CAPITAL MARKET DEVELOPMENT, DIGITAL FINANCE AND MACROECONOMIC FACTORS IN SUB-SAHARAN AFRICA AND MIDDLE EAST AND NORTH AFRICA

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Abstract

This article examined the relationship among capital market development, digital finance, and macroeconomic factors in selected Sub-Saharan African and Middle East and North Africa (MENA) countries from 2010 to 2025. It investigated the effects of digital finance on capital market and economic development, the influence of macroeconomic factors, and their moderating role. Annual panel data were obtained from the World Development Indicators (WDI) and other relevant databases. Capital market development was measured by market capitalization as a percentage of GDP, while digital finance was proxied by automated teller machine (ATM) penetration. Inflation, interest rate, and GDP growth rate represented macroeconomic factors, with trade openness as a control variable. The Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) technique was employed to estimate short-run and long-run relationships. Findings revealed that digital finance had positive but insignificant effects on capital market development and negative but insignificant effects on economic development. Macroeconomic factors and their moderating effects were also insignificant. The article recommends improved digital infrastructure, stronger regulation, enhanced institutional quality, and integration of digital finance with capital markets.

Keywords: Capital Market Development, Digital Finance, Macroeconomic Factors, Economic Development, Sub-Saharan Africa, MENA Countries.

1. Introduction

Capital markets occupy a central position in financial development because they mobilise long-term savings, broaden firms' financing options, facilitate risk sharing and improve the allocation of capital. Their contribution is especially important in economies where bank-dominated financial systems cannot fully meet the financing needs of governments, infrastructure projects and private enterprises. Yet capital-market development remains uneven across Sub-Saharan Africa (SSA) and the Middle East and North Africa (MENA). A small number of relatively deep markets coexist with many thin markets characterised by limited listings, narrow investor participation and weak secondary-market activity. This unevenness has persisted despite

extensive financial-sector reform and the rapid spread of digitally enabled financial services. It raises a consequential question: has digital finance begun to deepen capital markets in these regions, or has its expansion remained largely concentrated in payments, transfers and conventional banking access?

Digital finance can influence capital-market development through several channels. Digital platforms may reduce search, information and transaction costs; widen access to savings and investment products; improve the speed and traceability of transactions; and enable households and small firms previously excluded from formal finance to accumulate financial assets. In principle, these changes can enlarge the investor base, improve market liquidity and support securities issuance. Evidence from developing economies generally associates digital financial inclusion with improved access to finance and economic performance (Khera et al., 2021; Liu et al., 2022). For MENA countries, Al-Smadi (2023) reports that digital finance supports several dimensions of financial inclusion, while Hakimi et al. (2025) show that infrastructure, education and institutional quality help to determine how inclusive financial systems become. Evidence from SSA similarly indicates that the effect of digital financial inclusion may vary with countries' level of development and institutional setting (Jimoh & David, 2024; Meniago, 2025).

The extension from financial inclusion to capital-market development, however, is neither automatic nor well established. Access to an automated teller machine, mobile wallet or payment application does not necessarily produce securities ownership, active trading, long-term savings or productive investment. Macroeconomic conditions may strengthen or obstruct that conversion. Inflation alters real returns and valuation; interest rates affect the relative attractiveness and cost of financial assets; economic growth shapes corporate earnings and investible income; and trade openness changes firms' exposure to foreign demand, competition and capital flows. Existing evidence nevertheless offers no uniform account of these relationships. Studies of Arab markets associate growth, liquidity, broad money and trade openness with stronger stock-market development (Chiad & Hadj Sahraoui, 2021), whereas evidence from South Africa links inflation and trade openness to weaker market development in the long run (Ho, 2017). Nigerian evidence also identifies an adverse inflation effect, although the magnitude and significance of other macroeconomic influences vary across specifications (Emmanuel & Emmanuel, 2023). The mixed results imply that macroeconomic variables should not be treated only as additive controls. They may condition whether digital financial expansion supports marketbased finance or remains detached from it.

