# EFFECT OF FINANCIAL TECHNOLOGY ON ECONOMIC GROWTH IN NIGERIA (1999Q1-2020Q4)

[1]Udo Emmanuel Samuel, [2]Prof. J. U. J. Onwumere, [3]Dr. Abner Ishaku Prince, [4]Dr. Inim Victor Edet, [5]Dr. Izuchukwu Ogbodo, [6]Dr. Akpan Ededem Jack
[1-6]Department of Banking and Finance, University of Nigeria, Enugu Campus
[3]Department of Management, University of Nigeria, Enugu Campus
[4]Department of Accountancy, Nile University of Nigeria
[5]Department of Banking and Finance, Enugu State University of Science and Technology

Corresponding Author: [6]Dr. Akpan Ededem Jack

## Abstract

Financial market imperfections of information asymmetries, market segmentation, operational and transaction cost, individual and institutions challenges collectively diminishes FinTech prowess for financial inclusion and economic growth. FinTech provides the enabling financial channels to include the base of the pyramid, reduce financial exclusion, poverty rate and income inequality. The UN 2030 Agenda for Sustainable Development recognises the importance of FinTech. This study investigates the effect of FinTech on economic growth by extension financial inclusion on a quarterly period from 1999-2020 in Nigeria. FinTech is posit to affects economic growth directly and indirectly through financial inclusion. The Johansen cointegration test, and the Granger non-causality test, a Toda–Yamamoto procedure were adopted. Findings shows that FinTech impact on economic growth and financial inclusion through a reduction in income inequality and poverty rate. To integrate the hitherto 68.1%, of the base of the pyramid and micro-enterprise in to the mainstream financial systems on quarterly periods. Also, the disequilibrium caused by demand-supply sides barriers is corrected for in the long run. Findings also revealed a unidirectional, bidirectional and a feedback causality. Overall, our results support the aspirations of the UN-2030-ASD.

JEL Classifications: D31; D63; F02; 011; 015

Keywords: Economic Growth, FinTech, financial inclusion, income inequality Nigeria

## Introduction

The realisation of the core macroeconomic and financial objectives of 21st-century economic and financial policies anchors on; inclusive growth and development through financial technology (FinTech). To reduce extreme poverty, financial exclusion, income inequality and enhance shared prosperity (World Bank, 2014; Demirguc-Kunt, Asli, Leora, Klapper, Dorothe, Saniya, & Jakes 2018). The 2010 G20 Summit held in Seoul, South Korea, recognises financial inclusion as one of the nine key pillars of the global development agenda (Global Partnership for Financial Inclusion (GPFI) 2011). FinTech embraces any form of information and communication technology applied in banking, data, payment, investment, insurance, infrastructure, securities trading among others. The utilization of FinTech has successfully included over 515million adults previously excluded (Akinyele, 2018).

To this extent, about 69% of the global adult population are financially included operating a bank account with a financial institution or with a mobile money provider. In the absence of high transaction and operational cost, asymmetric information, and market imperfection. This percentage varies significantly from developed to emerging countries. According to the Global Findex report, in high-income countries, 94% of adults owned bank accounts, in low and middle income 63% and Sub-Saharan Africa 20%.

In Africa, Nigeria accounts for 51.41% of account ownership, South Africa, 68.4%, Kenya 85.84%, Rwanda 55.75%, Mauritius 92.71, and Burundi accounts for 7.50% the least. Sub-Saharan African countries accounts for 6% of ATMs (per 100,000adults), low and middle income 27% and high income 68%. Bank branches (per 100, 000 adults) Sub-Saharan African countries account for 5%, low and middle income 9%, and high income 20%. This shows a wide variation in various inclusion and development indicators hindering growth and development economically. This study anchors on goals 8 and 10 of the Sustainable Development Goals (SDGs) (Klapper, El-Zoghbi, & Hess 2016). Financial inclusion takes on affordability, accessibility and availability of financial services-products to all households and businesses, regardless of the level of income. Formal financial inclusion begins with operating a deposit or transaction account, in any financial institution or other financial service providers, (Demirguc-Kunt, Klapper, & Singer, 2017).

The geometric increase in FinTech in Nigeria and globally is attributed to the new social structure of FinTech facilitated by internet services and smart phones (World Bank, 2018; Global Findex 2017). The Nigerian Inter-Bank Settlement System (NIBSS) report revealed that between 2015-2018 about 43.6 million adult Nigerians enrolled for Bank Verification Number (BVN) and are financially included. Notwithstanding, the positive gains and impact of FinTech on financial inclusion, about 1.7 billion adults worldwide are not financial included and about 56million adult Nigerians fall into the categories of underbanked, unbanked, and financially excluded. Compare to South Africa with 31% of financially excluded and Kenya 44% among others. Triki and Faye (2013), argued that less than a quarter of adult Africans are financially included. The plausible reasons for this exclusion include and not limited to high cost, distance, and documentation requirements (Demirgüç-Kunt et al. 2018).

In the bid to financially include the excluded, the adequacy, relevance, and structure of the Nigerian financial system were examined in 1976 to provide an enabling climate for inclusive growth and development (Okigbo, 1976). With the 1977 rural banking scheme, focused on stirring the habit of banking, savings, and delivering credit facility to the active poor (Okafor, Chijindu & Anyalechi, 2017). Despite the decades of implementation of various financial and economic inclusion policies, available statistics show sub-optimal performance, in terms of credit accessibility falling below par; with only about 2% of Nigerians having access to formal credit compared to 32% of South Africans (World Bank, 2014).

On the other hand, 21.6% of Nigerians have access to formal payment systems compared to South Africa with 46% (Mckinsey Global Institute, 2014). The financial inclusion strategy was re-launched in 2012 with mandate to focused increasing adult access to financial products-service from 21.6% to 70% in 2020, savings from 24.0% to 60%, credit from 2% to 40%, insurance from 1% to 40%, and pension from 5% to 40% (Mckinsey Global Institute, 2014; Ayinde, Ganiyu, & Yinusa, 2016; Madichie, Maduka, Oguanobi, & Ekesiobi, 2014; Cyn-Young & Ragelio, 2015).

The financially excluded groups largely comprise of the rural dwellers in extreme poverty, living on an income of less than $2.00 per day, most commonly referred to as the "*Base of the Pyramid*" (BoP) (Udoh, Udo, Abner, Ike, Tingir & Ibekwe, 2016). Empirical studies on FinTech, financial inclusion, and economic growth globally revealed mixed and inconclusive results on the nexus. Bara and Mudzingiri, (2016) Paripunyapat and Kraiwanit, (2018). Manyika, Lund, Singer, White, and Berry, (2016) Kiilu, (2018) Azizah, and Choirin, (2018) Motsatsi (2016) on FinTech observed a significant impact and improvement on banks performance, cost-effective service delivery, transformed and restructured bank services and transaction. Kamalu, Ibrahim, Ahmad, and Mustapha (2019), Mlanga, (2019), Akhisar, Tunay, and Tunay, (2015), Lauret, (2018), Iqba and Sami, (2017); Niankara, and Muqattash (2018) on the causal link in cross-sectional study's reported mixed and inconclusive results.

