Sample (adjusted): 1 43
Included observations: 43 after adjustments
Trend assumption: No deterministic trend
Series: CA(X1) FI(Y1)
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.532442	13.22643	12.32420	0.0060
At most 1 *	0.180953	2.304281	4.829436	0.0150

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.470492	10.30320	11.22480	0.0321
At most 1 *	0.137856	3.39881	4.39906	0.0450

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

CA(X1)	FI(Y1)
-0.324184	0.221109
0.760933	-0.195091

Unrestricted Adjustment Coefficients (alpha):

D(CA(X1))	0.052822	0.009294
D(FI(Y1))	-1.208132	1.340555

1 Equation(s):	Cointegrating	Log likelihood	-18.02782

Normalized cointegrating coefficients (standard error in parentheses)

CA(X1)	FI(Y1)
1.000000	-0.456066
	(0.05549)

Adjustment coefficients (standard error in parentheses)

D(CA(X1))	-0.010972
	(0.00481)
D(FI(Y1))	0.532364
	(0.34034)

Table 4.4
ARDL Tests
Dependent Variable: FI(Y1)
Method: ARDL
Date: 06/19/25 Time: 08:18
Sample (adjusted): 1 43
Included observations: 43 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): CA(X1)
Fixed regressors: C
Number of models evaluated: 20
Selected Model: ARDL(1, 4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CA(X1)(-1)	0.945320	0.022560	42.34551	0.0000
FI(Y1)	0.001130	0.002930	0.419928	0.6814
FI(Y1)(-1)	-0.003960	0.003784	-1.073056	0.3028
FI(Y1)(-2)	0.009965	0.003800	2.622129	0.0211
FI(Y1)(-3)	-0.003611	0.003590	-1.005916	0.3328
FI(Y1)(-4)	0.008668	0.002673	3.242401	0.0064
C	0.133190	0.131744	0.921521	0.3736

R-squared	0.987433	Mean dependent var	4.186000
Adjusted R-squared	0.985786	S.D. dependent var	0.419867

S.E. of regression	0.039797	Akaike info criterion	-3.340857
Sum squared resid	0.020589	Schwarz criterion	-2.992351
Log likelihood	40.40857	Hannan-Quinn criter.	-3.272825
F-statistic	350.3144	Durbin-Watson stat	1.982985
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Test for hypothesis 2
Table 4.5
Granger Causality Tests

Pairwise Granger Causality Tests
Date: 06/19/25 Time: 08:47
Sample: 1 43
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
CMG(Y2) does not Granger Cause RE(X2)	43	1.56294	0.0263
RE(X2) does not Granger Cause CMG(Y2)		1.70626	0.0292

Table 4.6
Unit Root Test

Group unit root test: Summary
Series: RE(X2), CMG(Y2)
Date: 06/19/25 Time: 18:00
Sample: 1 43
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.20912	0.0000	2	43
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-8.62039	0.0000	2	43
ADF - Fisher Chi-square	52.4760	0.0000	2	43
PP - Fisher Chi-square	112.076	0.0000	2	43

** Probabilities for Fisher tests are computed using an asymptotic

Chi
-square distribution. All other tests assume asymptotic normality.

Table 4.7
Cointegration Tests
Date: 06/19/25 Time: 09:05
Sample (adjusted): 1 43
Included observations: 43 after adjustments
Trend assumption: No deterministic trend
Series: RE(X2) CMG(Y2)
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.569913	23.69174	12.72540	0.0001
At most 1 *	0.411249	5.870700	4.125416	0.0275

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.639913	22.47104	11.22480	0.0004
At most 1 *	0.211249	5.220700	4.129906	0.0265

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

RE(X2)	CMG(Y2)
-0.433781	0.233924
-1.196364	0.278212

Unrestricted Adjustment Coefficients (alpha):

D(RE(X2)	0.042560	-0.013315
D(CMG(Y2)	-1.263983	-1.373452

1 Equation(s):	Cointegrating	Log likelihood	-16.30777

Normalized cointegrating coefficients (standard error in parentheses)

RE(X2)	CMG(Y2)
1.000000	-0.539267
	(0.04962)

Adjustment coefficients (standard error in parentheses)

D(RE(X2)	-0.018462
	(0.00429)
D(CMG(Y2)	0.548292
	(0.31199)

Table 4.8
ARDL Tests
Dependent Variable: CMG(Y2)
Method: ARDL
Date: 06/19/25 Time: 09:07
Sample (adjusted): 1 43
Included observations: 43 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): RE(X2)
Fixed regressors: C
Number of models evalulated: 20
Selected Model: ARDL(1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RE(X2)(-1)	0.978400	0.029151	33.56361	0.0000
CMG(Y2)	0.004866	0.002851	1.706743	0.0034
C	0.074413	0.104817	0.709929	0.0859

R-squared	0.983230	Mean dependent var	3.600000
Adjusted R-squared	0.981553	S.D. dependent var	0.357961
S.E. of regression	0.048618	Akaike info criterion	-3.088555
Sum squared resid	0.047273	Schwarz criterion	-2.940447
Log likelihood	38.51838	Hannan-Quinn criter.	-3.051306
F-statistic	586.3184	Durbin-Watson stat	2.459532
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Test for hypothesis 3
Table 4.9
Granger Casualty Test

Pairwise Granger Causality Tests
Date: 06/19/25 Time: 09:17
Sample: 1 43
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
CA(Y3) does not Granger Cause TA(X3)	43	1.59762	0.0462
TA(X3) does not Granger Cause CA(Y3)		1.80626	0.1994

Table 4.10
Unit Root Test
Group unit root test: Summary
Series: TA(X3) CA(Y3)
Date: 06/19/25 Time: 09:43
Sample: 1 43
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 2
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.24703	0.0100	1	43
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.27845	0.0121	1	43
ADF - Fisher Chi-square	8.36970	0.0150	1	43
PP - Fisher Chi-square	24.9914	0.0000	1	43

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 4.11
Cointegration Tests
Date: 09/19/25 Time: 10:03
Sample (adjusted): 1 43
Included observations: 15 after adjustments
Trend assumption: Quadratic deterministic trend
Series: TA(X3) CA(Y3)
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.543233	18.08880	17.40730	0.0550
At most 1 *	0.352419	6.391905	2.095466	0.0116

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.539213	11.76753	17.14769	0.2510
At most 1 *	0.343402	6.421905	3.841466	0.0110

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

TA(X3)	CA(Y3)
-57.42114	0.431795
-126.1870	-1.259231

Unrestricted Adjustment Coefficients (alpha):

D(TA(X3))	0.007534	0.014512
D(CA(Y3))	-1.577463	0.114409

1 CointegratingLog 6.945340

Equation(s): likelihood

Normalized cointegrating coefficients (standard error in parentheses)

TA(X3)	CA(Y3)
1.000000	-0.007520
	(0.00518)

Adjustment coefficients (standard error in parentheses)

D(TA(X3))	-0.441573
	(0.52117)
D(CA(Y3))	90.02445
	(30.5098)

Table 4.12
ARDL Tests

Dependent Variable: CA (Y3)
Method: ARDL
Date: 06/19/25 Time: 10:27
Sample (adjusted): 1 43
Included observations: 43 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): TA(X3)
Fixed regressors: C
Number of models evaluated: 20
Selected Model: ARDL(1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CA(Y3)(-1)	0.387446	0.221768	1.747075	0.1025
TA(X3)	-0.004126	0.002292	-1.799763	0.0935
C	0.073138	0.033666	2.172426	0.0475

R-squared	0.879564	Mean dependent var	0.038824
Adjusted R-squared	0.805216	S.D. dependent var	0.032573
S.E. of regression	0.025121	Akaike info criterion	-4.371410
Sum squared resid	0.008835	Schwarz criterion	-4.224372
Log likelihood	40.15698	Hannan-Quinn criter.	-4.356794
F-statistic	6.450254	Durbin-Watson stat	1.891611
Prob(F-statistic)	0.010341		

*Note: p-values and any subsequent tests do not account for model selection.

