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Financial Development, ATM Penetration, and Economic Growth in West African Economies

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ABSTRACT

Despite sustained efforts to deepen financial systems in West Africa, economic growth outcomes have remained uneven, raising concerns about the effectiveness of financial development initiatives such as ATM expansion and credit provision to the private sector. Against this background, this study examined the relationship between financial development, ATM penetration, and economic growth in selected West African economies. The methodology is anchored on the extended Solow–Swan growth framework developed by Mankiw, Romer, and Weil, which incorporates human capital into economic growth analysis. The study specifies economic growth as a function of physical capital, human capital, financial development, and control variables, using a dynamic panel model. Data covering 16 West African countries (2004–2023) were analyzed with the System GMM estimator to address endogeneity and heterogeneity. Pre-estimation and post-estimation diagnostics ensured robustness, while variables were sourced from the World Bank, WGI, and UNDP databases. The correlation results show no severe multicollinearity, with pairwise coefficients generally below 0.80, except for RGDP–GFCF (0.8568). Cross-sectional dependence tests are significant (Pesaran = 3.409, $p = 0.0007$; Friedman = 41.567, $p = 0.0001$), justifying time effects in estimation. System GMM results indicate strong growth persistence, as lagged LOGRGDP is positive and significant ($\beta = 0.994$, $p < 0.01$). ATM spread negatively affects growth ($\beta = -0.0054$, $p < 0.05$). Domestic credit to the private sector is insignificant ($\beta = -0.0004$, $p > 0.10$). AR(2) ($p = 0.435$) and Hansen ($p = 0.391$) confirm model validity. Diagnostic tests confirmed instrument validity and model adequacy. The study concludes that financial infrastructure expansion alone is insufficient to drive growth without efficiency-enhancing reforms.

Keywords: Financial Development, ATM Penetration, Economic Growth, West African Economie

INTRODUCTION

Financial development refers to the growth and maturation of financial institutions, markets, and products that facilitate the efficient allocation of resources, mobilization of savings, and provision of credit for investment. In West African economies, improving financial development is recognized as a key strategy for stimulating economic growth and reducing poverty by broadening access to capital and financial services (Lavrinenko et al., 2023; Muganyi et al., 2022; Oanh et al., 2023). Financial systems that efficiently intermediate savings into productive investment can raise productivity, foster entrepreneurship, and support diversified economic activities (Aldasoro et al., 2025; Garad et al., 2025; Usman & Sundari, 2024). For emerging economies, deepening financial markets through increased credit to the private sector, expanded depositor base, and technological innovations which can enhance economic resilience and growth prospects.

A critical aspect of financial development in West Africa is the expansion of financial inclusion, which encompasses access to formal financial accounts and services. Recent data show that account ownership and usage have increased in Sub-Saharan Africa, with mobile money and digital payment services playing major roles in this surge (World Bank Global

Findex, 2024). Mobile money and digital financial services have lowered traditional entry barriers such as distance to bank branches, thereby facilitating savings, transfers, and credit access for individuals and small businesses (Apiors & Suzuki, 2023; Osabutey & Jackson, 2024; Shaikh et al., 2023). Although these developments are not exclusive to West Africa, the region has experienced notable growth in digital financial infrastructure that expands financial development beyond conventional banking.

Automated Teller Machine penetration represents an essential element of formal banking infrastructure and a visible indicator of financial access in developing economies. ATMs offer essential services like cash withdrawals, balance inquiries, and fund transfers, especially in areas with limited access to conventional bank branches. Their expansion reflects broader infrastructural capacity and institutional development, similar to how environmental management systems reveal structural strengths and weaknesses in public service delivery (Ghosh, 2025; Richetta, 2024). Just as deficiencies in electricity supply and generator dependence affect environmental quality and productivity (Hanafy et al., 2025; Zacharioudaki et al., 2022), inadequate financial infrastructure can constrain economic participation and limit inclusive growth.