Abaenewe, Ogbulu, and Ndugbu (2013); Akhisar, Tunay, and Tunay (2015) argued that cross-sectional studies cannot account for a specific country-level of economic, technological advancement, and financial development. Patrick (1966) substantiates this assertion arguing that country-specific heterogeneous factors influences the stages of a nation's economic and financial development.

In country-specific studies, Schindler (2017); Demir, Pesqué-Cela, Altunbas, and Murinde, (2020); Igoni, Onwumere, and Ogiri, (2020) reported mixed and inconclusive results, attributed to diverse measures and technique of analysis used.

Nigeria lags behind other emerging economies in Africa in FinTech ranking, adoption, stability and integrity, product outlets, consumers' protection, infrastructure and policy framework. Methodologically Nwanna, and Chinwudu (2016); Nkoro and Uko (2013); Akinwale (2018) Ndubuisi (2017) Alenoghena (2014); Nwafor and Aremu (2016) Igwe, Edeh and Ukpere (2016) Nwakobi, Oleka and Ananwude (2019) Balago (2014) used the classical linear regression model and other linear models predominately. Which begs the questions are the findings and results based on linearity assumption or earth evidence? Thus, casting a doubt on the validity of the results. Gunst and Mason (1980) argued that inferences drawn on the foundation of a distinct model are statistically questionable (p.169-206).

Nam, Pyun, and Arize (2002), Grassa, and Gazdar (2014) noted that the adoption of an alternative model will be of significance in policy formations. Similarly, Brooks (2014) argued that most economic and financial time series data are typically skewed and leptokurtic. Producing more outliers than the normal distribution. The variations and spikes render the linear models deficient for a wholesome and conclusive estimation. This study differs from previous studies by using the Johansen cointegration test, and the Granger non-causality test, a Toda–Yamamoto procedure that is applicable regardless of whether a series is I(0), I(1), or I(2), non-cointegrated, or cointegrated of any order. The Zivot and Andrews (1992) test for structural breaks and unit root was also adopted to check for the structural breaks. The broad objective of this study is to examine the effect of financial technology on economic growth in Nigeria on a quarterly period from 1999 to 2020.

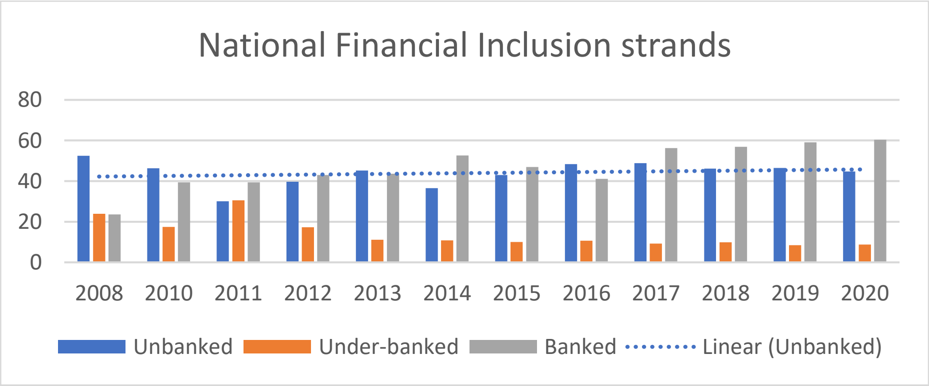
## 2. Review of Literature

### 2.1 FinTech, Financial Inclusion, and Economic Growth

The FinTech-financial inclusion nexus is theoretically underpinned on the premise that a large proportion of the financially excluded adults owns (or have) a mobile phone as an asset. The provision of financial services via mobile banking, agency banking, credit, and debit card payments, and internet banking and related devices could accelerate the inclusion of the excluded population (World Bank, 2016). The findings of Andrianaivo and Kpodar (2012); Ghosh (2016) revealed evidence of a robust nexus between the level of mobile phone penetration and financial inclusion across and within countries. Mobile technology and internet facilities are catalyst for digital financial inclusion (Chu, 2018). Households operating mobile money accounts are financially included (Jack & Suri, 2011; Mbiti & Weil 2011; Ouma, Odongo, & Were, 2017). Revealing a robust evidence of a positive impact of mobile money, on financial inclusion. FinTech drives financial growth facilitated monetary policy operation and extends financial products-services to the rural inhabitants who owns mobile phones but remain unbanked (or informally banked).

The lack of government and policy support, stability and integrity, products outlets, consumers' protection, and infrastructure significantly impede the prowess of the 902 microfinance banks and 22 deposit money banks operating in Nigeria for decades to close the exclusion and inclusion gap (see figure 1). On the contrary, ADB, (2016); ITU, (2016); Malady, (2016) argued that Fintech may not lead to increase financial inclusion but increased financial data inclusion. Financial data inclusion refers to the integration of individuals' biometric information to their bank accounts to license financial transactions that are verifiable and traceable to the individual.

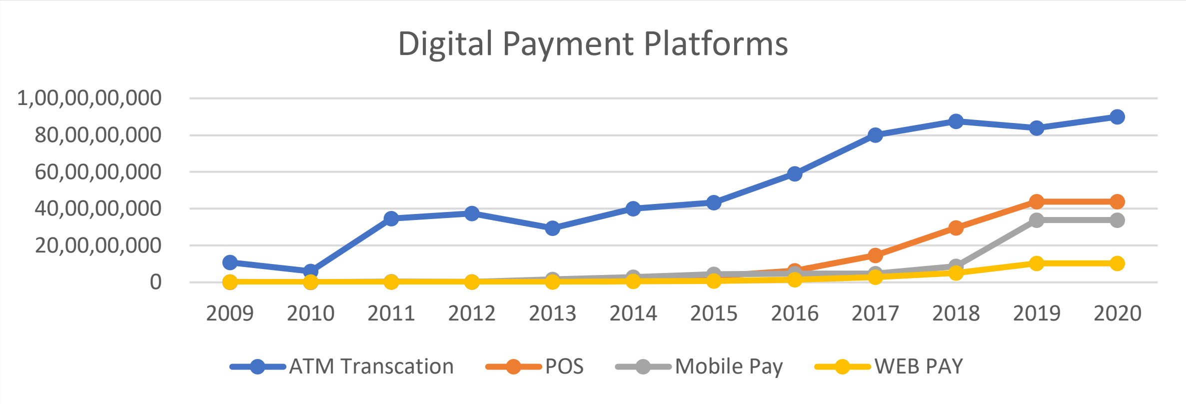
**Figure 1 National Financial Inclusion Strands (2008 - 2020)**




**Source:** Compiled by the author with survey data from EFinA, Intermedia & World Bank (2021)

Before the outbreak of Covid-19 businesses decline digital payment for products-services, due to high bank operational and transaction cost, possibility of fraud, among others. Malady (2016) argues that regardless of the aside from the increase in financial inclusion consumers with digital banking credentials, are not active users of the digital channels due to a lack of consumer trust and confidence. The lack of trust in digital finance channels by customers has significantly decreased financial inclusion in countries lacking consumer protection institutions and frameworks. ADB (2016) argued that a low level of financial literacy and low awareness of FinTech channels can significantly reduce customers' patronage of digital financial channels to perform basic financial platforms. This is evident in Nigeria from 2009-2017 for P.O.S, WEB PAY, and Mobile Pay (see figure 2). The recent geometric increase in the use of these digital financial channels can be attributed to the COVID-19 safety protocol of social distancing, long waiting in the banking halls, among others. Financial innovation has transformed and restructured banking services globally, and its impact on economies is becoming increasingly noteworthy (Bara and Mudzingiri, 2016).