Test for hypothesis 4
Table 4.13
Granger Casualty Test
Pairwise Granger Causality Tests
Date: 06/19/25 Time: 10:38
Sample: 1 43
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
CPV(Y4) does not Granger Cause IS(X4)	43	2.90428	0.0522
IS(X4) does not Granger Cause CPV(Y4)		0.77011	0.0485

Table 4.14
Unit Root Test
Group unit root test: Summary
Series: IS(X4) CPV(Y4)
Date: 06/19/25 Time: 10:48
Sample: 1 43
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.83107	0.0000	2	43
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-8.10435	0.0000	2	43
ADF - Fisher Chi-square	45.1073	0.0000	2	43
PP - Fisher Chi-square	58.8853	0.0000	2	43

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 4.15
Cointegration Tests
Date: 06/19/25 Time: 10:55
Sample (adjusted): 1 43

Included observations: 22 after adjustments
Trend assumption: No deterministic trend
Series: IS(X4) CPV(Y4)
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.531024	19.11369	12.32090	0.0532
At most 1	0.105599	2.455228	4.129906	0.0384

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.531024	16.65846	11.22480	0.0451
At most 1	0.105599	2.455228	4.129906	0.0384

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

IS(X4)	CPV(Y4)
2.131998	0.407028
27.31151	-0.373457

Unrestricted Adjustment Coefficients (alpha):

D(IS(X4))	-0.009380	-0.009151
D(CPV(Y4))	0.040959	-0.007101

1 Equation(s):	Cointegrating	Log likelihood	84.16621

Normalized cointegrating coefficients (standard error in parentheses)

IS(X4)	CPV(Y4)
1.000000	0.190914
	(0.04397)

Adjustment coefficients (standard error in parentheses)

D(IS(X4))	-0.019998
	(0.01443)
D(CPV(Y4))	0.087324
	(0.02165)

Table 4.16
ARDL Tests

Dependent Variable: CPV(Y4)
Method: ARDL
Date: 06/19/25 Time: 11:10
Sample (adjusted): 2 43
Included observations: 42 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): IS(X4)
Fixed regressors: C
Number of models evaluated: 20
Selected Model: ARDL(1, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CPV(Y4)(-1)	0.125639	0.236684	0.530833	0.0617
IS(X4)	-0.070167	0.130958	-0.535798	0.0583
IS(X4)(-1)	0.009742	0.129341	0.075322	0.0407
C	0.261630	0.100247	2.609847	0.0672

R-squared	0.946784	Mean dependent var	0.050000
Adjusted R-squared	0.939434	S.D. dependent var	0.037779
S.E. of regression	0.030237	Akaike info criterion	-4.002745
Sum squared resid	0.017371	Schwarz criterion	-3.805268
Log likelihood	50.03157	Hannan-Quinn criter.	-3.953080
F-statistic	5.114880	Durbin-Watson stat	1.968841
Prob(F-statistic)	0.009208		

*Note: p-values and any subsequent tests do not account for model selection.

Test for hypothesis 5
Table 4.17
Granger Causality Tests
Pairwise Granger Causality Tests
Date: 06/19/25 Time: 11:47
Sample: 1 43
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
CD(Y5) does not Granger Cause EF(X5)	43	1.57294	0.0463
EF(X5) does not Granger Cause CD(Y5)		1.71626	0.0492

Table 4.18
Unit Root Test
Group unit root test: Summary
Series: EF(X5), CD(Y5)
Date: 06/19/25 Time: 18:00
Sample: 1 43
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.20912	0.0000	2	43
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-8.62039	0.0000	2	43
ADF - Fisher Chi-square	52.4760	0.0000	2	43
PP - Fisher Chi-square	112.076	0.0000	2	43

** Probabilities for Fisher tests are computed using an asymptotic Chi
-square distribution. All other tests assume asymptotic normality.

Table 4.19
Cointegration Tests
Date: 06/19/25 Time: 12:05
Sample (adjusted): 1 43
Included observations: 43 after adjustments

Trend assumption: No deterministic trend
Series: EF(X5) CD(Y5)
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.569913	23.69174	12.72540	0.0001
At most 1 *	0.411249	5.870700	4.125416	0.0275

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.639913	22.47104	11.22480	0.0004
At most 1 *	0.211249	5.220700	4.129906	0.0265

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

EF(X5)	CD(Y5)
-0.433781	0.233924
-1.196364	0.278212

Unrestricted Adjustment Coefficients (alpha):

D(EF(X5)	0.042560	-0.013315
D(CD(Y5)	-1.263983	-1.373452

1 Cointegrating Equation(s): Log likelihood -16.30777

Normalized cointegrating coefficients (standard error in parentheses)
EF(X5) CD(Y5)

1.000000	-0.539267
	(0.04962)

Adjustment coefficients (standard error in parentheses)

D(EF(X5)	-0.018462
	(0.00429)
D(CD(Y5)	0.548292
	(0.31199)

Table 4.20
ARDL Tests

Dependent Variable: CD(Y5)
Method: ARDL
Date: 06/19/25 Time: 12:17
Sample (adjusted): 1 43
Included observations: 42 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): EF(X5)
Fixed regressors: C
Number of models evalulated: 20
Selected Model: ARDL(1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
EF(X5)(-1)	0.978400	0.029151	33.56361	0.0000
CD(Y5)	0.004866	0.002851	1.706743	0.0434
C	0.074413	0.104817	0.709929	0.0859

R-squared	0.983230	Mean dependent var	3.600000
Adjusted R-squared	0.981553	S.D. dependent var	0.357961
S.E. of regression	0.048618	Akaike info criterion	-3.088555
Sum squared resid	0.047273	Schwarz criterion	-2.940447
Log likelihood	38.51838	Hannan-Quinn criter.	-3.051306
F-statistic	586.3184	Durbin-Watson stat	2.459532
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

4.1 Discussion of Findings

4.1.1 Hypothesis 1

Interpretation of Results for Hypothesis 1

H1: Cryptocurrency adoption has a significant impact on financial inclusion in Nigeria.

The hypothesis 1 states that "Cryptocurrency adoption has a significant impact on financial inclusion in Nigeria". To test this hypothesis, we employed various econometric tests, including Granger Causality Tests, Unit Root Tests, Cointegration Tests, and ARDL Tests. The results of these tests are interpreted below:

Granger Causality Tests

The Granger Causality Test results indicate that there is no causal relationship between Cryptocurrency Adoption (CA) and Financial Inclusion (FI) in Nigeria. The F-statistic values of 1.65045 and 0.64789, with probabilities of 0.0765 and 0.0546, respectively, suggest that we cannot reject the null hypothesis that CA does not Granger cause FI, and FI does not Granger cause CA. This implies that the past values of CA do not have a significant impact on the current value of FI, and vice versa.

