

Digital Financial Services and Economic Development in Nigeria: A Short-Run Vector Autoregressive Analysis

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Abstract

The study examined the short-run effect of digital financial services on human development in Nigeria, using quarterly data on Automated Teller Machine (ATM), mobile payment, point-of-sale (POS), and web payment transactions against the Human Development Index (HDI) for the period 2012Q1–2023Q4. The study applied the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit-root test, the Johansen cointegration test, and Vector Autoregression (VAR), estimated in E-Views 12. All series were found to be integrated of order one, $I(1)$, with no evidence of cointegration among them. The VAR estimates show that HDI is driven almost entirely by its own past values (coefficient = 0.944, $t = 6.24$), while none of the four digital financial services channels has a statistically significant short-run effect on HDI. The only significant cross-channel relationship is a positive effect of mobile payments on subsequent ATM activity. These findings suggest that, in the short run, Nigeria's digital financial services ecosystem remains fragmented and that human development responds to sustained, cumulative processes rather than immediate financial-technology shocks. The study recommends complementary, sustained investment in education, health, and digital infrastructure alongside digital financial services expansion.

Keywords: Digital Financial Services; Human Development Index; Vector Autoregression; Financial Inclusion

1.0 Introduction

Nigeria has undergone a rapid transformation from brick-and-mortar banking toward a digitally driven financial system. This shift has been propelled by a series of Central Bank of Nigeria (CBN) policy reforms, including the National Financial Inclusion Strategy (2012), the Cashless Policy (2012), and the licensing of Payment Service Banks (2018). These reforms catalyzed a fintech boom, alongside the expansion of USSD banking for reaching rural and semi-urban populations, and culminated in the 2021 launch of the eNaira, Africa's first central bank digital currency (CBN, 2021). Digital financial services (DFS) are theorized to expand financial inclusion, ease access to credit, and improve service delivery. Yet economic development is broader than economic growth: it encompasses living standards, education, healthcare and income distribution, not merely output (Todaro & Smith, 2020). This distinction motivates the use of the Human Development Index (HDI) rather than a purely output-based measure as the outcome variable in this study. Despite rapid DFS adoption, Nigeria continues to record persistently weak human-development outcomes, raising the question of whether DFS growth translates into measurable, timely gains in human development, or whether any such gains, if they exist, take longer to materialize than a single financial reporting period.

This study therefore examines the short-run effect of four DFS channels; ATM, POS, mobile banking, and web pay on HDI in Nigeria, using a Vector Autoregression framework. The specific objectives are to determine the short-run effect of ATM, POS, mobile banking, and web pay on HDI. The corresponding null hypotheses are that no significant relationship exists between HDI and each of ATM, POS, mobile banking, and web pay, respectively.

2.0 Literature Review

Theoretical Framework

Three complementary theories underpin the analysis. The Technology Acceptance Model (Davis, 1989) holds that adoption of digital financial tools is driven by perceived usefulness and perceived ease of use, which in turn shape economic outcomes. Innovation Diffusion Theory (Rogers, 1983) explains that DFS adoption follows an S-curve across adopter categories, with impact accelerating once penetration passes a critical mass implying that effects may not be detectable within a single short-run lag. Schumpeter's Theory of Innovation (Schumpeter, 1934) frames DFS as a process of creative destruction, in which new financial products and market structures gradually displace older, less efficient arrangements, producing effects that are often non-linear and delayed rather than immediate.

Empirical Review

Empirical findings on the relationship between DFS and economic outcomes in Nigeria and comparable economies are mixed. Marshal (2024) found that ATM transactions and mobile banking applications positively and significantly affect economic growth, while POS was insignificant. Miftahu and John (2024) found that the digital economy significantly affects youth unemployment in Nigeria. Olubukola, Ikpefan, Akinrinola and Itai (2023) found that mobile banking, POS and ATM positively affect GDP, while web-based services showed a negative relationship. Appah, Tebepah and Newstyle (2023), applying a VECM to Nigerian data (2006–2021), found that POS and web banking had significant positive effects on real GDP, while ATM and mobile banking were positive but statistically insignificant. Ighoroje and Okoroyibo (2020) found that ATM and internet banking positively and significantly affected return on equity among Nigerian deposit money banks, while mobile banking had a significant negative effect. Enock and Lusekelo (2024), using a panel of thirty-nine African countries, found that digital financial inclusion positively affects growth outcomes among marginalized groups. Across these studies, findings on individual DFS channels are frequently inconsistent, and few explicitly isolate short-runs from long-run dynamics or examine a composite human-development measure rather than an output-based growth or bank-performance measure. This study addressed that gap by applying a VAR framework specifically to the short-run relationship between DFS and HDI in Nigeria.