**Figure 2: Access to Financial Service in Nigeria Volume of Transaction**




**Source:** Author (2020)

## 2.2 Theoretical Framework

The complexities of FinTech make it impracticable to establish a unifying theory that explains the growth impact of FinTech on financial inclusion and economic growth. Khraisha and Arthur (2018) identified a metatheory that groups and links FinTech in a way that explains the complex nature of financial innovation. Khraisha and Arthur (2018) classified financial innovation theories as follows:

**Table 1: Theoretical Summary**

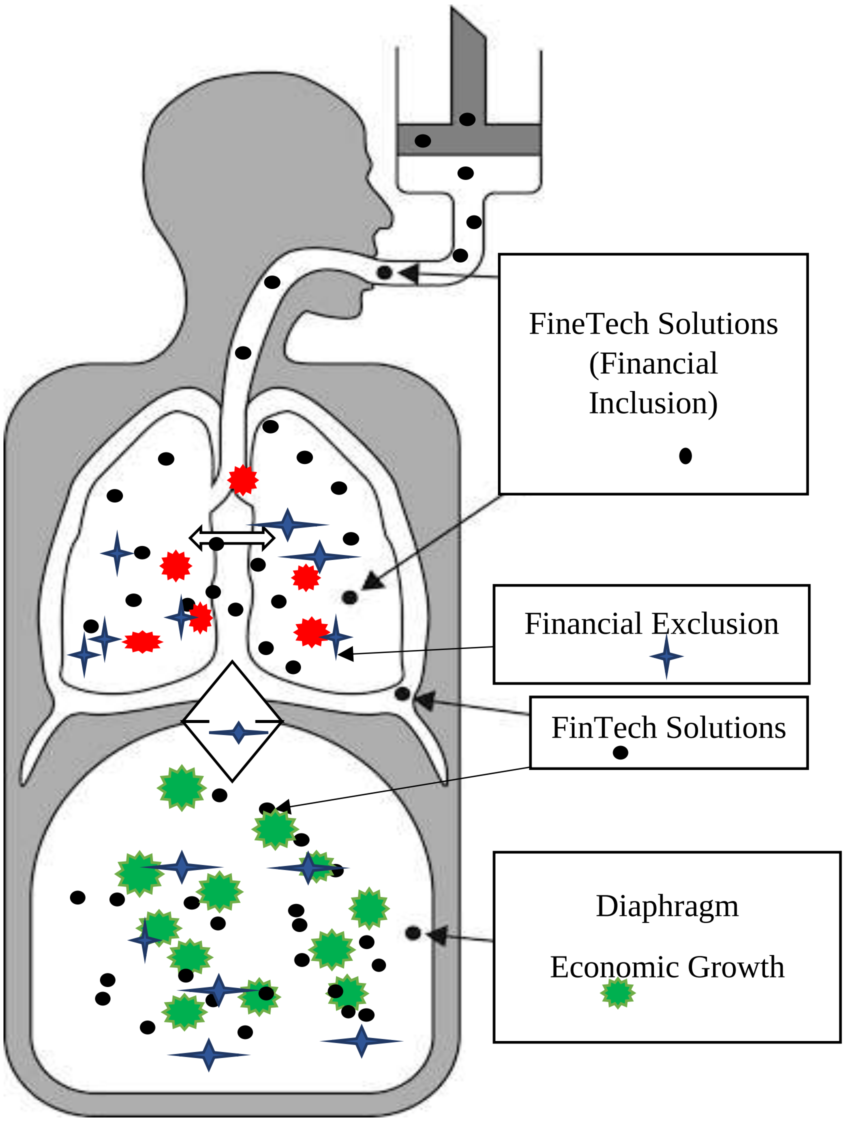
| Theories | Inference | Remark |
|---|---|---|
| Life cycle Theory and Evolution Theory | Fintech is a continuous uninterrupted process propelling the growth of the global financial system towards a specific goal of financial inclusion | Positive impact |
| Economic Theory | FineTech demand-supply forces for are an outcome of financial market participants responding to market imperfections and other inefficiencies. | Positive impact |
| Institutional and Behaviour Theories | Fintech is influenced by institutional or organisational changes or regulations. | positively impact |
| Endogenous Growth Theory | Financial intermediation enhances financial sector growth through investment, financial inclusion, and private sector development | Positive impact |
| Disruptive Innovation Theory and Diffusion of Innovation Theory | Innovation is key to the competitive advantage prowess of any organization. Disruptive innovation improves the growth of any company and lays down a new trend in the market. | Positive impact financial sector development |
| Constraint-Induced Financial Innovation Theory | Focus on profit maximization of a financial institution as the key reason for financial innovation. | Positive impact |
| Regulation Innovation Theory | Focus on the relationship between financial innovation and social regulation. | Positive impact |

**Author Computation (2021)**

**Lungs Model of FinTech, Financial Inclusion, and Economic Growth**

This study developed the lungs model to show economic reaction to financial inclusion through FinTech. Financial exclusion increases income inequality and extreme poverty rate. The economy is expected to respond positively to financial inclusion through the application of FinTech solutions of Point of Sale (POS); Mobile Pay; Web Pay; Remita; Automatic Teller Machine (ATM), Electronic Fund Transfer (NEFT) among others. To provide affordable, accessible, and available financial products services to all individuals irrespective of income level.