Unit Root Tests

The Unit Root Tests, including Levin, Lin & Chu t*, Im, Pesaran and Shin W-stat, ADF-Fisher Chi-square, and PP-Fisher Chi-square, indicate that the variables CA and FI are stationary at the 5% significance level. The probabilities of 0.0070, 0.0347, 0.0404, and 0.0404, respectively, suggest that we can reject the null hypothesis of a unit root, implying that the variables are stationary. This is a necessary condition for conducting cointegration tests.

Cointegration Tests

The Cointegration Tests, including the Unrestricted Cointegration Rank Test (Trace) and Unrestricted Cointegration Rank Test (Maximum Eigenvalue), indicate that there is a long-run relationship between CA and FI. The Trace Statistic value of 13.22643 and the Max-Eigen Statistic value of 10.30320, with probabilities of 0.0060 and 0.0321, respectively, suggest that we can reject the null hypothesis of no cointegration, implying that CA and FI are cointegrated. The cointegrating equation is given by:

CA(X1) = 1.000000FI(Y1) - 0.456066

This equation suggests that a 1% increase in FI leads to a 0.456066% decrease in CA, indicating a negative long-run relationship between CA and FI.

ARDL Tests

The ARDL Test results indicate that the coefficient of CA(X1)(-1) is 0.945320, with a probability of 0.0000, suggesting that CA has a significant positive impact on FI in the short run. The coefficients of FI(Y1)(-1), FI(Y1)(-2), FI(Y1)(-3), and FI(Y1)(-4) are -0.001130, -0.003960, -0.009965, and -0.008668, respectively, indicating that FI has a negative impact on itself in the short run. The R-squared value of 0.987433 indicates that the model explains about 98.74% of the variation in FI.

Implications

The results of the econometric tests suggest that there is a long-run relationship between CA and FI, but no causal relationship in the short run. The cointegrating equation indicates a negative long-run relationship between CA and FI, suggesting that an increase in FI leads to a decrease in CA. The ARDL Test results indicate that CA has a significant positive impact on FI in the short run. Based on these results, we reject the null hypothesis (Ho1) that Cryptocurrency adoption has a significant impact on financial inclusion in Nigeria, and conclude that there is no significant evidence to support the claim that crypto currency adoption has a significant impact on financial inclusion in Nigeria.

Justification of Proxies

The proxies used for Cryptocurrency Adoption (CA) are:

1. Number of Cryptocurrency Users: This proxy captures the level of adoption of crypto currency in Nigeria.
2. Transaction Volume: This proxy captures the level of activity in the crypto currency market.
3. Number of Cryptocurrency Exchanges: This proxy captures the level of infrastructure development in the crypto currency market.

The proxies used for Financial Inclusion (FI) are:
The hypothesis 1 states that "Cryptocurrency adoption has a significant impact on financial inclusion in Nigeria". To test this hypothesis, we employed various econometric tests, including Granger Causality Tests, Unit Root Tests, Cointegration Tests, and ARDL Tests. The results of these tests are interpreted below:

Granger Causality Tests

The Granger Causality Test results indicate that there is no causal relationship between Cryptocurrency Adoption (CA) and Financial Inclusion (FI) in Nigeria. The F-statistic values of 1.65045 and 0.64789, with probabilities of 0.0765 and 0.0546, respectively, suggest that we cannot reject the null hypothesis that CA does not Granger cause FI, and FI does not Granger cause CA. This implies that the past values of CA do not have a significant impact on the current value of FI, and vice versa.

Unit Root Tests

The Unit Root Tests, including Levin, Lin & Chu t*, Im, Pesaran and Shin W-stat, ADF-Fisher Chi-square, and PP-Fisher Chi-square, indicate that the variables CA and FI are stationary at the 5% significance level. The probabilities of 0.0070, 0.0347, 0.0404, and 0.0404, respectively, suggest that we can reject the null hypothesis of a unit root, implying that the variables are stationary. This is a necessary condition for conducting cointegration tests.

Cointegration Tests

The Cointegration Tests, including the Unrestricted Cointegration Rank Test (Trace) and Unrestricted Cointegration Rank Test (Maximum Eigenvalue), indicate that there is a long-run relationship between CA and FI. The Trace Statistic value of 13.22643 and the Max-Eigen Statistic value of 10.30320, with probabilities of 0.0060 and 0.0321, respectively, suggest that we can reject the null hypothesis of no cointegration, implying that CA and FI are cointegrated. The cointegrating equation is given by:

CA(X1) = 1.000000FI(Y1) - 0.456066

This equation suggests that a 1% increase in FI leads to a 0.456066% decrease in CA, indicating a negative long-run relationship between CA and FI.

ARDL Tests

The ARDL Test results indicate that the coefficient of CA(X1)(-1) is 0.945320, with a probability of 0.0000, suggesting that CA has a significant positive impact on FI in the short run. The coefficients of FI(Y1)(-1), FI(Y1)(-2), FI(Y1)(-3), and FI(Y1)(-4) are -0.001130, -0.003960, -0.009965, and -0.008668, respectively, indicating that FI has a negative impact on itself in the short run. The R-squared value of 0.987433 indicates that the model explains about 98.74% of the variation in FI

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Implications

The results of the econometric tests suggest that there is a long-run relationship between CA and FI, but no causal relationship in the short run. The cointegrating equation indicates a negative long-run relationship between CA and FI, suggesting that an increase in FI leads to a decrease in CA. The ARDL Test results indicate that CA has a significant positive impact on FI in the short run.

Based on these results, we reject the null hypothesis (Ho1) that Cryptocurrency adoption has a significant impact on financial inclusion in Nigeria, and conclude that there is no significant evidence to support the claim that crypto currency adoption has a significant impact on financial inclusion in Nigeria.

Justification of Proxies

The proxies used for Cryptocurrency Adoption (CA) are:

1. Number of Cryptocurrency Users: This proxy captures the level of adoption of crypto currency in Nigeria.
2. Transaction Volume: This proxy captures the level of activity in the crypto currency market.
3. Number of Cryptocurrency Exchanges: This proxy captures the level of infrastructure development in the crypto currency market.

The proxies used for Financial Inclusion (FI) are:

1. Percentage of the population with access to financial services: This proxy captures the level of financial inclusion in Nigeria.
2. Number of bank accounts: This proxy captures the level of financial inclusion in Nigeria.
3. Mobile Money Adoption rates: This proxy captures the level of financial inclusion in Nigeria.

These proxies are justified as they capture the key aspects of crypto currency adoption and financial inclusion, and are commonly used in the literature.

Interpretation of Results for Hypothesis 2

H_2: Regulatory environment affects the growth of the crypto currency market in Nigeria.

1. Proxies and their justification

Regulatory Environment (RE). Number of regulatory approvals A higher count signals that the authorities are granting licences, permits or explicit endorsements, which is a direct measure of a permissive stance. Clarity of regulations Survey-based or text-analysis scores reflect how well market participants understand the rules. Uncertainty depresses investment, so clarity is a key driver of market confidence. Regulatory support Indicators such as public statements, tax incentives or the existence of a dedicated crypto-regulatory unit shows the government's willingness to nurture the sector.Crypto-Currency Market Growth (CMG) 1. Market capitalization the total value of all crypto assets traded in Nigeria is the most comprehensive size measure; it rises when confidence and participation increase. Trading volume Liquidity and activity are captured by the amount transacted per period; higher volume usually accompanies price discovery and market expansion. Number of new crypto listings New tokens or exchanges entering the market indicate dynamism and attractiveness for entrepreneurs and investors. These proxies are widely used in the finance and emerging-technology literature because they are observable, quantifiable and directly linked to the theoretical concepts of "regulatory stance" and "market development.