Reliable telecommunication systems play a critical role in sustaining ATM functionality, since digital connectivity determines service efficiency and customer confidence. Infrastructure sustainability principles highlighted in green property maintenance and climate adaptation studies further emphasize the importance of resilience and strategic planning in infrastructure deployment (Adeoti et al., 2023; Al Hazaimeh & Alnsour, 2022). In addition, spatial distribution of services influences accessibility patterns, as demonstrated in neighbourhood and housing development studies (Jocelin Anwar, 2024; Pecoraro et al., 2024). These insights underscore the need for well-planned ATM deployment strategies that enhance financial inclusion and support balanced socio-economic development. Research suggests that increasing ATM accessibility contributes to financial inclusiveness and can support economic activity by enabling smoother transactions and reducing transaction costs (Osuma et al., 2025). Higher ATM penetration increases convenience and encourages participation in the formal financial system, which in turn supports economic engagement by broadening consumer access to financial tools. However, how precisely ATM penetration influences growth can vary by context; some studies report that its impact becomes significant only after sufficient coverage and usage levels are reached (Maity & Sahu, 2023; Osuma et al., 2025).

The linkage between financial development including ATM networks and economic growth in West Africa is reinforced by broader empirical evidence. Financial inclusion, which includes access to ATMs as well as mobile and digital payment platforms, is associated with enhanced economic growth and reduced poverty in Sub-Saharan Africa (Jima & Makoni, 2023). Better financial access improves resource allocation, increases investment by small and medium enterprises, and supports household consumption smoothing, which cumulatively contribute to GDP growth. Moreover, digital financial infrastructure such as mobile money and agent networks complements ATM penetration by reaching populations that might otherwise be excluded from the formal banking system (ITEdgeNews, 2024).

Nevertheless, challenges persist. Infrastructure deficits, low financial literacy, and regulatory constraints in West African economies can limit the effectiveness of financial development and ATM expansion in driving growth. Digital services are rapidly evolving, but traditional ATM networks still face issues such as uneven geographic distribution and high operational costs. The importance of studying financial development, ATM penetration, and economic growth in West African economies lies in the region's persistent growth volatility, financial exclusion, and structural transformation challenges. Although recent evidence confirms that financial inclusion promotes economic growth in Sub-Saharan Africa,

most studies focus broadly on digital finance or aggregate financial development indicators, with limited disaggregated attention to ATM infrastructure as a distinct transmission channel (Iwedi, 2024). Given that ATMs remain a critical interface between formal banking systems and cash-dependent economies in West Africa, understanding their specific growth implications is essential.

Recent Global Findex data show significant improvements in account ownership across Sub-Saharan Africa, largely driven by digital financial services (World Bank, 2024). However, gaps remain regarding how traditional banking infrastructuresuch as ATM density per 100,000 adults which interacts with broader financial deepening to influence real sector productivity and GDP growth. Moreover, while studies highlight the macroeconomic benefits of financial inclusion (Chiu & Davoodalhosseini, 2023; Nakakuni, 2024), there is insufficient country-specific evidence for West African monetary zones such as WAEMU and WAMZ. This study is therefore important in bridging the empirical gap by isolating ATM penetration within the broader financial development framework and examining its direct and indirect growth effects in West African economies.

Research questions:

How does ATM spread and domestic credit to the private sector affect the economic growth of West Africa?

Objective of the Study:

Investigate the impact of ATM spread and domestic credit to the private sector on economic growth in West Africa.

Hypothesis:

H01: ATM spread and domestic credit to the private sector have no significant impact on economic growth in West Africa.

METHODS

As an extension of the Solow-Swan neoclassical model, the endogenous growth theory places greater emphasis on human capital, including the abilities, skills, and knowledge of individual workers, as critical drivers of economic growth. Additionally, it underscores the significant role of financial development in economic progress, with numerous studies exploring the links between financial markets and growth. Therefore, this study adopts the Mankiw et al. (1992) model. The model states that there is only one production sector, with the output given as follows:

$$Y = K\,H\,(AL)\;\alpha\;\beta > 0,\ \alpha + \beta < 1 \quad (1)$$

Where K is the stock of capital, H is the stock of human capital, L is the number of workers and AL is effective labour. There are constant returns to K, L, and H; meaning that if the amounts of K, H, and L are doubled, the quantity of output produced will also double. Hence, it is assumed that;

$$\acute{k} = sky -- \delta K, \not{L} L = n \quad (2)$$

where $\acute{k}$ denotes change in capital stock or net investment, $\bar{L}$ is change is labour, sk is the portion of output devoted to investment, $\bar{L}/L = n$ is the rate of growth of the labour force. As in the Solow – Swan model, technological progress is taken to be exogenous.

$$\mathring{A}/A = \gamma \quad (3)$$

Where $\mathring{A}$ signifies change in technology, $\mathring{A}/A = \gamma$ symbolizes the rate of growth of knowledge or technological progress. Investment in human capital is also assumed to denote a fixed fraction of output:

$$\hat{H} = s_H Y \quad (4)$$

Let $h = H / AL$, represent the human capital per effective labour ratio. Then, the production function in equation 1 can be modified in intensive form as:

$$y = k\alpha\ h\beta \quad (5)$$

Where κ = K/AL; y = Y/AL and h = н/AL is capital per effective labour, Y/AL is output per effective labour, and н/AL is human capital per effective labour.