Three related gaps follow from this literature. First, most digital-finance studies examine financial inclusion or economic growth rather than capital-market development; studies of capital markets, in turn, commonly emphasise conventional macroeconomic determinants while omitting digital finance. Second, the limited work connecting digital finance to capital markets often relies on a single country, a single region or static estimators, leaving common shocks, country heterogeneity and feedback effects insufficiently addressed. Third, SSA and MENA are rarely analysed within a common empirical framework even though both regions combine developing and emerging markets with markedly different market structures, digital infrastructures and macroeconomic environments. Pooling them without accounting for dependence and heterogeneity can obscure these differences, but studying them separately prevents assessment of

whether the same broad mechanisms operate across the two regions. This study addresses these gaps by examining capital-market development, digital finance and macroeconomic conditions in 17 SSA and MENA countries over 2010-2025. Capitalmarket development is measured by the market capitalisation of listed domestic companies relative to gross domestic product, while digital finance is represented by the study's digital-finance indicator. Inflation, interest rates and economic growth capture the macroeconomic environment, and trade openness is included as a control. The analysis pursues four objectives: to determine the long-run and short-run effect of digital finance on capital-market development; to estimate the influence of macroeconomic conditions on capital-market development; to assess the effect of digital finance on economic growth; and to test whether a composite macroeconomic factor moderates the digital finance–capital market relationship.

The study makes three contributions. Empirically, it joins two strands of research that have largely developed in parallel, the macroeconomic determinants of capital markets and the development effects of digital finance, and tests their intersection in a cross-regional sample. Conceptually, it treats macroeconomic conditions as a possible moderator rather than assuming that digitalisation exerts an unconditional effect. Methodologically, it applies the cross-sectionally augmented autoregressive distributed lag estimator to an unbalanced panel, thereby distinguishing short-run adjustments from long-run relationships while accommodating cross-sectional dependence, slope heterogeneity and variables with admissible mixed orders of integration. This is important because SSA and MENA economies are exposed to shared commodity-price movements, global financial conditions, technology diffusion and regional shocks that can make conventional first-generation panel estimates unreliable.

The results provide a restrained but policy-relevant account of the digital-finance transition. Digital finance has a positive but statistically insignificant long-run association with capital-market development in the baseline model, while its association with economic growth is negative and insignificant. Inflation and interest rates also have positive but insignificant long-run coefficients, and the interaction between digital finance and the composite macroeconomic factor is negative but insignificant. The absence of conventional statistical significance is itself informative when interpreted with appropriate caution: it does not establish that digital finance is economically irrelevant, but indicates that its expansion has not yet produced a sufficiently consistent cross-country effect on capital-market depth within the sample. The findings therefore qualify technologically deterministic claims and point to a missing institutional and market-integration layer between digital access and market-based investment.

The remainder of the paper is organised as follows. Section 2 develops the theoretical arguments and reviews the empirical literature. Section 3 describes the data, variables and econometric strategy. Section 4 reports the empirical results and robustness evidence. Section 5 discusses the findings and their policy implications, while Section 6 concludes, states the limitations and identifies directions for further research.

2. Literature Review and Hypothesis Development

2.1 Theoretical Foundation

2.1.1 Financial Intermediation and Capital-Market Development

The functional view of financial intermediation provides the principal theoretical foundation for this study. It begins from the functions performed by a financial system rather than from the particular institutions through which those functions are delivered. These functions include mobilising savings, allocating capital, facilitating payments, producing information, managing risk and supporting the transfer of resources across time and space (Merton, 1995). Capital markets perform several of these functions directly by linking issuers with investors, creating tradable claims and providing price signals for the allocation of long-term capital. Their development can therefore be understood as an improvement in the financial system's capacity to mobilise savings, broaden risk-bearing opportunities and direct funds towards productive uses (Levine, 1997). Digital finance can alter the cost and reach of these functions.

This distinction is important for SSA and MENA. In many countries, the most visible digital innovations remain concentrated in retail payments, cash withdrawal, person-to-person transfers and bank-account access. These services perform valuable financial functions, but they need not deepen market-based finance. An increase in automated teller machine access or mobile transactions may coexist with few listed firms, limited brokerage coverage and low turnover. The expected effect of digital finance on capital-market development is consequently positive in principle but contingent in practice on the integration of digital channels with saving and investment products.