**Figure 3: Lungs Model of FinTech, Financial Inclusion, and Economic Growth**




**Source: Author (2021)**

Financial exclusion negatively impacts the economy causing extreme poverty

- FinTech Solutions positively impact the economy through financial inclusion

**Table 2 Summary of Empirical Review**

| Authors | Objective | Scope | Methodology |
|---|---|---|---|
| **Positive Results** | | | |
| Nwafor (2018) | Nexus between Internet Penetration and Financial Inclusion in Nigeria | Nigeria | Two-staged Regression analysis |
| Bara and Mudzingiri, (2016) | Financial innovation on economic growth | India | Autoregressive Distributed Lag (ARDL) |
| Turégano, & Herrero. (2018). | Financial Inclusion, Rather Than Size, is the Key to Tackling Income Inequality | Singapore | Inferential analysis |
| **Negative Results** | | | |
| Idun and Aboagye (2014) | Evaluated the relationship between bank competition, financial innovations, and economic growth | Ghana | ARDL, Granger causality |
| Tyavambiza and Nyangara (2015) | Financial invocation on economic growth | Tanzania | Granger causality |
| Adolfo Barajas, Ralph Chami and Seyed Reza Yousefi (2020) | Financial inclusion on economic growth | More than 130 countries 1975 to 2005 | Generalized Method of Moment (GMM) estimator. |
| FinTech on industries (Beck et al, (2016) | 20 industries | Africa | Regression Analysis |
| **Mixed Results** | | | |
| Okoye, Nwisienyi and Obi (2019) | Financial technological innovation and economic growth | Nigeria. Quarterly data form 2009 – 2019 | Autoregressive Distributed Lag (ARDL) |
| Idun and Aboagye (2014) | FinTech on economic growth | Ghana | ARDL |
| **Inclusive Results** | | | |
| Ozurumba and Charles (2019) | impact of financial innovation on economic growth in Nigeria | Nigeria 2012-2018 | Regression Analysis |
| Igoni, Onwumere and Ogiri (2020) | Examined the Nigerian digital finance environment and its economic growth: pain or gain | Nigeria 2012-2017 | Granger Causality |
| Okoye, Adetiloye, Erin, and Modebe (2019) | Financial inclusion as a strategy for Enhanced economic growth and development | Nigeria 1986-2015. | Regression Analysis |

**Source: Author (2021)**

## 3. METHODOLOGY

Grounded on theoretical underpinning which asserts that financial inclusion and economic growth nexus are influenced by FinTech and theoretically underpinned on the premise that a large proportion of the financially excluded adults owns (or have) a mobile phone as an asset but are not financially included. The Johansen cointegration test and the Granger non-causality test, a Toda–Yamamoto procedure were employed to analyse the long causal-effect nexus. The datasets are collated from the Central Bank of Nigeria (CBN) Statistical bulletins and World Bank Development indicators quarterly from 1999Q1 to 2019Q4. To test for the directional causality the Toda and Yamamoto (1995) model based on the estimation of augmented VAR model ($k+d_{max}$) where k is the optimal time lag on the first VAR model and $d_{max}$ is the maximum integrated order on the system's variables (VAR model) was adopted.

The Toda–Yamamoto procedure is applicable regardless of whether a series is I(0), I(1), or I(2), non-cointegrated or cointegrated of any order. This implies that it avoids the potential bias associated with unit root and cointegration tests (Rambaldi & Doran 1996) among others. The Johansen technique applies the maximum likelihood procedure to examine the existence of cointegrating vectors in non-stationary time series in a dimensional VAR (Baharumshah et al., 2008). Expressed with the variables matrix as shown in equation (1). The VAR of order k is considered in equation (1). The I(1) time series $X_{t-i}$ and $X_{t-k}$ are said to be cointegrated if a linear relationship exists of the form as in equation (1), where $X_t$ is I(0).

The VECM is expressed as: $\Delta Z_t = \Psi + \sum_{j=0}^{k-1} \mu_j \Delta Z_{t-j} + \Pi Z_{t-k} + \varepsilon_t$……………………………(eq 1)

**Where:** $\Delta$ = the first difference notation, $Z_t$ is the $p$x1 which is the vector of the n variables, $\psi$ is the $p$x1, constant vector demonstrating a direct movement in a system, and $k$ = Lag structure. The Gaussian white noise residual vector is represented by the $\varepsilon_t$.

While $\mu j$ is a $p$ $x$ $(k - 1)$ matrix that shows short-term changes between variables across $p$ equations at the $j^{th}$ lag, $\Pi$ is a (p $x$ $p$) coefficient matrix, which is the cointegrating vectors.

To assess the reduced rank of the matrix $\Pi$, the vector error correction model of Johansen and Juselius (1991) employs: The $\lambda_{Trace} = -T \sum_{i=r+1}^{p} In(1-\lambda_t)$, which is the trace statistics and $\lambda_{max} = -Tin\ (1- \lambda_r +_t)$, which represents the Maximum Eigenvalue method. Where T represents the number of observations in the sample study, $r$ is the number of individual series and $\lambda$ is the Eigenvalues. To assess the short-run interrelationship between the variables, we used the Vector Error-Correction Model (VECM), which is a controlled form of VAR with the inbuilt specification. We specify the VECM for the short-run relationship as follows:

$\Delta In\ Y_t = \beta + \sum_{K=1}^{p} \mu^{2k}\ \Delta InX_{t-k} + \sum_{K=1}^{p} \delta_{2k}\ \Delta In\ Y_{t-k} + \lambda_2{}^{\alpha\ t-1} + \varepsilon_t$……………………………(eq 2)

$\Delta In\ X_t = \beta + \sum_{K=1}^{p} \mu^{1k}\ \Delta InX_{t-k} + \sum_{K=1}^{p} \delta_{1k}\ \Delta In\ Y_{t-k} + \lambda_1{}^{\alpha\ t-1} + \varepsilon_t$……………………………(eq 3)

**Where** $\lambda_1$ and $\lambda_2$ are the coefficients for the error correction that signifies the promptness of change to restore the long-run equilibrium connection between the variables and $\alpha_{t-1}$ represents the error correction term from the cointegration model. The short-run dynamics of the variables are captured using $\Delta In\ Y_{t-k}$ and $\Delta In\ X_{t-k}$.$^s$

To test for the causal nexus the augmented Granger causality test developed by Toda and Yamamoto (1995) is expressed as following the VAR system:

$$RGDP_t = \alpha_0 + \sum_{j=1}^{k+dmax} \alpha_{1j}RGDP_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{2j}DINB_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{3j}MOBP_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{4j}WEB_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{5j}DR\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{6j}M3\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{7j}CPS\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{8j}BBS_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{9j}INP_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{10j}ALR_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{11j}GIN_{t-j} + \sum_{j=1}^{k+dmax} \alpha_{12j}ATM_{t-j} + \varepsilon_{1t} \ldots\ldots (eq3)$$

$$ATM_t = \lambda_0 + \sum_{j=1}^{k+dmax} \lambda_{1j}RGDP_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{2j}DINB_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{3j}MOBP_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{4j}WEB_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{5j}DR\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{6j}M3\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{7j}CPS\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{8j}BBS_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{9j}INP_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{10j}ALR_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{11j}GIN_{t-j} + \sum_{j=1}^{k+dmax} \lambda_{12j}ATM_{t-j} + \varepsilon_{2t} \ldots\ldots (eq4)$$

$$DINB_t = \varphi_0 + \sum_{j=1}^{k+dmax} \varphi_{1j}RGDP_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{2j}DINB_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{3j}MOBP_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{4j}WEB_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{5j}DR\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{6j}M3\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{7j}CPS\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{8j}BBS_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{9j}INP_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{10j}ALR_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{11j}GIN_{t-j} + \sum_{j=1}^{k+dmax} \varphi_{12j}ATM_{t-j} + \varepsilon_{3t} \ldots\ldots (eq5)$$