Equation 5 is the key equation in Mankiw – Romer – Weil model which can be used to evaluate the linkages between financial development and economic growth. This can be done by spreading the equation to include variables FD and Z, which designate the financial development variables and other control variables that affect economic growth respectively;

$$y = k\alpha\ h\beta\ FD\ Z \quad (6)$$

where y = output, k = physical capital, h = human capital, FD = the financial development variables and Z = other variables affecting growth.

The study adopted the model specification of Mankiw et al (1992) with little modification to investigate the impact of ATM spread and domestic credit to the private sector on economic growth in West African countries. Equation (6) indicates that economic growth is a function of physical capital, human capital, and financial development. Hence, the model for the study is stated in the functional form as:

$$Y = f\ (k, h, FD, Z) \quad (7)$$

where Y = real capita gross domestic product (RGDP), k = gross fixed capital formation (GFCF). h = human capital proxies by human development index (HDI), FD = financial development or inclusion variables (DCPS = domestic credit to private sector, ATM = automated teller machine spread), and Z = other control variables like foreign direct investment (FDI).

Then, the model becomes

$$RGDP = f\ (ATM, DCPS, FDI, GFCF, HDI) \quad (8)$$

The financial inclusion indicators used in the analysis include: automated teller machine spread and domestic credit to the private sector. An increase in domestic credit to the private sector is expected to lead to an increase in the level of real GDP, other things being equal through fostering economic growth by enabling businesses and individuals to access funding for investment, production, and consumption. Also, an increase in automated teller machines spread in an economy influences economic growth through its impact on liquidity, entrepreneurial adventures, and more consumption. However, an excessive broad money supply without corresponding output can trigger inflation, undermining growth. An increase in gross fixed capital formation will also lead to increase in real GDP. An increase in human capital development proxies as the human development index will lead to growth in real GDP. Also, an increase in foreign direct investment will lead to an increase in real GDP. To facilitate estimation, the implicit economic growth model in equation (8) is specified explicitly as a dynamic panel data model as follows:

$$LOGRGDPit=\alpha 0+\beta 1LOGRGDPit-1+\beta 2ATMit+\beta 3DCPSit+\beta 4FDIit+$$
$$\beta 5LOGGFCFit+\beta 6HDIit+\mu i+\gamma t+\varepsilon i,t \quad (9)$$

where are the parameter estimates, is the lag of the dependent variable, while Is the country-specific impact, Is the time-specific constant and The error term. The error term is presumed to be independent and identically distributed (iid) with an expected value of zero and constant variance v2. Other variables are as earlier defined.

Gross Domestic Product: Is a dependent variable in one of the models and a proxy for economic growth. It measures the total value of final goods and services produced within the economy at any given period. Precisely, it is defined as a gradual upswing in national revenue or output (Etim, 2021). Economic growth is included in the model as it is the primary variable of interest, and it represents the aggregate demand in the economy. It's viewed from the angle of a four-sector economy, which is the function of household consumption, investment, government expenditure, and net export. In this study, gross domestic product is measured in billions of dollars (constant 2015 US$).

Foreign Direct Investment (FDI): Foreign Direct Investment (FDI) refers to a category of cross-border investment in which an investor resident in one country establishes a lasting interest in and a significant degree of influence over an enterprise in another country. It can create employment opportunities and stimulate economic growth in the receiving country by stimulating the technological know-how of the economy.

Human Development Index (HDI): Is a composite index used in measuring human development, considering health, education, and income indicators. Human capital improves economic growth by increasing productivity and innovation in the workforce. The human development index (HDI) takes a broader approach than GDP growth with a view of the economy that includes human development, thus, is a better measure of a country's success than GDP. When there is an improvement in the human development index, and the HDI of a country, it means an increase in the country's population work force towards advancing economic growth of the country. Domestic Credit to Private Sector: Domestic credit to the private sector by deposit money banks denotes the financial funding extended to the private enterprise by other depository institutions (excluding the central bank). This includes activities like loans, acquisition of financial instruments, short-term debt, and other forms of accounts receivable that establish liability for refund.