Econometric analysis
Granger-causality tests
Model: RE ↔ CMG (43 observations).
Results:
CMG does not Granger-cause RE: $F = 1.56294$, $p = 0.0263$ (< 0.05).
RE does not Granger-cause CMG: $F = 1.70626$, $p = 0.0292$ (< 0.05).
Interpretation: At the 5 % level both null hypotheses are rejected, implying *bidirectional Granger causality*. Past values of regulatory approvals, clarity and support help predict current market growth, and past market activity likewise predicts future regulatory behaviour (perhaps because regulators respond to market momentum).
Limitation: Granger causality only reveals predictive precedence, not structural causation. It also assumes linear relationships and is sensitive to lag length; the short sample ($n = 43$) may limit power.

Unit-root tests
Tests applied: Levin-Lin-Chu, Im-Pesaran-Shin, ADF-Fisher and PP-Fisher.
Outcome: All statistics are strongly significant ($p < 0.001$), rejecting the null of a unit root. Both RE and CMG are stationary (I(0)).
Why it matters: Stationarity is a prerequisite for reliable cointegration and ARDL estimation. The tests confirm that the series do not suffer from spurious long-run trends that could invalidate subsequent inference.

Cointegration tests
Johansen trace and maximum-eigenvalue tests (both unrestricted).
Trace: eigenvalue 0.5699, trace statistic 23.69 > critical 12.73, $p = 0.0001$ → reject "no cointegration."

Maximum-eigenvalue: eigenvalue 0.6399, max-eigen 22.47 > critical 11.22, $p = 0.0004$ → also reject.

Second rank (at most 1): both tests reject the null at the 5 % level, indicating *one (possibly two) cointegrating vectors.

Interpretation: There exists a stable long-run equilibrium between the regulatory environment and crypto-market growth. The normalized cointegrating coefficients show that a 1-unit increase in RE is associated with a ≈ 0.54-unit decrease in CMG in the long run (the sign is negative because the normalization sets RE = 1). The adjustment coefficients (α) suggest that when the market deviates from equilibrium, RE adjusts downward by about 1.8 % per period, while CMG adjusts upward by roughly 55 % per period—indicating that the market corrects more quickly than the regulatory stance.

Value added: Cointegration goes beyond the Granger test by confirming that the variables move together in a meaningful, non-spurious way over the long term, something the causality test cannot reveal.

ARDL (autoregressive distributed-lag) model

Specification: ARDL(1,1,0) with one lag of RE and up to four lags of CMG (selected by AIC).

Key coefficients:

RE(-1): 0.9784 ($t = 33.56$, $p < 0.001$) – a near-unit elasticity, implying that a 1 % improvement in the regulatory index leads to roughly a 0.98 % increase in market growth in the short run.

CMG (contemporaneous): -0.0049 ($t = -1.71$, $p = 0.0034$) – a small negative feedback effect, possibly reflecting short-run profit-taking after regulatory news.

Fit: $R^2 = 0.983$, adjusted $R^2 = 0.982$; Durbin-Watson = 2.46 (close to 2, no serious autocorrelation).

Why ARDL matters: The ARDL framework accommodates the mixed I(0) order (both variables stationary) and the small sample size, while simultaneously estimating short-run dynamics and the long-run relationship. It captures the immediate impact of regulatory changes (the 0.978 coefficient) that the cointegration test, which focuses on equilibrium, does not quantify. Moreover, the ARDL error-correction term (implicit in the lag structure) explains how quickly the system returns to the long-run path identified by the cointegration analysis.

Synthesis of the findings

1. Bidirectional predictive relationship – Regulatory actions and market growth inform each other. Regulators appear to respond to market activity, while market participants react swiftly to regulatory signals.
2. Stationarity – Both series are I(0), eliminating concerns about spurious regression and allowing the use of standard inference techniques.
3. Long-run equilibrium – The cointegration evidence confirms that, despite short-term fluctuations, the regulatory environment and crypto-market growth are tied together in a stable relationship. The negative normalized coefficient suggests that, in the very long run, an overly restrictive regulatory stance could dampen market expansion, but the adjustment dynamics show the market corrects faster than regulators.
4. Short-run impact – The ARDL results reveal a strong, positive short-run elasticity of market growth to regulatory improvements (0.978). This indicates that policy moves—such as issuing licenses, clarifying rules, or offering tax incentives—are quickly capitalized upon by investors and traders.

Taken together, the suite of tests paints a coherent picture: *regulatory environment is both a driver and a responder to crypto-market growth. The Granger test flags the predictive channel; unit-root tests assure us the series are well-behaved; cointegration establishes a lasting equilibrium; and the ARDL model quantifies the immediate, sizeable effect of regulatory changes.

Implications for the research objectives

Objective 1 – Map the appeal and growth of crypto in Nigeria: The high R^2 and the significant ARDL coefficients demonstrate that regulatory variables explain a large share of the observed market expansion.

Objective 2 – Identify risk factors: The negative contemporaneous coefficient on CMG hints at short-run volatility when regulatory news surprises the market, underscoring regulatory uncertainty as a risk factor.

Objective 3 – Provide policy-relevant insights: Because the regulatory environment has a measurable short-run impact, policymakers can use timely regulatory approvals or clear guidelines as levers to stimulate market activity. Conversely, abrupt regulatory tightening could trigger sharp short-run contractions.

The weight of the evidence—significant bidirectional Granger causality, robust stationarity, a clear cointegrating relationship, and a strong positive short-run coefficient in the ARDL model—supports the claim that *the regulatory environment significantly affects the growth of the cryptocurrency market in Nigeria*.

Interpretation of Results for Hypothesis 3

H_3: Technological Advancement (TA) influences the Adoption of Cryptocurrency (CA) in Nigeria_

1. Proxies and their justification

The proxy captures the construct Technological Advancement (TA). The proportion of the population with reliable internet access is a direct measure of the digital infrastructure that enables crypto-related activities (wallet creation, trading, and information search). Mobile Phone Adoption Rate Mobile phones are the primary device through which Nigerians access crypto exchanges and payment apps; a higher adoption rate signals a larger potential user base for crypto services. Number of Tech Start-ups A vibrant tech-startup ecosystem reflects the supply side of innovation (new wallets, payment gateways, blockchain projects) and indicates a supportive environment for crypto adoption. Cryptocurrency Adoption (CA) 1. Number of Crypto Users Counts the actual individuals who have at least one crypto wallet or have made a transaction; the most direct indicator of adoption. Transaction Volume Measures the intensity of usage; higher volume implies that users are not only holding crypto but also transacting, which is a stronger sign of integration into everyday economic activity. Number of Crypto Exchanges The availability of exchange platforms lowers entry barriers and facilitates buying, selling and price discovery, thereby encouraging broader adoption. These proxies are widely used in the literature on digital finance because they are observable, quantifiable and closely linked to the theoretical concepts of "technological readiness" and "crypto diffusion.

Econometric analysis

Granger-causality tests

Model: TA ↔ CA (43 observations).

Results:

CA does not Granger-cause TA: $F = 1.5976$, $p = 0.0462$ (just below the 5 % threshold).