$$MOBP_t = \delta_0 + \sum_{j=1}^{k+dmax} \delta_{1j}RGDP_{t-j} + \sum_{j=1}^{k+dmax} \delta_{2j}DINB_{t-j} + \sum_{j=1}^{k+dmax} \delta_{3j}MOBP_{t-j} + \sum_{j=1}^{k+dmax} \delta_{4j}WEB_{t-j} + \sum_{j=1}^{k+dmax} \delta_{5j}DR\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \delta_{6j}M3\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \delta_{7j}CPS\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \delta_{8j}BBS_{t-j} + \sum_{j=1}^{k+dmax} \delta_{9j}INP_{t-j} + \sum_{j=1}^{k+dmax} \delta_{10j}ALR_{t-j} + \sum_{j=1}^{k+dmax} \delta_{11j}GIN_{t-j} + \sum_{j=1}^{k+dmax} \delta_{12j}ATM_{t-j} + \varepsilon_{4t} \ldots\ldots (eq6)$$

$$WEB_t = \pi_0 + \sum_{j=1}^{k+dmax} \pi_{1j}RGDP_{t-j} + \sum_{j=1}^{k+dmax} \pi_{2j}DINB_{t-j} + \sum_{j=1}^{k+dmax} \pi_{3j}MOBP_{t-j} + \sum_{j=1}^{k+dmax} \pi_{4j}WEB_{t-j} + \sum_{j=1}^{k+dmax} \pi_{5j}DR\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \pi_{6j}M3\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \pi_{7j}CPS\text{-}GDP_{t-j} + \sum_{j=1}^{k+dmax} \pi_{8j}BBS_{t-j} + \sum_{j=1}^{k+dmax} \pi_{9j}INP_{t-j} + \sum_{j=1}^{k+dmax} \pi_{10j}ALR_{t-j} + \sum_{j=1}^{k+dmax} \pi_{11j}GIN_{t-j} + \sum_{j=1}^{k+dmax} \pi_{12j}ATM_{t-j} + \varepsilon_{5t} \ldots\ldots (eq7)$$

**Where:**

k is the lag length, (k + dmax) is the order of VAR: $\alpha_{j's}$, $\lambda_{j's}$, $\varphi_{j's}$, $\delta_{j's}$, $\psi_{j's}$, $\pi_{j's}$, and $\psi_{j's}$, are parameters to be estimated; and $\varepsilon_{1t}$, $\varepsilon_{2t}$, $\varepsilon_{3t}$, $\varepsilon_{4t}$, and $\varepsilon_{5t}$ are error terms that are assumed to be white noise. For the relationship between $ATM_t$ and $RGDP_t$, equations (3) and (4) are relevant. Causality runs from $ATM_t$ to $RGDP_t$ if, $a_{2j} \neq 0$ in equation (3), and from $RGDP_t$ to $ATM_t$, if $\lambda_{1j} \neq 0$ in Equation (4). If $\alpha 2j \neq 0$ and $\lambda 1j \neq 0$ do (not) hold simultaneously then, there is a feedback (independent) relationship between $ATM_t$ and $RGDP_t$.

The relationship between $RGDP_t$ and $DINB_t$ equations (3) and (5) are relevant. Unidirectional causality runs from DINB to RGDP if, at least some $a_{3j} \neq 0$ in (5) and all $\varphi_{1j}$'s $\neq 0$ in (3) and; from $RGDP_t$ to $DINB_t$ if, all $a_{3j} \neq 0$ in (3) and at least some all $\varphi_{1j}$'s $\neq 0$ in (5). The relationship between $RGDP_t$ and $MOBP_t$ is defined by equations (3) and (5).

Unidirectional causality runs: from $MOBP_t$ to $RGDP_t$ if, at least some $a_{4j} \neq 0$ in (6) and all $\varphi_{j's,}$ $\neq 0$ in (3) and; from $RGDP_t$ to $MOBP_t$ if, at least some $\varphi_{j's,}$ $\neq 0$ in (3) and all $a_{4j} \neq 0$ in (6). Feedback relationship exists if $a_{4j} \neq 0$ in (3) and $\varphi_{j's,}$ $\neq 0$ in (6) in holds simultaneously. The relationship is independent of all $\varphi_{j's,}$ = 0 and all $a_{4j}$ = simultaneously. Similarly, unidirectional causality runs: from $WEB_t$ to $RGDP_t$ if, at least some $a_{5j} \neq 0$ in (7) and all $\pi_j \neq 0$ in (3) and; from $RGDP_t$ to $WEB_t$ if, at least some $\pi_j \neq 0$ in (3) and all $a_{5j} \neq 0$ in (7). There is feedback if, at least some $a_{5j} \neq 0$ in (7) and some $\pi_j \neq 0$ in (3) holds simultaneously, and independence exists if, all $a_{5j} \neq 0$ in (3) and some $\pi_j \neq 0$ in (7).

**Where:** Y = Dependent variable

$\beta_0$ = Constant; the value Y assumes when the independent variable is zero

$\beta_1$- $\beta_7$ = Coefficient; the rate of change in Y

$X_1$-$X_7$ = The independent variables

$\mu_t$ = Error Term

**Financial Technology:** ATM = Depth of Automated Teller Machine; DINB = Depth of Internet Banking; MOBP = Depth of Mobile Pay (Mobile Money); WEB = Web Pay

**Financial Inclusion Proxy by Financial Deepening:** DR-GDP = The ratio of deposits-GDP or credit-GDP or (deposit + credit)/GDP; M3-GDP = M3; Money supply percentage of GDP; CPS-GDP = Bank loans to small scale enterprises percentage of GDP

BBS = Bank Branch Spread, (Urban and Rural).

**Economic Growth:** RGDP = Real Gross Domestic Product

**Control Variables**: INP = Internet penetration rate per 100; ALR = Adult literacy rate; GIN = Gini coefficient.

# 4. DATA PRESENTATION AND ANALYSES

## 4.1 Descriptive Statistics

**Table 3 Basic descriptive statistics as they concern the variables under study**

| | RGDP | ATM | DINB | MOBP | WEB | M3GDP | DRGDP | CPSGDP | BBS | ALR | GINI | INP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 10.75 | 10.78 | 9.23 | 9.20 | 8.76 | 18.92 | 8.85 | 14.70 | 4.27 | 58.49 | 46.17 | 9.75 |
| Median | 10.86 | 18.21 | 13.80 | 14.18 | 14.38 | 20.97 | 9.70 | 17.45 | 4.71 | 55.92 | 45.40 | 8.23 |
| Std. Dev. | 0.38 | 9.91 | 8.64 | 8.55 | 8.12 | 4.80 | 3.21 | 5.25 | 1.94 | 6.26 | 4.47 | 9.14 |
| Skewness | -0.55 | -0.17 | -0.07 | -0.10 | -0.12 | -0.30 | -0.77 | -0.30 | -0.76 | 0.54 | 0.63 | 1.17 |
| Kurtosis | 1.94 | 1.042 | 1.13 | 1.10 | 1.09 | 1.41 | 2.44 | 1.26 | 2.21 | 1.99 | 2.65 | 4.07 |
| Jarque-Bera | 8.65 | 14.48 | 12.80 | 13.29 | 13.56 | 10.57 | 9.99 | 12.42 | 10.89 | 8.04 | 6.37 | 24.38 |
| Proba… | 0.013 | 0.071 | 0.016 | 0.013 | 0.011 | 0.050 | 0.067 | 0.020 | 0.043 | 0.017 | 0.041 | 0.0005 |