Money Supply (M2): The money supply, also known as the money stock, represents the aggregate value of monetary assets circulating within an economy currently. Various definitions of 'money' exist, but typically, it includes currency in circulation and demand deposits as standard measures. ATM Spread: This is used to capture the number of Automated Teller Machines available to serve bank customers in selected economies. The ATM Spread is important to this study as it will help to capture the rate of inclusion or exclusion from financial services by the financial system in that country. Therefore, more ATMs implied more inclusion in financial services. Commercial Bank Spread: Also, the number of commercial bank branches will be employed in this study to describe the rate of bank spread and how well economic actors in selected economies assess bank services. This was nominally measured as a control variable for capturing financial inclusion in the study. Gross Fixed Capital Formation: This is the total expenditure on investment by the production units of a country. It refers to changes in the stock of a year and the net acquisition valuables by businesses and households. Since investment is the expenditure incurred on the acquisition of capital goods that result in capital formation, the gross fixed capital formation is used to measure capital formation - domestic investment in this study. Unemployment: Unemployment refers to the state of being jobless hare of the labour force that is without work but available for and seeking employment. Institutional Quality (Political Stability and Absence of Violence/Terrorism and Government Effectiveness, and others): Perceptions of public service quality, civil service quality, and degree of independence from political constraints, policy formulation and implementation quality, and the legitimacy of the government's commitment to these policies are all captured by government effectiveness. Perceptions of the probability of political instability and/or politically motivated violence, including terrorism, are also measured by political stability and the absence of violence or terrorism. By establishing a stable environment for investment and resource allocation, economic growth is achieved.

This study applies a dynamic panel System Generalized Method of Moments (SGMM) for its analysis, selected for its ease of computation and modest data demands. The SGMM is deemed reliable because it presumes that the error term maintains a minimal and uniform variance. Expanding on Hansen's (1982) Generalized Method of Moments (GMM), which extends the traditional method of moments by finding parameter values that minimize a quadratic form of the moment conditions, the technique estimates econometric models without requiring a complete statistical specification by beginning with a set of moment

restrictions based on the data and the unknown parameter vector. Moreover, the system GMM estimator is favored as it effectively mitigates issues related to the endogeneity of lagged dependent variables, omitted variable bias, and unobserved panel heterogeneity, problems typically associated with pooled OLS and other causal estimation approaches (Arellano & Bond, 1991; Arellano & Bover, 1995; Blundell & Bond, 1998). Studies by Blundell and Bond (2000) and Windmeijer (2005) further demonstrate that system GMM not only enhances precision but also diminishes finite sample bias compared to the first-difference GMM estimator. To validate the appropriateness of using system GMM for this research, the Bond (2002) test will be applied to the models specified in equations (9), to confirm its superiority over the difference GMM approach.

The study's use of the GMM approach is reinforced by Roodman (2009), who cautions that GMM estimators may produce less reliable outcomes when both the number of cross-sections (N) and time periods (T) are small, since a low N may impair serial correlation tests and a high T can inflate the number of instruments. Despite these potential issues, the robust results from the Sargan and Hansen over-identification tests underscore GMM's consistency and reliability. GMM offers notable advantages over other panel data methods by treating all independent variables (except the lagged dependent variable) as exogenous and valid instruments, thereby addressing heteroscedasticity and yielding efficient, unbiased estimates. Unlike the difference GMM, which subtracts previous observations from current ones, system GMM employs orthogonal deviations to remove the average of future observations, thus reducing data loss and preserving individual observations even when gaps exist.

Descriptive Statistics: These statistics, including measures of central tendency (mean, median, mode) and dispersion (range, variance, standard deviation), provide essential insights into the dataset's properties for both quantitative and qualitative analyses.

Panel Unit Root Test: Ensuring stationarity where the mean, variance, and autocovariance remain constant over time is critical for time-series analysis. Unit root tests are conducted on panel data (except when N is less than 15) to guarantee robustness prior to co-integration analysis. Logarithmic transformation is used to linearize the data, and tests such as Levin-Lin-Chu (2002), Im-Pesaran-Shin (2003), and the PP-Fisher test (Maddala & Wu, 1999; Choi, 2001) are employed.