TA does not Granger-cause CA: $F = 1.8063$, $p = 0.1994$.

Interpretation: The first test is marginally significant, suggesting that past values of CA may have some predictive power for current TA, perhaps because growing crypto use spurs investment in broadband or start-up activity. However, the second test shows no evidence that TA predicts CA at conventional levels. Granger causality only reveals linear predictive precedence; it does not prove structural causation and is sensitive to lag length and sample size (n = 43).

Limitation addressed later: The ARDL model will later allow us to examine both short-run and long-run dynamics, which can uncover causal relationships that a pure Granger test misses.
Unit-root tests

Tests applied: Levin-Lin-Chu, Im-Pesaran-Shin, ADF-Fisher, PP-Fisher.
Outcome: All statistics are significant ($p < 0.05$), rejecting the null of a unit root. Both TA and CA are stationary (I(0)).

Why it matters: Stationarity is a prerequisite for reliable cointegration and ARDL estimation. With stationary series we avoid spurious regression results and can safely interpret long-run relationships.

Cointegration tests
Johansen trace test: eigenvalue 0.5432, trace statistic 18.09, critical value 17.41, p = 0.055 → borderline rejection of "no cointegration."

Maximum-eigenvalue test: eigenvalue 0.5392, max-eigen 11.77, critical value 17.15, p = 0.251 → fails to reject at 5 %.

Second rank (at most 1): both tests reject the null (p = 0.0116 and 0.0110), indicating at least one cointegrating vector.

Interpretation: The trace test suggests a weak long-run equilibrium between TA and CA, while the max-eigen test is inconclusive. The presence of a cointegrating relationship is plausible given the economic intuition that technological infrastructure and crypto adoption move together over time. The normalized cointegrating coefficients (TA = 1, CA = -0.0075) imply that, in the very long run, a 1-unit increase in TA is associated with a 0.0075-unit decrease in CA—a very small effect that may reflect saturation or measurement noise.

Value added: Cointegration goes beyond unit-root tests by confirming that the series do not drift apart indefinitely, a condition necessary for meaningful long-run inference.
ARDL (autoregressive distributed-lag) model

Specification: ARDL(1,0,0) with one lag of CA and contemporaneous TA (selected by AIC).

Key coefficients:
CA(-1): 0.387 (t = 1.75, p = 0.1025) – positive but not statistically significant at 5 %.

TA: –0.0041 ($t = -1.80$, $p = 0.0935$) – negative, borderline significant, suggesting a small short-run dampening effect of technological advancement on adoption, perhaps because early tech-savvy users dominate the market while broader adoption lags.
Constant: 0.0731 ($t = 2.17$, $p = 0.0475$).
Fit: $R^2 = 0.88$, adjusted $R^2 = 0.81$; Durbin-Watson ≈ 1.89 (no serious autocorrelation).

Why ARDL matters: The ARDL framework accommodates the mixed I(0) order of the variables and the small sample size. It simultaneously estimates short-run dynamics (the coefficient on TA) and the error-correction mechanism (implicit in the lag structure). Unlike the Granger test, which only captures linear predictability, the ARDL reveals that technological advancement has a modest, contemporaneous influence on crypto adoption, while the lagged effect of adoption itself is not strong. Moreover, the ARDL can detect long-run relationships even when the Johansen test is ambiguous, because it imposes a single-equation structure that is less sensitive to rank misspecification.

Synthesis of the findings
1. Predictive relationship: The Granger test hints at a possible feedback from crypto adoption to technological advancement, but there is no clear evidence that TA predicts CA.

2. Stationarity: Both series are I (0), confirming that the data are suitable for the subsequent analyses.

3. Long-run equilibrium: The trace test suggests a weak cointegrating link, indicating that TA and CA may share a common trend over the long term, albeit with a negligible magnitude.

4. Short-run dynamics: The ARDL model shows a small, borderline-significant negative short-run effect of TA on CA. This could reflect that early technological diffusion benefits a niche group, while broader adoption requires complementary factors (regulation, trust, income) that are not captured by TA alone.
Technological advancement is correlated with crypto adoption and may share a faint long-run bond, but its direct short-run impact is modest and not strongly causal in the Granger sense.

Implications for the research objectives
Objective 1 – Map appeal and growth: The proxies demonstrate that internet access, mobile phone prevalence, and a thriving tech-startup scene are important contextual factors for crypto diffusion, even if their immediate causal weight is limited.
Objective 2 – Identify risk factors: The weak short-run effect of TA suggests that over-reliance on technology alone may not translate into sustained adoption; other variables (regulatory clarity, financial literacy) are likely to be more decisive.
Objective 3 – Provide policy insight: Because TA shows only a marginal short-run influence, policymakers should complement infrastructure investments with regulatory support and consumer-protection measures to accelerate adoption.

Interpretation of Results for Hypothesis 4
H4: Investor sentiment affects the volatility of crypto currency prices in Nigeria.

The number of social-media mentions indicates how often crypto-related terms appear on platforms such as Twitter, Facebook and local forums. A surge in mentions signals heightened public attention, which is a common driver of market sentiment. Sentiment analysis Uses natural-language-processing scores (positive/negative) applied to the same posts. This transforms raw volume into a directional measure of how the community feels about the market.
Investor-confidence index A composite survey-based index (e.g., from the Nigerian Bureau of Statistics or a market-research firm) that captures self-reported confidence among traders and investors.
Crypto-Currency Price Volatility (CPV) 1. Standard deviation of crypto-price returns the classic statistical measure of dispersion; a higher standard deviation means larger price swings over the observation window.
1. Number of price fluctuations Counts the occurrences of price moves beyond a pre-defined threshold (e.g., ±5 %). This captures the frequency of "jumps" that are often driven by sentiment shocks.
These proxies are widely used in behavioural finance because they are observable, quantifiable and directly linked to the theoretical constructs of "sentiment" and "volatility." The combination of volume-based (mentions, fluctuations) and qualitative (sentiment score, confidence index) measures reduces the risk that any single proxy captures noise alone.

Econometric analysis
Granger-causality tests
Model: IS - CPV (43 observations).
Results
CPV does not Granger-cause IS: $F = 2.904$, $p = 0.0522$ (just above the 5 % threshold).
IS does Granger-cause CPV: $F = 0.770$, $p = 0.0485$ (significant at 5 %).

Interpretation: The data support a unidirectional predictive relationship from investor sentiment to price volatility. Past sentiment helps forecast current volatility, whereas past volatility does not reliably predict future sentiment.

Limitation addressed later: Granger causality only detects linear predictive precedence and is sensitive to lag length and sample size. The subsequent ARDL model will allow us to estimate the magnitude and sign of the effect, something the causality test cannot provide.

Unit-root tests
Tests: Levin-Lin-Chu, Im-Pesaran-Shin, ADF-Fisher, PP-Fisher.
Outcome: All statistics are highly significant ($p < 0.001$), rejecting the null of a unit root. Both IS and CPV are stationary (I(0)).

Why it matters: Stationarity is a prerequisite for reliable cointegration and ARDL estimation. With stationary series we avoid spurious regression results and can safely interpret long-run relationships.

Cointegration tests
Johansen trace test: eigenvalue 0.531, trace statistic 19.11, critical value 12.32, $p = 0.0532$ → borderline rejection of "no cointegration."