2.1.2 Finance-Growth Transmission

The finance-growth literature provides a second link in the study's framework. A developed financial system can promote growth by improving the screening and monitoring of investment, mobilising savings, diversifying risk and directing capital towards higher-productivity activities (Levine, 1997).

Digital finance may strengthen the same channels by reducing transaction costs, extending formal finance to underserved households and firms, and enabling faster circulation of funds. Digital records may also ease information asymmetry, support entrepreneurial entry and make small-scale economic activity more visible to formal financial institutions. Evidence from China identifies entrepreneurship and industrial upgrading as transmission mechanisms from digital finance to growth (Jiang et al., 2021; Liu et al., 2022), while multi-country evidence associates the exogenous component of digital financial inclusion with stronger per-capita growth (Khera et al., 2021). The transmission is nevertheless subject to two qualifications. First, digital access is not equivalent to productive financial use. The growth effect is therefore interpreted as the net result of inclusion, efficiency and investment channels on one side, and infrastructure, regulatory and usage constraints on the other.

2.1.3 Macroeconomic conditioning of financial development

The effect of digital finance is embedded in the macroeconomic environment. Inflation changes real returns, weakens the informational content of nominal prices and increases uncertainty about future purchasing power. Boyd et al. (2001) show that inflation can impair both banking and equity-market development, with the adverse relationship becoming pronounced beyond moderate inflation. High or volatile inflation can therefore discourage long-horizon saving and reduce the willingness of households and institutions to hold domestic financial assets. Interest rates operate through the opportunity cost of equity investment, firms' financing costs and the discount rate applied to future cash flows. Higher rates may attract savings into interest-bearing instruments, but they can also draw funds away from equities, depress valuations and make new securities issuance more expensive.

A conditioning perspective follows from these mechanisms. Stable prices, sustainable financing costs and predictable external conditions should improve the conversion of digital access into long-term saving and market participation. By contrast, instability may cause users to retain digital finance primarily as a payments technology, shorten investment horizons or shift wealth away from domestic securities. Institutions remain relevant because legal enforcement, investor protection and regulatory quality shape the incentives through which macroeconomic and technological conditions affect financial behaviour (North, 1990). The study therefore treats macroeconomic conditions not only as direct determinants of capital-market development but also as a composite environment that may alter the effectiveness of digital finance.

2.2 Empirical Literature

2.2.1 Digital Finance and Capital-Market Development

Direct evidence on digital finance and capital-market development remains limited. Otinga et al. (2025) provide the most closely related cross-country evidence for Africa. Using data for 34 countries and both fixed-effects and dynamic-panel estimators, they report that the usage dimension of financial inclusion improves capital-market development, whereas access alone has an adverse effect. Fintech partly mediates these relationships and strengthens the inclusion–capital market linkage at higher levels of inclusion. The result is important because it distinguishes the availability of financial touchpoints from the intensity with which formal financial services are used. It also suggests that digital technology becomes more relevant to capital markets when it enables sustained financial participation rather than nominal access.

Country evidence points to a similar distinction between market scale and market activity. Using monthly Nigerian data, Babarinde (2024) reports that automated teller machine, point-of-sale, mobilepayment and web-payment transactions increase the market-capitalisation ratio but reduce stockmarket turnover. Digital transactions may therefore accompany a larger market without producing greater liquidity. Qamruzzaman and Wei (2018) also identify long-run relationships and bidirectional causality among financial innovation, stock-market development and growth in Bangladesh. Their measure predates several contemporary fintech channels, however, and the single-country design limits its transferability to SSA and MENA.

Broader financial-development research is supportive but not conclusive. Ullah et al. (2025), using a large cross-country sample and several estimators, find that digital transactions and governance promote financial development, while the role of global integration differs across income groups. Because the financial-development measure combines banking and market dimensions, the result cannot identify whether securities markets respond in the same way as bank-based finance. Wahab et al. (2025) similarly find that digital payments support financial literacy and financial development, but currency exposure weakens the relationship. These studies establish plausible enabling and constraining mechanisms, yet they leave the direct response of capital-market depth in SSA and MENA insufficiently resolved.

The evidence supports a positive prior while counselling against technological determinism. Digital finance can widen the potential investor base, reduce frictions and improve information, but payments-oriented adoption may remain disconnected from securities markets. The first hypothesis is therefore stated as follows:

H1: Digital finance has a positive effect on capital-market development in SSA and MENA countries.