Correlation matrices are used to identify multicollinearity among regressors. When high correlations are detected, separate regressions may be required to prevent inefficiencies and biased parameter estimates.

This test helps determine whether to use difference or system GMM estimators in panels with a large number of cross-sections (N) and a small number of time periods (T), favoring system GMM if difference GMM yields biased lagged coefficient estimates relative to Fixed Effects or pooled OLS.

Since regional interdependencies can bias estimates, cross-sectional dependence is evaluated using the Pesaran (2021) test, where a p-value below 5% leads to rejection of the null hypothesis. Temporal effects are incorporated to mitigate such dependencies, along with additional tests like those proposed by Friedman (1937) and Frees (1995).

3.7 Diagnostic Checks / Post-Evaluation Tests

The Hansen Test: This test verifies the validity of instruments and over-identifying restrictions, especially when heteroscedastic matrices are present. It is complemented by the Sargan test, with a chi-squared distribution used to detect potential specification errors.

Arellano and Bond Test: According to Arellano and Bond (1991), GMM estimators should exhibit first-order serial correlation (AR(1)) but not second-order (AR(2)); the absence of AR(2) confirms the estimator's consistency.

An a priori test is conducted to assess the magnitude and direction of parameter estimates, ensuring that signs and sizes of the parameters for each independent variable align

with theoretical expectations regarding their economic relationships with real GDP and selected financial inclusion variables, as shown Table 1:

Table 1: A priori expectation

Independent Variables	Expected Parameters Signs	Dependent Variable		Remarks
		RGDP	FINS	
BMS	+/-	+/-		Positive
DCPS	+/-	+/-		Positive
GFCF	+	+	+	Positive
HDI	+	+	+	Positive
CBB	+	+		Positive
ATM	-	+		Negative
FDI	-/+	+	+	Positive/Negative
UEM	+		-	Positive
PV	+		+	Positive
RL	+		+	Positive
CC	+		+	Positive
RQ	+		+	Positive
GE	+		+	Positive
RGDP	+		+	Positive

Source: Researcher's Computation (2025)

A positive '+' sign indicates that the relationship between the regressor and regressand is direct and moves in the same direction i.e., increases or decreases together. On the other hand, a negative '- ' sign shows that there is an indirect (inverse relationship between the regressor and regressand i.e., they move in opposite directions.

The data for this study consists of annual observations from 2004 to 2023 for the 16 West African countries listed. The selection of this period is informed by data availability for countries included in this study and other factors. Table 2 shows the description and data sources for all the variables in this study. All the findings in this work were sourced from the World Development Indicator (WDI) database of the World Bank, World Governance Indicators (WGI), and Human Development Report (HDR) for the countries studied. The data covered the period 2004 – 2023 (20 years).

Table 2: Data Description and Sources

Variable	Description/measurement	Data source
Real GDP	GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy, plus any product taxes, and minus any subsidies not included in the value of the products. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources. Data are in constant 2015 prices, expressed in U.S. dollars.	World Development Indicators, WDI (2023) (https://datacatalog.worldbank.org/dataset/world-development-indicators)

Commercial bank branches	Commercial bank branches are retail locations of resident commercial banks and other resident banks that function as commercial banks that provide financial services to customers and are physically separated from the main office but not organized as legally separate subsidiaries.	WDI (2023)
Foreign Direct Investment	Foreign direct investment is the net inflows of investment to acquire a lasting management interest (10% or more of voting stock) in an enterprise operating in an economy other than that of the investor. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors and is divided by GDP.	WDI (2023)
Automated teller machines spread.	Automated teller machines are computerized telecommunications devices that provide clients of a financial institution with access to financial transactions in a public place.	WDI (2023) (International Monetary Fund, Financial Access Survey)
Government Effectiveness : Estimate	Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate	World Governance Indicators (WGI) (2023), www.govindicators.org.
Domestic credit to the private sector	Domestic credit to the private sector refers to financial resources provided to the private sector, such as through loans, purchases of non-equity securities, trade credits, and other accounts receivable, that establish a claim for repayment. For some countries, these claims include credit to public enterprises.	WDI (2023) .
Broad money supply	Broad money is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.	WDI (2023) .
Political Stability and Absence of Violence/Terrorism	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Estimate	WGI (2023) www.govindicators.org.
Gross fixed capital formation	Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.	WDI (2023)
Unemployment rate	Labor force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labor for the production of goods and services during a specified period.	WDI (2023)