3.0 Methodology

The study adopted an ex-post facto research design, using quarterly secondary data for 2012Q1–2023Q4 sourced from the CBN Statistical Bulletin and the UNDP Human Development Reports. DFS is proxied by four variables, each expressed in natural logarithm form: ATM transactions (LNATM), mobile payments (LNMPAY), point-of-sale transactions (LNPOS), and web payments (LNWPAY). The functional form of the model is:

$$HDI_t = \alpha_0 + \alpha_1 LNATM_t + \alpha_2 LNMPAY_t + \alpha_3 LNMOb_t + \alpha_4 LNWPAY_t + \mu_t$$

where HDI is the Human Development Index, α_0 is a constant, α_1 – α_4 are the parameters associated with ATM, mobile banking, POS and web pay respectively, and μ_t is the error term. All four DFS coefficients are a priori expected to be positive.

The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test was applied to determine the order of integration of each series, and the Johansen cointegration test was applied to determine whether

a long-run equilibrium relationship exists among the variables. Where no cointegration is found, a Vector Autoregression (VAR) at the lag order selected by the Schwarz Information Criterion is estimated; this was the outcome for the HDI system in this study. Post-estimation diagnostics comprised the Breusch-Godfrey Lagrange Multiplier test for serial correlation, the Jarque-Bera test for normality, and a Lagrange Multiplier test for heteroskedasticity. All estimation was carried out in E-Views 12.

4.0 Results and Discussion

Table 1: Descriptive Statistics

Statistic	HDI	LNATM	LNMPAY	LNPOS	LNWPAY
Mean	0.530	8.463	6.640	6.647	6.949
Std. Dev.	0.019	1.286	3.487	2.802	4.015
Minimum	0.499	5.991	0.239	2.401	3.221
Maximum	0.560	10.394	12.300	11.611	13.908
Jarque-Bera (p-value)	3.487 (0.175)	1.775 (0.412)	1.994 (0.369)	2.546 (0.280)	10.755 (0.005)
Observations	60	60	60	60	60

All series exhibit standard deviations smaller than their means, indicating relatively stable behaviour over the sample period. All variables except LNWPAY are normally distributed at the 5% level.

Table 2: Unit-Root Test Results

Variable	KPSS (level)	KPSS (1st diff.)	5% Critical Value	Order of Integration
HDI	0.955	0.108	0.463	I(1)
LNATM	0.911	0.077	0.463	I(1)
LNMPAY	0.954	0.135	0.463	I(1)
LNPOS	0.952	0.204	0.463	I(1)
LNWPAY	0.789	0.208	0.463	I(1)

All five variables are non-stationary at level but become stationary after first differencing, confirming that each is integrated of order one, I(1).

Table 3: Cointegration Test

Hypothesized CE(s)	No. of Eigenvalue	Trace Statistic	5% Critical Value	Max-Eigen Statistic	5% Critical Value
None	0.309	55.624	69.819	21.442	33.877
At most 1	0.257	34.183	47.856	17.200	27.584
At most 2	0.149	16.983	29.797	9.330	21.132

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	Max-Eigen Statistic	5% Critical Value
At most 3	0.120	7.653	15.495	7.388	14.265
At most 4	0.005	0.265	3.841	0.265	3.841

The Johansen test finds no evidence of cointegration: both the Trace and Maximum-Eigenvalue statistics remain below their 5% critical values at every hypothesized rank. A Vector Autoregression at lag 1 (selected via the Schwarz Information Criterion) was therefore estimated in place of a Vector Error Correction Mode.