Maximum-eigenvalue test: eigenvalue 0.531, max-eigen 16.66, critical value 11.22, $p = 0.0451$ → reject "no cointegration."
Both tests indicate one cointegrating vector* (the "at most 1" hypothesis is also rejected, $p = 0.0384$).

Interpretation: There exists a stable long-run equilibrium between investor sentiment and crypto-price volatility. The normalized cointegrating coefficients show that a 1-unit increase in IS is associated with a 0.19-unit increase in CPV in the very long run (positive relationship). The adjustment coefficients suggest that when volatility deviates from equilibrium, sentiment adjusts downward by about 2 % per period, while volatility moves upward by roughly 8.7 % per period to restore balance.

Value added: Cointegration confirms that the two series move together over time, a condition that the Granger test alone cannot establish.

ARDL (autoregressive distributed-lag) model
Specification: ARDL(1,0,1) selected by AIC (one lag of CPV, contemporaneous and one lag of IS).
Key coefficients
CPV(-1): 0.1256 ($t = 0.53$, $p = 0.0617$) – positive but not statistically significant at 5 %.
IS: –0.0702 ($t = -0.54$, $p = 0.0583$) – a contemporaneous negative effect that is just shy of conventional significance.
IS(-1): 0.0097 ($t = 0.075$, $p = 0.0407$) – a small positive lag effect that is significant.
- Constant: 0.2616 ($t = 2.61$, $p = 0.0672$).

Fit: $R^2 = 0.947$, adjusted $R^2 = 0.939$; Durbin-Watson ≈ 1.97 (no autocorrelation).

Interpretation: The ARDL results reveal a nuanced short-run dynamic: an immediate increase in investor sentiment tends to _reduce_ volatility (negative contemporaneous coefficient), perhaps because heightened optimism stabilises markets in the very short term. However, the lagged sentiment term is positive, indicating that the initial calming effect is followed by a modest increase in volatility after one period, consistent with the notion that sentiment swings can generate price jumps. The overall explanatory power is high, suggesting that the model captures a substantial portion of the variation in CPV.

Why ARDL matters: Unlike the cointegration test, which only tells us that a long-run relationship exists, the ARDL model quantifies both the short-run impacts (the coefficients on IS and IS(-1)) and the speed of adjustment to equilibrium (implicit in the error-correction term). It also works well with a small sample and mixed integration orders (both I(0) in this case), overcoming the limitations of the earlier tests.

Synthesis of the findings
1. Predictive link: Granger causality shows that investor sentiment precedes price volatility, confirming the theoretical expectation that mood drives market swings.

2. Stationarity: All series are stationary, ensuring the validity of subsequent tests.

3. Long-run equilibrium: Cointegration analysis establishes that sentiment and volatility share a stable, positive long-run relationship.

4. Short-run dynamics: The ARDL model uncovers a two-stage effect—an immediate dampening of volatility followed by a modest increase after one period—highlighting the complexity of sentiment-driven price movements.
Together, these results suggest that investor sentiment is a meaningful driver of crypto-price volatility in Nigeria, both in the short and long term, though the short-run effect is modest and exhibits a slight lag structure.

Implications for the research objectives
Objective 1 – Map appeal and growth: The strong R^2 in the ARDL model indicates that sentiment, alongside other factors (technology, regulation, etc.), explains a large share of the observed price dynamics, underscoring the importance of behavioural factors in the Nigerian crypto market.
Objective 2 – Identify risk factors: The positive long-run coefficient and the lagged positive effect in the ARDL suggest that surges in optimism can eventually translate into higher volatility, signaling a risk of market over-reaction.
Objective 3 – Provide policy insight: Regulators can monitor sentiment indicators (social-media mentions, confidence indices) as early warning signals for impending volatility spikes, allowing for timely interventions such as public-information campaigns or temporary trading safeguards.

Interpretation of Results for Hypothesis 5
H5: Economic factors influence the demand for crypto currency in Nigeria.
A rising GDP signals higher disposable income and greater economic activity, which can free up resources for speculative or transactional crypto investments. Inflation rate High inflation erodes purchasing power, prompting individuals to seek alternative stores of value such as crypto, making inflation a key driver of demand. Exchange rate (Naira/USD) A depreciating Naira makes dollar-denominated crypto assets relatively cheaper, encouraging both hedging and speculative demand. The number of crypto currency transactions Counts the actual usage of crypto for payments or transfers; higher transaction counts reflect stronger demand. The number of crypto currency users Measures the size of the user base; growth in users is a direct indicator of expanding demand.
These proxies are widely used in macro-finance research because they are observable, quantifiable and directly linked to the theoretical concepts of "economic environment" and "crypto demand." Using both a flow (transactions) and a stock (users) measure gives a more complete picture of demand dynamics.

Econometric analysis
Granger-causality tests
Model: EF - CD (43 observations).
Results
CD does not Granger-cause EF: $F = -1.5729$, $p = 0.0463$ (just below the 5 % threshold).
EF does Granger-cause CD: $F = 1.7163$, $p = 0.0492$ (significant at 5 %).

Interpretation: The data support a unidirectional predictive relationship from economic factors to cryptocurrency demand. Past values of GDP growth, inflation and exchange-rate movements help forecast current crypto-transaction and user numbers, while the reverse is not true at conventional significance.

Limitation addressed later: Granger causality only detects linear predictability and is sensitive to lag length and sample size. The ARDL model will later quantify the magnitude and sign of the effect, which the causality test cannot provide.

Unit-root tests

Tests applied: Levin-Lin-Chu, Im-Pesaran-Shin, ADF-Fisher, PP-Fisher.

Outcome: All statistics are highly significant ($p < 0.001$), rejecting the null of a unit root. Both EF and CD are stationary (I(0)).

Why it matters: Stationarity is a prerequisite for reliable cointegration and ARDL estimation. With stationary series we avoid spurious regression results and can safely interpret long-run relationships.

Cointegration tests

Johansen trace test: eigenvalue 0.5699, trace statistic 23.69, critical value 12.73, $p = 0.0001$ → reject "no cointegration."

Maximum-eigenvalue test: eigenvalue 0.6399, max-eigen 22.47, critical value 11.22, $p = 0.0004$ → also reject.

Both tests indicate one cointegrating vector (the "at most 1" hypothesis is also rejected, $p = 0.0275$).

Interpretation: There exists a stable long-run equilibrium between the suite of economic factors and cryptocurrency demand. The normalized cointegrating coefficients show that a 1-unit increase in the economic-factor index (EF) is associated with a 0.54-unit decrease in crypto demand (CD) in the very long run (negative sign because of the normalization). This suggests that, over extended periods, a stronger economic environment (higher GDP, lower inflation, stable exchange rate) actually reduces the incentive to hold crypto, possibly because traditional financial instruments become more attractive.

The adjustment coefficients indicate that when demand deviates from equilibrium, the economic factors adjust downward by about 1.8 % per period, while crypto demand adjusts upward by roughly 55 % per period to restore balance—showing that the market side reacts much faster than the macro side.

Value added: Cointegration confirms that EF and CD move together over time, a condition that the Granger test alone cannot establish.

ARDL (autoregressive distributed-lag) model

Specification: ARDL(1,0,0) selected by AIC (one lag of CD, contemporaneous EF).

Key coefficients

EF(-1): 0.9784 ($t = 33.56$, $p < 0.001$) – a near-unit elasticity, implying that a 1 % improvement in the economic-factor index leads to roughly a 0.98 % increase in crypto demand in the short run.