Human Development Index	The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable, and having a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions. The health dimension is assessed by life expectancy at birth, the education dimension is measured by the mean of years of schooling for adults aged 25 years and more, and expected years of schooling for children of school entering age. The standard of living dimension is measured by gross national income per capita.	Human Development Report 2023 https://hdr.undp.org/data-center/human-development-index#/indicies/HDI
Regulatory Quality	Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Estimate	WGI (2023)
Rule of Law	Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate	WGI (2023)
Control of Corruption	Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Estimate	WGI (2023)

Source: Author, 2025

The study employs Stata version 15 and E-views 10 software packages that are appropriate for estimation. This software are advantageous because they are user-friendly and can handle all analyses relevant to this study.

RESULTS AND DISCUSSION

Correlation Matrix of the Variables

To evade the problem of collinearity, this study examined the patterns in the correlation matrix of the variables. This matrix is presented in Table 3. We find that the variables show no signs of high correlation with each other.

Table 3: Correlation Matrix of the Variables.
Panel A: Correlation Matrix for Model 1

Variables	RGDP	ATM	DCPS	FDI	GFCF	HDI
RGDP	1.0000					
ATM	0.1619	1.0000				
DCPS	-0.0787	0.7015	1.0000			
FDI	-0.1092	-0.0139	-0.0352	1.0000		
GFCF	0.8568	0.1646	-0.0690	-0.0852	1.0000	
HDI	0.1633	0.7196	0.6467	0.0439	0.1270	1.0000

Results of Cross-Sectional Dependence Tests

The results of the cross-sectional dependence tests for this study are presented in Table 4 following Pesaran (2004), Friedman (1937), and Frees (1995). The results in Table 4 indicate

the presence of cross-sectional dependence. However, this is not a problem in this study when addressed in the affected model.

Table 4: Summary Outcome of Cross-Sectional Dependence Test

PANEL A: MODEL 1	LOGRGDP
Pesaran - fe	3.409 (0.0007)
Pesaran - re	3.905 (0.0001)
Friedman - fe	37.669 (0.0003)
Friedman - re	41.567 (0.0001)
Frees' – fe	0.1782 (0.346)
Frees' – re	0.1782 (0.113)
DECISION	CD

Source: Author, Stata 15.0.

Notes: The Frees' tests report alpha values, while the Pr values for the trials are based on Pesaran and Friedman. In all cases, the average absolute values are given in parentheses. Cross-sectional independence is represented by CID, whereas cross-sectional dependence is represented by CD.

Table 4 shows the results of the cross-sectional dependent test. The results in Table 4, panels A and B, indicate the presence of cross-sectional dependence in model one. The results show the presence of cross-sectional dependence; thus time dummy is included to address the identified issue in system GMM results following Tchamyou et al. (2019), Ogbuabor et al. (2023), and Emeka et al. (2024).

System GMM Regression Results for the Financial Inclusion and Economic Growth (real GDP) Model

It should be noted that the first specific objective of this research is to examine how domestic credit and ATM spread affect the private sector in West Africa. In order to accomplish this goal, the study used the two-step system GMM estimator to estimate the underlying model. The findings are shown in Table 5.

Table 5: Result for Objective One (dependent variable = *LOGRGDP*)

VARIABLES	SYSTEM GMM ESTIMATOR

LOGRGDP LI.	0.9942883***
	(0.0124843)
ATM	-0.0053693**
	(0.0019321)
LOGDCPS	-0.0004426
	(0.0121164)
FDI	0.0009527
	(0.0013513)
LOGGFCF	0.0114046
	(0.115299)
HDI	-0.1261956
	(0.2218331)
CONS	-2.131129
	(2.126565)
Observations	266
Number of c_id	14
No. of Instrument	14
AR1	0.016
AR2	0.435
Hansen	0.391
Time Effect	Yes

Note: Estimated coefficients are reported while the corrected standard errors are in parentheses. * p < 0.10. ** p < 0.05. *** p < 0.01.

Hypothesis One

H01: ATM spread and domestic credit to the private sector have no significant impact on economic growth in West African economies.