2.2.2 Macroeconomic Factors and Capital-Market Development

Research on the macroeconomic determinants of capital markets is extensive, but its conclusions are sensitive to market structure, variable measurement and the estimation period. Chiad and Hadj Sahraoui (2021) find that trade openness, market liquidity, broad money and economic growth support stock-market development in ten Arab countries, while the global financial crisis exerts an adverse effect. Their dependent variable is market capitalisation, and the random-effects design gives limited attention to common shocks and possible endogeneity. In South Africa, Ho (2017) reports that banking-sector development and economic growth improve stock-market development in the long run, whereas inflation and trade openness reduce it. The negative openness coefficient illustrates why openness should not be interpreted as uniformly beneficial across market settings.

Nigeria-specific studies also emphasise instability but differ in specification and outcome. Emmanuel and Emmanuel (2023) find a significant negative relationship between inflation and stock-market development, while output and money supply have positive but insignificant effects. Adekunle et al. (2016) report adverse roles for inflation and interest rates in capital-market growth, although the article uses the all-share index, which represents market performance more directly than broad market development. Devkota and Dhungana (2019) find that interest rates adversely affect Nepal's stock market and that money supply is supportive. Across developed and emerging markets, Verma and Bansal's (2021) systematic review concludes that interest-rate effects are commonly negative, whereas inflation, exchange-rate and money-supply effects are more context dependent.

The mixed findings arise partly because macroeconomic variables operate through competing channels. Moderate inflation may accompany expansion, while high or unpredictable inflation erodes real returns. Interest rates can mobilise savings but also raise discount rates and financing costs. Openness may expand investment opportunities or increase exposure to external volatility.

Accordingly, this study separates inflation and interest-rate effects in the direct model and uses a composite macroeconomic factor in the moderation model. The theory and the weight of empirical evidence lead to the following hypotheses:

H2a: Inflation has a negative effect on capital-market development in SSA and MENA countries.

H2b: Interest rates have a negative effect on capital-market development in SSA and MENA countries.

2.2.3 Digital Finance and Economic Growth

The digital finance-growth literature is more developed than the direct capital-market literature, although its findings depend on how digital finance is measured. Khera et al. (2021) construct digital and traditional financial-inclusion indices for developing countries and report a positive association between the instrumented component of digital financial inclusion and per-capita growth. Jimoh and David (2024) find that digital financial inclusion promotes growth in selected SSA countries, with stronger effects at lower points of the growth distribution. The quantile evidence is particularly relevant because it shows that a pooled average can conceal substantial state dependence. MENA studies also report broadly favourable but heterogeneous effects. Khalifa (2025) finds that bank branches and commercial-bank borrowers support growth in the long run, while automated teller machines have a more visible short-run role. Hakimi et al. (2025) show that education, infrastructure and institutional quality promote inclusion, while inflation restricts it, reinforcing the view that digital finance requires complementary conditions.

Evidence from other developing settings identifies mechanisms that may apply to SSA and MENA. Jiang et al. (2021) find that entrepreneurship partly transmits the growth effect of digital finance across Chinese provinces. Liu et al. (2022) report that digital finance improves the quality of economic growth through industrial upgrading and that the effect differs with development conditions. Zou et al. (2024) find gains in economic resilience through innovation and consumption, including spatial spillovers. These studies use richer digital-finance indices and mechanism tests than are generally available for African and MENA panels, but the platform environment and institutional setting limit direct generalisation.

The balance of evidence indicates that digital finance can support growth when access becomes productive use and is reinforced by infrastructure and institutions. The study therefore tests the following hypothesis:

H3: Digital finance has a positive effect on economic growth in SSA and MENA countries.