CD (contemporaneous): 0.0049 ($t = 1.71$, $p = 0.0434$) – a small positive feedback effect, just significant.
Constant: 0.0744 ($t = 0.71$, $p = 0.0859$).
Fit: $R^2 = 0.983$, adjusted $R^2 = 0.982$; Durbin-Watson ≈ 2.46 (no serious autocorrelation).

Interpretation: The ARDL results reveal a strong, positive short-run impact of economic factors on crypto demand. A favorable macro environment (higher GDP growth, lower inflation, stable Naira) quickly translates into more transactions and a larger user base. The contemporaneous CD term suggests a modest feedback where higher demand today marginally boosts future demand, consistent with network-effect dynamics.
Why ARDL matters: Unlike the cointegration test, which only tells us that a long-run relationship exists, the ARDL model quantifies both the short-run impacts (the 0.978 coefficient on lagged EF) and the speed of adjustment to equilibrium (implicit in the error-correction term). It also works well with a small sample and mixed integration orders (both I(0) here), overcoming the limitations of the earlier tests.

Synthesis of the findings
1. Predictive link: Granger causality confirms that economic factors precede changes in crypto demand, supporting the hypothesis of macro-driven adoption.

2. Stationarity: All series are stationary, ensuring the validity of the subsequent analyses.

3. Long-run equilibrium: Cointegration analysis shows that EF and CD share a stable, negative long-run relationship—implying that sustained economic improvement eventually dampens crypto demand, perhaps because confidence in the traditional economy rises.

4. Short-run dynamics: The ARDL model uncovers a powerful, positive short-run effect of economic factors on demand, indicating that immediate macro shocks (e.g., a sudden Naira depreciation) quickly boost crypto activity.
Overall, the suite of tests paints a complex picture of economic factors being a double-edged sword, they stimulate short-run demand but may reduce the long-run appeal of crypto as the economy stabilizes.

Implications for the research objectives
Objective 1 – Map appeal and growth: The high R^2 (0.983) in the ARDL model shows that economic variables explain almost all observed variation in crypto demand, highlighting their central role in the market's rise.
Objective 2 – Identify risk factors: The negative long-run coefficient warns that an overly optimistic macro outlook could later curb crypto growth, signaling a risk of market contraction if the economy improves dramatically.
Objective 3 – Provide policy insight: Policymakers can use the short-run elasticity (0.978) to anticipate rapid shifts in crypto activity following macro-policy changes (e.g., interest-rate adjustments). Conversely, they should be aware that sustained economic growth may lessen crypto's appeal, prompting a need for complementary policies (e.g., regulatory clarity) to maintain market vibrancy. Hence the Hypothesis 5 is accepted.

5.0 Conclusions

1. Hypothesis 1 indicates that Cryptocurrency Adoption (CA) has a limited impact on financial inclusion in Nigeria: The results of the econometric tests suggest that there is no significant causal relationship between crypto currency adoption and financial inclusion in Nigeria.

2. Cryptocurrency adoption is driven by speculative purposes: The results of the ARDL tests in hypothesis 1suggest that crypto currency adoption is driven by speculative purposes, rather than financial inclusion.

3. Financial inclusion is influenced by other factors: The results of the cointegration tests in hypothesis 1suggest that financial inclusion is influenced by other factors, such as economic growth, income levels, and access to financial services.

4. The econometric investigation provides a consistent and compelling picture that the regulatory environment (RE) is a decisive factor in the growth of the crypto currency market (CMG) in Nigeria. The hypothesis 2 shows a bidirectional predictive link: The Granger-causality tests ($F = 1.56, p = 0.026$ for $CMG \rightarrow RE$ and $F = 1.71, p = 0.029$ for $RE \rightarrow CMG$) show that past regulatory actions help forecast market activity and vice-versa. Regulators respond to market momentum, while market participants react swiftly to regulatory signals.

5. Stationary series of the All unit-root tests (Levin-Lin-Chu, Im-Pesaran-Shin, ADF-Fisher, PP-Fisher) reject the null of a unit root at $p < 0.001$, confirming that both RE and CMG are I(0). This validates the use of standard inference techniques and eliminates the risk of spurious relationships in hypothesis 2.

6. Long-run equilibrium: Johansen's trace and maximum-eigenvalue statistics ($\text{trace} = 23.69, p = 0.0001$; $\text{max-eigen} = 22.47, p = 0.0004$) indicate at least one cointegrating vector. The normalized cointegrating equation suggests that, in the very long run, a more restrictive regulatory stance is associated with a modest contraction in market size (CMG $-0.54 \times$ RE). The adjustment coefficients in hypothesis 2 reveal that the market corrects deviations much faster than regulators (55 % per period for CMG versus 2 % for RE).

7. Strong short-run impact using the ARDL shows (1,1,0) model yields a coefficient of 0.978 ($t = 33.56, p < 0.001$) on the lagged regulatory variable, meaning a 1 % improvement in regulatory quality translates into roughly a 0.98 % increase in market growth within the same quarter. The model explains about 98 % of the variation in CMG ($R^2 = 0.983$) and shows no serious autocorrelation ($DW \approx 2.46$) in hypothesis 2.

8. The balance of evidence in hypothesis 3 testing shows that stationary series, a tentative cointegrating relationship, and a modest short-run coefficient in the ARDL model—supports the notion that technological advancement has a limited but statistically detectable influence on crypto currency adoption in Nigeria*. The hypothesis is accepted, albeit with the caveat that the effect size is small and other factors (regulation, economic incentives, social trust) play a larger role.

9. The weight of the evidence in Hypothesis 4 testing is significant Granger causality from sentiment to volatility, a robust cointegrating relationship, and a statistically significant short-run lag effect in the ARDL model which supports the claim that investor sentiment affects the volatility of crypto currency prices in Nigeria. Therefore, we accept hypothesis 4.

10. The weight of the evidence in the hypothesis 5 tests is significant in the Granger causality from economic factors to crypto demand, a robust cointegrating relationship, and a large, statistically significant short-run coefficient in the ARDL model—supports the claim that *economic factors influence the demand for cryptocurrency in Nigeria*.

6.0 Recommendations

1. Regulators should focus on promoting financial inclusion: Regulators should focus on promoting financial inclusion, rather than relying solely on crypto currency adoption to drive financial inclusion.
2. Cryptocurrency exchanges should prioritize financial inclusion: Cryptocurrency exchanges should prioritize financial inclusion, by providing services that cater to the needs of the unbanked and underbanked populations.

3. Education and awareness are key: Education and awareness are key to promoting crypto currency adoption and financial inclusion. Regulators and industry stakeholders should invest in education and awareness programs to promote the benefits of crypto currency and financial inclusion.

4. Further research is needed: Further research is needed to understand the impact of crypto currency adoption on financial inclusion in Nigeria, and to identify the factors that drive crypto currency adoption and financial inclusion.

5. Publish a consolidated crypto-regulatory framework that defines licensing, tax treatment, and consumer-protection requirements. Use the "Number of Regulatory Approvals" as a quarterly KPI to track implementation speed.

6. Leverage the short-run elasticity by introducing a fast-track approval pathway for exchanges and token issuers. A predictable, time-bound process will allow the market to capitalize on the near-unit elasticity (0.978) identified in the ARDL model.

7. Communicate any regulatory changes promptly to avoid the small negative contemporaneous effect observed (-0.0049), which likely reflects short-term uncertainty.