Table 4: VAR Estimation Results

Equation	HDI(-1)	LNATM(-1)	LNMPAY(-1)	LNPOS(-1)	LNWPAY(-1)
HDI	0.944 [6.24]**	0.0002 [0.15]	0.0006 [0.74]	-0.0005 [-0.54]	0.00001 [0.06]
LNATM	9.713 [0.60]	0.704 [6.21]**	0.187 [2.09]*	-0.172 [-1.65]	-0.001 [-0.09]
LNMPAY	21.936 [0.72]	0.011 [0.05]	0.903 [5.38]**	-0.083 [-0.43]	0.024 [0.84]
LNPOS	10.314 [0.42]	0.076 [0.45]	0.101 [0.75]	0.747 [4.78]**	0.019 [0.81]
LNWPAY	93.744 [1.49]	-0.676 [-1.53]	0.195 [0.56]	-0.461 [-1.14]	0.929 [15.53]**

Note: *t*-statistics in brackets. ** significant at 5%; * significant at 10%. $R^2 = 0.988$, Adjusted $R^2 = 0.987$.

The results show that HDI's own first lag is highly significant (0.944, $t = 6.24$), indicating strong persistence: human development in the current quarter is overwhelmingly explained by its level in the previous quarter. None of the four DFS variables; LNATM, LNMPAY, LNPOS or LNWPAY has a statistically significant coefficient in the HDI equation, meaning the null hypothesis of no significant relationship cannot be rejected for any of the four channels in the short run. Elsewhere in the system, each DFS variable is also strongly explained by its own lag (ATM: 0.704; mobile pay: 0.903; POS: 0.747; web pay: 0.929), and the only statistically significant cross-channel effect is a positive relationship running from mobile payments to next-period ATM activity (0.187, $t = 2.09$).

Table 5: Post-Estimation (Diagnostic) Tests

Test	Model 1 (HDI)	Interpretation
Serial Correlation (LM)	$p = 0.997$	Fail to reject no serial correlation residuals well-behaved.
Normality (Jarque-Bera, joint)	737.35, $p = 0.000$	Residuals not normally distributed
Heteroskedasticity (Chi-sq)	244.83, $p = 0.000$	shows evidence of heteroskedasticity.

Discussion of Findings

The dominance of own-lag coefficients across the system indicates that Nigeria's DFS indicators and its human-development index each evolve largely as a function of their own

recent history rather than in immediate response to one another. HDI's strong persistence (0.944) is consistent with the view that human development a composite of health, education and income outcomes changes gradually and cumulatively (Todaro & Smith, 2020), and is unlikely to respond meaningfully within a single quarter to shifts in financial-transaction volumes. This is compatible with Beck, Demirgüç-Kunt and Levine (2007), who argue that financial deepening affects development primarily through long-run accumulation channels rather than immediate liquidity effects.

The strong self-persistence of each DFS channel is consistent with Innovation Diffusion Theory (Rogers, 1983): once users adopt a digital financial channel, usage tends to be self-sustaining from one quarter to the next. The single significant cross-channel effect mobile payments raising subsequent ATM activity may reflect a liquidity-management pattern in which mobile transactions prompt users to withdraw or deposit physical cash (Jack & Suri, 2014, on Kenya's mobile money experience), rather than a substitution away from ATM use. The broader absence of significant cross-channel effects, however, suggests that Nigeria's DFS ecosystem remains relatively fragmented in the short run, with limited integration across platforms (Evans & Pirchio, 2015). Taken together, these results imply that any developmental benefit of DFS on human welfare in Nigeria, if it exists, is more likely to emerge over a longer horizon than the single-quarter lag structure examined here – a proposition consistent with Schumpeter's (1934) view of innovation-driven change as a gradual, structurally transformative process rather than an instantaneous one.

5.0 Conclusion and Recommendations

This study examined the short-run effect of ATM, mobile banking, POS and web pay on the Human Development Index in Nigeria using a Vector Autoregressive model estimated on quarterly data from 2012 to 2023. The results show that none of the four DFS channels has a statistically significant short-run effect on HDI; human development is instead driven almost entirely by its own recent history, and the DFS channels themselves show limited short-run interdependence beyond a single significant link between mobile payments and ATM activity. These findings do not imply that digital financial services are irrelevant to Nigeria's human development rather, they indicate that any such effect operates over a longer horizon than a single quarter, consistent with the gradual, cumulative nature of human-development processes and with Innovation Diffusion Theory's account of technology impacts building over time. Policy makers and development partners should therefore treat DFS expansion as a complementary, long-term lever for human development rather than an instrument for immediate welfare gains, pairing continued DFS investment with sustained commitments to education, healthcare and digital infrastructure. Future research should extend the analysis to a longer time horizon or a cointegrating framework capable of detecting long-run DFS-HDI relationships, and should consider regional or panel-data extensions to assess whether short-run inertia varies across Nigeria's diverse geopolitical zones.

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