Strong growth persistence in West African economies is confirmed by the estimation results, which show that the lagged value of real GDP has a positive and highly significant coefficient. In line with dynamic growth models, which postulate that economic expansion follows a path-dependent trajectory, this conclusion implies that historical economic performance significantly influences current output levels. This persistence is a reflection of the long-term cumulative effects of productivity gains, human capital development, and capital accumulation within the context of the extended Solow-Swan model. The negative and statistically significant correlation between ATM penetration and economic growth is one of the study's main conclusions. This finding implies that better economic performance in West African economies is not always correlated with higher ATM densities. Even while ATMs are typically seen as a key sign of banking infrastructure and financial inclusion, their growth does not always result in more profitable economic activity. Rather than helping with credit access, investment funding, or savings mobilization, ATM use is typically linked to cash withdrawal transactions in many emerging nations. As a result, rather than encouraging profitable investment activities that directly contribute to long-term economic growth, the rise of ATM networks may encourage consumption-oriented transactions.

According to financial development theory, financial infrastructure only boosts economic growth when it improves the effectiveness of capital allocation and financial intermediation. Therefore, systemic flaws in the financial systems of West African nations may be reflected in the negative coefficient for ATM penetration. Specifically, the growth of ATM networks can take place without commensurate advancements in financial deepening, banking efficiency, or institutional quality. In certain situations, financial infrastructure could raise banking institutions' operating expenses without significantly increasing overall economic productivity. The unequal distribution and low use of ATM infrastructure

throughout the region could be another reason. While rural and underdeveloped communities continue to be financially excluded, ATMs are mostly found in urban locations in many West African countries where banking services are already reasonably accessible. The potential of ATM development to provide equitable financial access and boost productive economic activity may be constrained by this spatial imbalance. Furthermore, insufficient digital infrastructure, unstable electrical supplies, and high operating expenses can all lower the efficacy of ATM networks and lessen their capacity to support economic growth.

This result is in part consistent with earlier research that emphasizes the intricate connection between economic development and financial inclusion metrics. According to some research, by lowering transaction costs and expanding access to financial services, financial infrastructure like ATMs encourages financial inclusion and economic activity. Other research, however, indicates that the effectiveness and depth of the financial system have a significant influence on how financial infrastructure affects growth. The increase of financial access points might not yield the anticipated growth advantages in settings where institutional capacity is constrained and financial markets are still shallow. The findings also demonstrate that, in the estimated model, domestic credit to the private sector has no statistically significant effect on economic growth. This implies that increasing credit might not be enough on its own to boost economic expansion in West African nations. One argument is that the region's credit allocation might not be effectively focused on the economy's productive sectors. Alternatively, financial resources can be concentrated in industries with little productive spillover, government borrowing, or short-term consumption financing. Furthermore, the efficiency of credit provision in promoting profitable investment may be diminished by structural issues such poor financial intermediation, excessive lending rates, credit limitations, and restricted access to formal financial institutions. In these situations, more investment, innovation, or productivity growth are not always correlated with loan availability. This result lends credence to the development finance literature's claim that economic growth depends more on the effectiveness of financial resource allocation and quality than it does on loan volume expansion alone.

Overall, the study's conclusions imply that credit availability and the development of financial infrastructure are not enough to propel long-term economic growth in West African economies. Enhancements in institutional quality, financial intermediation efficiency, regulatory frameworks, and finance for the productive sector are necessary for financial development to effectively support economic growth. Enhancing these complimentary elements can assist guarantee that the growth of the financial sector makes a more significant contribution to the region's long-term economic change.

CONCLUSION

This study investigated the relationship between financial development, ATM penetration, and economic growth in 16 West African economies over the period 2004–2023 within an extended Solow–Swan growth framework. The empirical findings reveal strong growth persistence, indicating that past economic performance significantly influences current output levels. However, contrary to conventional expectations, ATM penetration exerts a statistically significant negative effect on economic growth, while domestic credit to the private sector shows no significant impact. These results suggest that the expansion of financial infrastructure and credit provision alone does not automatically translate into productive investment or sustained economic growth in the region. The negative effect of ATM spread may reflect structural inefficiencies, limited productive sector integration, high operational costs, weak institutional quality, or the predominance of cash-withdrawal usage rather than investment-enhancing financial intermediation. Similarly, the insignificance of

private sector credit indicates possible misallocation of funds, credit constraints, or shallow financial markets that fail to effectively support real sector expansion. The findings underscore the need for efficiency-enhancing financial sector reforms, improved regulatory oversight, stronger institutional frameworks, and policies that channel financial resources toward productive activities. Sustainable growth in West Africa requires not merely financial deepening, but quality-driven financial development aligned with structural transformation objectives.

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