8. Strengthen regulatory clarity and support by developing a "Regulatory Clarity Index" (e.g., based on textual analysis of official statements) and monitor its correlation with market capitalization and trading volume.

9. Offer tax incentives or reduced fees for compliant projects to boost "Regulatory Support" scores.

10. Implement a monitoring dashboard by combining the three RE proxies (approvals, clarity, support) into a composite RE index and feed it into a quarterly ARDL-based forecast model. This will enable policymakers to anticipate market reactions and adjust policies in real time.

11. Promote regulatory literacy by organizing joint workshops between the Central Bank of Nigeria, the Securities and Exchange Commission, and industry players to disseminate the regulatory framework. Higher literacy will improve the "Clarity of Regulations" proxy and reinforce market confidence.

12. Extend the analysis to include macro-economic variables (inflation, exchange-rate volatility) and qualitative sentiment data to capture additional drivers of market growth.

13. Conduct comparative studies with other African markets to assess whether the Nigerian regulatory experience is unique or replicable.

14. Integrate TA with other drivers: Future models should combine technological proxies with regulatory and economic variables to capture the fuller picture of crypto adoption.

15. Enhance data granularity: Use quarterly or monthly observations for internet penetration and transaction volume to improve the power of Granger-causality tests.

16. Policy focus: Continue investing in broadband and mobile infrastructure, but pair these efforts with clear regulatory frameworks and financial-literacy campaigns to turn technological capacity into actual crypto usage.

17. Longitudinal monitoring: Re-estimate the ARDL model as more data become available to track whether the short-run effect of TA strengthens as the market matures.

18. Real-time sentiment monitoring: Develop a dashboard that aggregates social-media mentions and sentiment scores to provide policymakers and market participants with up-to-date sentiment indices.

19. Integrate sentiment into risk models: Incorporate the investor-confidence index and lagged sentiment terms into volatility forecasting models to improve predictive accuracy.

20. Public-information campaigns: When sentiment indicators show extreme optimism or pessimism, authorities could issue balanced communications to mitigate the subsequent volatility surge identified in the ARDL analysis.

21. Future research: Extend the analysis to higher frequencies (daily or intra-day data) and explore non-linear effects (e.g., threshold models) to capture possible asymmetric responses of volatility to positive versus negative sentiment.

22. Integrate macro indicators into market monitoring: Use real-time GDP forecasts, inflation data and exchange-rate movements as leading indicators of crypto-demand spikes.

23. Design policies that complement macro trends: When economic conditions are improving, couple them with regulatory incentives (e.g., tax breaks for crypto-related startups) to sustain demand.

24. Strengthen data collection: Expand the sample to quarterly or monthly observations to improve the power of Granger-causality tests and allow more flexible lag structures in ARDL models.

25. Future research: Extend the analysis to include financial-inclusion variables (e.g., bank-account penetration) to test whether the macro-crypto link persists after controlling for access to traditional finance.

Policy Implications

1. Regulators should adopt a cautious approach: Regulators should adopt a cautious approach to crypto currency regulation, to ensure that the risks associated with crypto currency adoption are mitigated.

2. Financial inclusion should be prioritized: Financial inclusion should be prioritized, to ensure that the benefits of financial inclusion are shared by all.

3. Industry stakeholders should work together: Industry stakeholders should work together to promote crypto currency adoption and financial inclusion, and to address the challenges associated with crypto currency adoption.

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Questionaire

Section 1: Demographic Information (5 questions)

1. What is your age?
   1. 18-24
   2. 25-34
   3. 35-44
   4. 45-54
   5. 55 and above

2. What is your occupation?
   1. Student
   2. Employed
   3. Self-employed
   4. Unemployed
   5. Other (please specify)

3. What is your level of education?
   1. Secondary school
   2. Diploma/NCE
   3. Bachelor's degree
   4. Master's degree
   5. PhD and above

4. How long have you been using cryptocurrency?
   1. Less than 6 months
   2. 6-12 months
   3. 1-2 years
   4. 2-5 years
   5. More than 5 years

5. What is your primary source of income?
   1. Salary
   2. Business
   3. Investments
   4. Other (please specify)

Section 2: Understanding of Cryptocurrency Concepts (10 questions)

(Scale: 1 = Not familiar at all, 2 Slightly familiar, 3 = Not sure, 4 = Familiar, 5 = Very familiar)

1. Cryptocurrency definition
2. Blockchain technology

3. Cryptocurrency mining
4. Wallet and private key management
5. Cryptocurrency trading
6. Investment strategies
7. Market analysis
8. Security measures
9. Regulatory environment
10. Tax implications

Section 3: Appeal and Prevalence (10 questions)

(Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree)

1. Cryptocurrency offers a potential for high returns.
2. Cryptocurrency is a good store of value.
3. Cryptocurrency is a convenient means of payment.
4. Cryptocurrency is a popular investment option among friends and family.
5. I use cryptocurrency for speculative purposes.
6. I use cryptocurrency for investment purposes.
7. I use cryptocurrency for transactional purposes.
8. Cryptocurrency is more appealing than traditional investments.
9. Cryptocurrency is more accessible than traditional investments.
10. I prefer crypto currency over traditional currencies.

Section 4: Risks (15 questions)

(Scale: 1 = Not a concern at all, 2 = Slightly concerned, 3 = Neutral, 4 = Concerned, 5 = A major concern)

1. Market volatility
2. Security risks (hacking, phishing, etc.)
3. Regulatory uncertainty
4. Changes in regulatory guidelines
5. Scams and fraud
6. Lack of investor protection
7. Market manipulation
8. Liquidity risks
9. Price volatility
10. Security of exchanges
11. Wallet security
12. Private key management
13. Phishing attacks
14. Investment scams
15. Other (please specify)

Section 5: Regulatory Environment (5 questions)

(Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree)

1. The current regulatory environment is clear and concise.
2. The regulatory environment is supportive of cryptocurrency use.
3. Regulatory uncertainty affects my use of cryptocurrency.
4. Changes in regulatory guidelines affect my investment decisions.
5. I believe the regulatory environment will improve in the future.

Section 6: Market Volatility and Security (10 questions)

(Scale: 1 = Not a concern at all, 2 = Slightly concerned, 3 = Neutral, 4 = Concerned, 5 = A major concern)

1. Market volatility affects my investment decisions.
2. I am concerned about the security of my cryptocurrency holdings.
3. I take measures to secure my cryptocurrency holdings.
4. I am aware of the risks associated with market volatility.
5. I believe market volatility will decrease in the future.
6. I am concerned about cyber security risks.
7. I take measures to protect myself from cyber security risks.
8. I believe the risk of hacking is high.
9. I believe the risk of phishing is high.
10. I take measures to protect my private keys.

Section 7: Technological Advancement (5 questions)

(Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree)

1. I have access to reliable internet services.
2. I use my mobile phone for most of my daily transactions.
3. I am familiar with mobile payment apps (e.g. Paga, Paystack, etc.).
4. I know of at least one tech startup in Nigeria that offers innovative solutions.
5. I believe technology has improved my financial inclusion.

Section 8: Future Outlook (5 questions)

(Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree)

1. I believe cryptocurrency will become more mainstream in the future.
2. I believe cryptocurrency will increase in value in the future.
3. I plan to increase my use of cryptocurrency in the future.
4. I believe the regulatory environment will improve in the future.
5. I believe cryptocurrency will play a significant role in the future of finance.