**Source: Author (2021)**

The results show the basic descriptive statistics metrics with an emphasis on aggregative averages of "mean and median" and measures of dispersion of the normal and relative standard deviation dimensions. The skewness measures the degree of departure from symmetry and kurtosis the peakedness or flatness of the observation. The Jacque-Bera Statistics is used as a benchmark for normality. The mean and the median values of the variables show that values are not too far from each other. Indicating no extreme projection and hence, making the variables standard for analysis. The study variables showed a positive mean return indicating an increasing impact of fintech and financial inclusion on economic growth in Nigeria. The standard deviations of the variables have lower values than their means values. This is an indication that the variables are not highly volatile around their respective mean values.

## 4.2 Unit Root Test

To confirm the stationarity properties of the series, variants of traditional and structural breaker liable unit root tests were conducted. The Augmented Dickey-Fuller (ADF), a serial technique for unit root test was employed with the Zivot and Andrews (1992) structural break test as robustness. The results shown in table (4) below revealed that the variables are integrated in the same order. That is the order I (1) first difference. Having confirmed that all the series are integrated of the same order. The precondition for the application of the Johansen (1988) and the Johansen and Juselius (1990) multivariate cointegration technique to determine the number of cointegrating vectors is met. The break dates fall 2010Q4, 2012Q3, 2013Q3, and 2015Q4 while financial inclusion break dates fall between 2010Q1, 2008Q1 and 2008Q1. Economic growth 2010Q1.

**Table 4 Unit Root Test Results**

| Traditional ADF (Trend and Intercept) | | | | Zivot and Andrews Unit Root Test (Trend and Intercept) | | | |
|---|---|---|---|---|---|---|---|
| **Variables** | **ADF Stat** | **Critical Value (0.05)** | **Order of Integration** | **ZAU Stat** | **Critical Value (0.05)** | **Break Date** | **Inference** |
| LogATM | -6.438 | -3.520 | I (1) | -8.13 | -5.09 | 2010Q4 | Stationary |
| LogRGDP | -8.085 | -3.467 | I (1) | -5.89 | -4.42 | 2010Q1 | Stationary |
| LogDINB | -5.101 | -3.529 | I (1) | -8.30 | -5.08 | 2012Q3 | Stationary |
| LogMOBP | -6.848 | -3.520 | I (1) | -8.78 | -5.08 | 2013Q3 | Stationary |
| LogWEB | -5.827 | -3.540 | I (1) | -8.76 | -5.08 | 2015Q4 | Stationary |
| LogDRGDP | -9.023 | -3.465 | I (1) | -5.44 | -4.08 | 2010Q1 | Stationary |
| M3-GDP | -9.07 | -3.465 | I (1) | -5.72 | -4.18 | 2008Q1 | Stationary |
| BBS | -7.87 | -3.48 | I (1) | -5.72 | -4.18 | 2008Q1 | Stationary |
| ALR | -8.91 | -3.46 | I (1) | -7.02 | -5.08 | 2008Q1 | Stationary |
| GINI | -7.94 | -3.47 | I (1) | -8.16 | -4.42 | 2003Q3 | Stationary |
| INP | -8.95 | -3.46 | I (1) | -8.90 | -5.08 | 2019Q4 | Stationary |
| CPS-GDP | -9.26 | -3.46 | I (1) | -6.09 | -5.08 | 2008Q1 | Stationary |

**Source: Authors Computation (2021)**

### 4.3 Cointegration Test

The cointegrating vectors are presented and discussed in Table 5, under the assumption that the series has a linear deterministic trend. The critical values were derived assuming no exogenous series. The Eigenvalue statistics indicate (9) cointegrating equations at a 95% confidence level. Signifying the rejection of the hypothesis at a 5% critical value. The presence of co-integration indicates shocks and diverges in the short run that may influence the individual series quarterly speed of converges with time in the long run. On the premise of the presence of cointegration, VECM was conducted.

**Table 5: Cointegration Test Results**

| Hypothesized Coefficients | Eigenvalue | Trace Statistic | Critical Value (5%) | Prob.** |
|---|---|---|---|---|
| None * | 0.500000 | 361.8084 | 285.1425 | 0.0000 |
| At most 1 * | 0.495909 | 305.6635 | 239.2354 | 0.0000 |
| At most 2 * | 0.452940 | 250.1786 | 197.3709 | 0.0000 |
| At most 3 * | 0.439779 | 201.3196 | 159.5297 | 0.0000 |
| At most 4 * | 0.418811 | 154.3863 | 125.6154 | 0.0003 |
| At most 5 * | 0.377972 | 110.4292 | 95.75366 | 0.0033 |
| At most 6 * | 0.234363 | 71.97281 | 69.81889 | 0.0333 |
| At most 7 * | 0.212818 | 50.34203 | 47.85613 | 0.0286 |
| At most 8 * | 0.187368 | 30.95911 | 29.79707 | 0.0366 |
| At most 9 | 0.130701 | 14.15343 | 15.49471 | 0.0788 |
| At most 10 | 0.034072 | 2.807910 | 3.841466 | 0.0938 |

*Trace test indicates 9 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; **MacKinnon-Haug-Michelis (1999) p-values*

### 4.4 Vector Error Correction Model Estimation

The VECM measures the speed of convergence from short-run disequilibrium instigated by unfriendly FinTech regulations, customers' lack of trust and confidence in the various digital financial channels, financial and individual bottlenecks among others back to long-run equilibrium. VECM is measured as the effects of residual from the long-run model.

The short-run imbalance and dynamic structure are expressed as VECM. The VECM results presented in Table 6 shows the fitting degree of VECM model $R^2 > 0.5$, and AIC and SC criteria values are relatively small, which indicates the reasonability of the model estimation. The zero average line represents a stable and long-term equilibrium relationship among variables.