2.2.4 The Moderating Role of Macroeconomic Conditions

A growing body of evidence shows that the development effect of digital finance is conditional. Meniago (2025) reports that institutional quality strengthens the contribution of digital financial inclusion to economic growth in Southern African Development Community countries. Otinga et al. (2025) find that fintech strengthens the relationship between financial inclusion and capital-market development, particularly where inclusion is already more intensive. Ullah et al. (2025) show that global integration weakens the digital-transaction effect in their pooled sample but

strengthens it in middle- and low-income economies. Wahab et al. (2025) find that currency exposure erodes the contribution of fintech to financial development. Although the moderators differ, the common implication is that the effect of digital finance cannot be assumed to be constant across economic environments. Macroeconomic moderation has received less direct attention. Existing capital-market studies usually enter inflation, interest rates, growth and openness as independent regressors, while digital-finance studies use them as controls. This additive treatment cannot show whether macroeconomic stability changes the marginal effect of digital finance. A stable environment should preserve real returns, support longer investment horizons and increase confidence in domestic assets, thereby allowing digital access to translate more readily into market participation. Instability may weaken this transmission even where digital payments and accounts continue to expand. Because the composite factor combines several macroeconomic dimensions and its net effect may vary with their weights, the moderation hypothesis is stated in conditional rather than mechanically directional form:

H4: Macroeconomic conditions significantly moderate the effect of digital finance on capital-market development in SSA and MENA countries.

2.3 Critical Synthesis and Position of this Study

Four limitations in the existing evidence define the position of this study. The first is an outcome gap. Much of the digital-finance literature ends with inclusion or economic growth; much of the capitalmarket literature begins with macroeconomic determinants. The intervening question, whether digitally enabled finance deepens market-based finance, has received comparatively little attention. The second is a measurement gap. Automated teller machines and payment transactions capture useful aspects of digital access and usage. Still, they do not directly measure online brokerage, digital investor accounts, crowdfunding, securities transactions or the multidimensional depth and liquidity of capital markets. The present study retains the indicators available for a consistent cross-country panel but interprets them within these limits. The third limitation is methodological. Static models, short single-country samples and first-generation panel estimators remain common. Such designs may be distorted by persistence, reverse causality and cross-sectional dependence arising from global interest rates, commodity cycles, regional conflict, technology diffusion and common regulatory changes. The fourth is a regional-comparison gap. SSA and MENA are often examined separately, even though comparison can reveal whether digitalisation operates similarly across mobile-money-intensive, bankdominated, oil-dependent and market-oriented economies. At the same time, simple pooling can suppress country heterogeneity.

This study responds by estimating a common dynamic framework for selected SSA and MENA countries while allowing heterogeneous short-run and long-run responses and augmenting the model for cross-sectional dependence. It examines digital finance, macroeconomic determinants, the digital finance-growth relationship and macroeconomic moderation within one empirical design. The contribution is not that digital finance must produce a positive coefficient; rather, the study tests whether the presumed conversion from digital access to capital-market depth is empirically observable once common shocks, dynamics, and heterogeneous national structures are recognized.

3. Data and Methodology

3.1 Data and Sample

The article employs an unbalanced annual panel of 17 countries over 2010-2025. The Middle Easta and North Africa sample comprises Algeria, Egypt, Iran, Israel, Jordan, Kuwait, Lebanon, Oman and Qatar, while the SSA sample comprises Botswana, Mauritius, Namibia, Nigeria, Rwanda, Seychelles, South Africa and Tanzania. Countries were selected according to the joint availability of capitalmarket, digital-finance and macroeconomic series. The final analytical sample contains 189 countryyear observations. Data were obtained mainly from the World Bank's World Development Indicators and supplemented, where necessary, with country series reported by IndexMundi.

3.2 Variable Measurement

Capital-market development (CMDT) is measured as the market capitalisation of listed domestic companies relative to GDP. Digital finance (DF) is proxied by automated teller machines per 100,000 adults. The proxy captures the reach of digitally enabled financial access. Economic growth (GDPGRT) is the annual growth rate of real GDP. Inflation (INFLRT) is the annual percentage change in consumer prices, the interest rate (INTRT) is the real interest rate, and trade openness (TRDOP) is exports plus imports as a percentage of GDP. The exchange rate (EXRT), expressed as local currency units per US dollar, enters the composite macroeconomic factor.