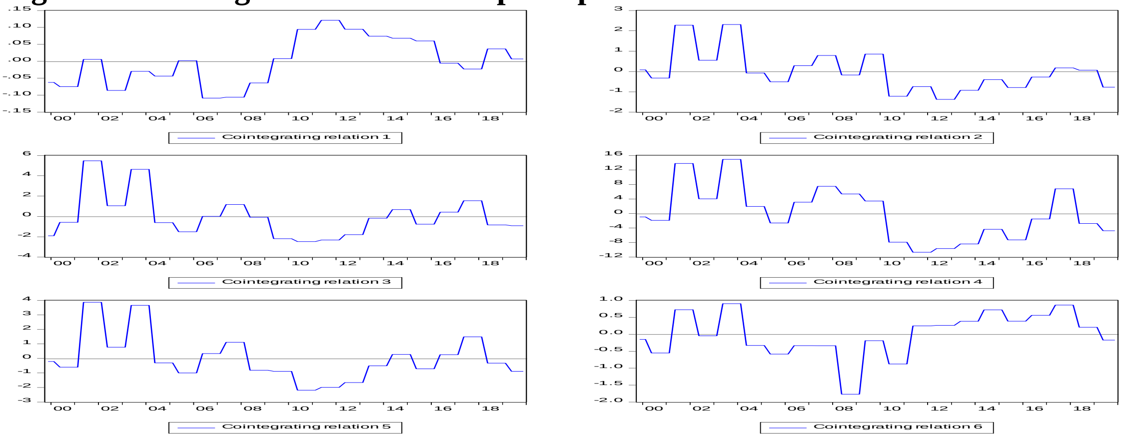
Figure 4 revealed the significant fluctuational effect of financial exclusion due to regulatory, institutional, individual and government bottlenecks on FinTech usage for financial inclusion and economic growth. The fluctuational effect shows that the short-term fluctuation within the period significantly deviated from the long-term equilibrium relationship. The short-term fluctuation effect shows a sharp increase in the gap between financial inclusion and exclusion gap. (see figure. 4).

**Table 6: Vector Error Correction Model Estimation**

| Error Correction: | D(LOGRGDP) | D(LOGWEB) | D(LOGMOBP) | D(LOGDRGDP) | D(LOGDINB) | D(LOGATM) | D(ALR) | D(M3GDP) | D(BBS) | D(GINI) | D(INP) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CointEq1 | -0.056 | 1.5647 | 1.6610 | -4.8526 | 0.7583 | 1.5278 | 2.2185 | -9.5306 | 650.60 | 3.5009 | 15.239 |
| | [-0.30] | [ 0.990] | [ 0.599] | [-0.84] | [ 0.556] | [ 1.051] | [ 0.110] | [-1.45] | [ 1.116] | [ 0.490] | [ 0.730] |
| CointEq2 | 0.017 | -0.7949 | -0.017 | -0.6636 | -0.2107 | -0.2267 | 0.2979 | 0.7618 | 54.445 | -1.0269 | -0.5395 |
| | [ 0.926] | [-5.02] | [-0.06] | [-1.14] | [-1.54] | [-1.55] | [ 0.147] | [ 1.163] | [ 0.934] | [-1.43] | [-0.25] |
| CointEq3 | 0.0195 | -0.0801 | -0.5416 | -0.1332 | -0.0480 | 0.0131 | -1.239 | 0.6399 | 37.027 | -1.3335 | -1.0924 |
| | [ 0.133] | [-0.64] | [-2.48] | [-0.29] | [-0.44] | [ 0.115] | [-0.78] | [ 1.243] | [ 0.808] | [-2.37] | [-0.66] |
| CointEq4 | -0.0408 | 0.0476 | -0.056 | -0.314 | -0.050 | 0.0354 | -0.3807 | -0.1470 | -2.5345 | 0.0364 | -0.3383 |
| | [-0.99] | [ 1.366] | [-0.93] | [-2.46] | [-0.16] | [ 0.110] | [-0.85] | [-1.01] | [-0.19] | [ 0.231] | [-0.73] |
| CointEq5 | 0.0283 | 0.4320 | 0.7910 | 1.8250 | 0.1173 | 0.1511 | 4.0044 | -1.3294 | -16.149 | 2.0660 | 2.1346 |
| | [ 0.082] | [ 1.467] | [ 1.531] | [ 1.696] | [ 0.461] | [ 0.557] | [ 1.065] | [-1.08] | [-0.14] | [ 1.553] | [ 0.549] |
| CointEq6 | -0.0139 | -0.2045 | 0.062 | -0.580 | 0.055 | -0.351 | -2.592 | 0.1958 | -36.677 | -0.4311 | -1.5486 |
| | [-0.63] | [-1.10] | [ 0.192] | [-0.85] | [ 0.349] | [-2.06] | [-1.09] | [ 0.255] | [-0.53] | [-0.51] | [-0.63] |
| CointEq7 | 0.0584 | -0.1203 | -0.0194 | 0.0228 | -0.0710 | -0.0278 | -0.3067 | 0.0698 | 1.3770 | -0.0382 | -0.0111 |
| | [ 0.518] | [-1.25] | [-0.11] | [ 0.649] | [-0.85] | [-3.15] | [-2.50] | [ 1.75] | [ 0.38] | [-0.88] | [-0.08] |
| CointEq8 | -0.048 | -0.0533 | -0.1053 | -0.012 | -0.024 | -0.0903 | -0.302 | -0.059 | 4.875 | -0.2219 | -0.1357 |
| | [ 1.270] | [-0.16] | [-1.84] | [ 0.010] | [-0.87] | [-0.30] | [-0.73] | [-0.04] | [ 0.407] | [-1.51] | [-0.31] |
| CointEq9 | -4.6805 | -0.0152 | -0.0172 | -0.0015 | -0.0241 | 6.88 | -0.0026 | 0.0104 | -1.1059 | 0.0027 | -0.0106 |
| | [-0.38] | [-0.14] | [-0.93] | [-0.39] | [-0.26] | [ 0.071] | [-0.19] | [ 2.404] | [-2.85] | [ 0.573] | [-0.76] |
| R-squared | 0.352 | 0.4342 | 0.3796 | 0.3784 | 0.3230 | 0.3709 | 0.1525 | 0.3217 | 0.3844 | 0.3429 | 0.1482 |
| F-statistic | 0.8620 | 1.2133 | 0.9674 | 0.9623 | 0.7541 | 0.9321 | 0.2844 | 0.7497 | 0.9872 | 0.8250 | 0.2751 |
| Log likelihood | 186.44 | 12.846 | -32.675 | -92.103 | 24.823 | 19.611 | -193.38 | -102.27 | -465.86 | -109.25 | -196.14 |
| Akaike AIC | **-3.813** | **0.472** | **1.596** | **3.064** | **0.177** | **0.3058** | **5.565** | **3.315** | **12.292** | **3.487** | **5.6331** |
| Schwarz SC | -2.867 | 1.4188 | 2.5428 | 4.0102 | 1.1231 | 1.2518 | 6.5110 | 4.2614 | 13.238 | 4.4336 | 6.5791 |

Source: Author' s Computation (2022)

**Figure. 4: Cointegration Relationship Graph.**




Source: Author (2022)

**Granger causality/Wald Test**

The VAR Granger causality/Wald test approach, computed statistics asymptotically follow the chi-square ($x^2$) distribution irrespective of the order of integration of the variables. Results for the Toda–Yamamoto augmented Granger causality test are reported in Table 7. At a 5% level of significance, the augmented Granger causality test reveals a mixed causal nexus between fintech, financial inclusion and economic growth in Nigeria. The augmented Granger causality test reveals that there is a bidirectional and feedback causality between fintech (ATM), financial inclusion, and economic growth variables at a 5% level. The economic growth equation has a chi-square ($X^2$) value of 10.83655 with a p-value of 0.0195, suggesting rejection of the null hypothesis that fintech and financial inclusion variables do not Granger-cause economic growth.

Internet banking (DINB) has a non-causal nexus with financial inclusion and economic growth variables jointly and individually. The economic Growth equation has a chi-square ($X^2$) value of 27.41474 with a probability value of 0.0371, which does not suggest rejection of the null hypothesis that fintech and financial inclusion variables Granger-cause economic growth. However, adult literacy Granger-cause fintech at 5% and there is no evidence of feedback.

Web pay (WEB) has a bidirectional and feedback causality with financial inclusion and economic growth variables jointly and not individually. The chi-square ($X^2$) value of 4.44689 with a p-value of 0.0979, suggest rejection of the null hypothesis that fintech and financial inclusion variables do not Granger-cause economic growth. There is evidence of feedback, which means that economic growth Granger-cause fintech and financial inclusion at 5% level in the models with fintech variable of (WEB) as the dependent variable.

Mobile money (MOBP) has a non-causal nexus with financial inclusion and economic growth variables jointly and individually in the model. The chi-square ($X^2$) value of 26.98351 with a p-value of 0.0417, does not suggest rejection of the null hypothesis that fintech and financial inclusion variables Granger-cause economic growth. Adult literacy Granger-cause fintech at 5% and there is no evidence of feedback at 5% level in the models with fintech variable of MOBP) and economic growth as the dependent variables. The findings collaborated in the studies conducted by Ajide, (2016); Akinwale (2018); Akinwunmi, Muturi, and Ngumi (2016); Ahmed-Ishmel, Onyeiwu and Onyeiwu (2018); Ansong, Marfo-Yiadom, and Ekow-Asmah (2011) among others. Finally, the results from this study tend to corroborate the evidence (Arestis and Demetriades, 1996) that the causal link between finance and growth is crucially determined by the nature and operation of financial institutions and policies pursued in each country.

**Table 7 Toda–Yamamoto Augmented Granger Causality**

| Dependent variable: LOGRGDP | | | |
|---|---|---|---|
| Excluded | Chi-sq | Df | Prob. |
| LOGATM | 9.018732 | 2 | 0.0044 |
| LOGDR_GDP | 8.249488 | 2 | 0.0354 |
| CPS_GDP | 8.272201 | 2 | 0.0028 |
| M3_GDP | 0.145714 | 2 | 0.9297 |
| BBS | 0.592882 | 2 | 0.7435 |
| ALR | 7.032204 | 2 | 0.0840 |
| GINI | 3.313409 | 2 | 0.8550 |
| INP | 9.751459 | 2 | 0.0868 |
| All | 10.83655 | 16 | 0.0195 |
| Dependent variable: LOGDINB | | | |
| Excluded | Chi-sq | Df | Prob. |
| LOGRGDP | 3.035073 | 2 | 0.2193 |
| LOGDR_GDP | 0.440403 | 2 | 0.8024 |
| M3_GDP | 0.109390 | 2 | 0.9468 |
| CPS_GDP | 0.324591 | 2 | 0.8502 |
| BBS | 0.134033 | 2 | 0.9352 |
| GINI | 2.448419 | 2 | 0.2940 |
| INP | 0.060683 | 2 | 0.9701 |
| **ALR** | **4.787916** | **2** | **0.0913** |
| **All** | **27.41474** | **16** | **0.0371** |
| **Dependent variable: LOGMOBP** | | | |
| Excluded | Chi-sq | Df | Prob. |
| LOGRGDP | 3.670367 | 2 | 0.1596 |
| LOGDR_GDP | 0.099997 | 2 | 0.9512 |
| CPS_GDP | 0.243152 | 2 | 0.8855 |
| M3_GDP | 0.105917 | 2 | 0.9484 |
| BBS | 0.106691 | 2 | 0.9481 |
| GINI | 2.765451 | 2 | 0.2509 |
| INP | 0.040020 | 2 | 0.9802 |
| **ALR** | **5.564238** | **2** | **0.0619** |
| **All** | **27.75782** | **16** | **0.0338** |
| **Dependent variable: LOGWEB** | | | |
| Excluded | Chi-sq | Df | Prob. |

| | | | |
|---|---|---|---|
| LOGRGDP | 9.293191 | 2 | 0.0340 |
| LOGDR_GDP | 0.511039 | 2 | 0.7745 |
| CPS_GDP | 0.200182 | 2 | 0.9048 |
| BBS | 0.010840 | 2 | 0.9946 |
| M3_GDP | 0.179089 | 2 | 0.9143 |
| GINI | 8.796817 | 2 | 0.0072 |
| INP | 0.068555 | 2 | 0.9663 |
| ALR | 4.681320 | 2 | 0.0963 |
| All | 26.98351 | 16 | 0.0417 |

Source: Author' s Computation (2022)

**Conclusion**

Theoretically financial, institutional, regulatory, and individual tailbacks taking on financial market imperfections, information asymmetries and transaction costs increases the financial exclusion gap. FinTech is a key enabler of financial inclusion to drive economic growth. The study investigated the effect of financial technology and financial inclusion on economic growth in Nigeria. Using annualized quarterly time-series data from 1999Q1-2020Q4. The Johansen and Juselius (1991) cointegration model and vector error correction model (VECM), was adopted to test for a co-integrating vector nexus. The Toda-Yamamoto causality test was also employed to investigate the causal nexus. Most empirical studies review examines used predominately the linear model. The major conclusions of this study can be drawn from our findings. FinTech reduces the financial exclusion gap, income inequality and poverty indirectly through its effects on financial inclusion. Financial inclusion increases economic growth, creates employment and financial sector development. Nigeria has a lower degree of financial inclusion.

The growth or developmental effect of fintech positively and significantly influences the traditional business operations of the traditional financial institutions. To provide affordable, accessible, flexible financial products and services to the base of the pyramid. Policy implications. FinTech aims to close the financial exclusion via an all-inclusive financial system that benefits the base of the pyramid through increased access to appropriate financial products-services to stimulate economic growth. The role of FinTech in this regard is vital by expanding account ownership among the unbanked, and account use among the banked. FinTech-financial inclusion nexus is an effective policy option for growth and development in Nigeria. The inability to achieve this policy objective can be attributed to the absence of adequate financial infrastructure, appropriate (consumer protection) regulations, and basic financial literacy. There is a dare need for a favourable FinTech and financial inclusion climate to serve low-income groups.

FinTech and financial policies alone are not enough to address the problem of income inequality, poverty, and financial exclusion. Fiscal policies are vital in addressing these issues. In this sense, financial inclusion should be accompanied by fiscal redistribution.

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