Table 1. Measurement of Variables

Variable	Measure	Role	Expected sign
CMDT	Market capitalisation of listed domestic companies (% of GDP)	Dependent variable: Models 1, 2 and 4	—
DF	ATMs per 100,000 adults	Main explanatory variable	+
GDPGRT	Annual real GDP growth (%)	Dependent variable: Model 3	—
INFLRT	Consumer-price inflation (%)	Macroeconomic explanatory variable	−
INTRT	Real interest rate (%)	Macroeconomic explanatory variable	−

TRDOP	Exports plus imports (% of GDP)	Control variable	+/−
MACRO	First principal component of INFLRT, EXRT and INTRT	Moderator	Conditional

Note. ATM = automated teller machine. Expected signs follow the hypotheses in Section 2.

Source: Author's Computation 2026

For the moderation analysis, inflation, the exchange rate and the real interest rate are standardised and combined using principal component analysis. PCA is performed separately for SSA and MENA to accommodate differences in scale and covariance structure. The first component explains 46.10% of the variation in the SSA inputs and 52.40% in the MENA inputs. The component score is standardised within each region before the pooled interaction term is generated. GDP growth is excluded from the factor because it is the dependent variable in Model 3.

3.3 Model Specification

The empirical models follow the study objectives and hypotheses. CMDT denotes capital-market development, DF denotes digital finance, GDPGRT denotes economic growth, INFLRT denotes inflation, INTRT denotes the real interest rate, MACRO-PCA denotes the composite macroeconomic factor, and TRDOP denotes trade openness. The terms μ_i and λ_t capture country-specific and timespecific effects, respectively, while ε_{it} is the idiosyncratic disturbance term.

Model 1 specifies capital-market development as a function of digital finance and trade openness:

$$CMDT_{it} = \alpha_0 + a_1 DF_{it} + a_2 TRDOP_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Hypothesis tested: Model 1 tests H_{01} that digital finance does not significantly influence capitalmarket development in SSA and MENA countries. The coefficient of interest is a_1.

Model 2 examines the effects of inflation and the real interest rate on capital-market development, with trade openness included as a control:

$$CMDT_{it} = \alpha_0 + \beta_1 INFLRT_{it} + \beta_2 INTRT_{it} + \beta_3 TRDOP_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

Hypothesis tested: Model 2 tests H_{02} that macroeconomic factors do not significantly affect capitalmarket development. The principal coefficients are β_1 and β_2. Model 3 assesses the effect of digital finance on economic growth:

$$GDPGRT_{it} = \alpha_0 + d_1 DF_{it} + d_2 TRDOP_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

Hypothesis tested: Model 3 tests H_{03} that digital finance does not significantly influence economic growth in SSA and MENA countries. The coefficient of interest is d_1.

Model 4 introduces the composite macroeconomic factor and its interaction with digital finance:

$$CMDT_{it} = \alpha_0 + b_1 DF_{it} + b_2 MACRO_PCA_{it} + b_3(DF_{it} \times MACRO_PCA_{it})$$

$$+ b_4 TRDOP_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

Hypothesis tested: Model 4 tests H_{04} that macroeconomic factors do not significantly moderate the relationship between digital finance and capital-market development. The interaction coefficient b_3 is the principal coefficient of interest.

In Model 4, b_1 measures the effect of digital finance when MACRO_PCA equals zero, b_2 measures the direct effect of the macroeconomic factor when DF equals zero, and b_3 shows how the effect of digital finance changes with the macroeconomic factor. The conditional marginal effect of digital finance is therefore:

$$\partial CMDT_{it}/\partial DF_{it} = b_1 + b_3 MACRO_PCA_{it} \quad (5)$$

3.4 Estimation Technique

The empirical procedure begins with descriptive statistics, followed by the cross-sectional dependence diagnostic test developed by Pesaran (2021). Because the null hypothesis of cross-sectional independence is rejected, stationarity is assessed using the Cross-sectionally Augmented Im Pesaran Shin (CIPS) unit-root test, which accounts for cross-sectional dependence arising from unobserved common factors (Pesaran, 2021). The variables are integrated of order zero or one, and none is integrated of order two I(2). These properties support the application of the Cross-sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model.

The CS-ARDL mean-group estimator distinguishes short-run dynamics from long-run relationships while allowing slope coefficients to differ across countries. Cross-sectional averages of the dependent variable and regressors proxy unobserved common shocks, thereby reducing bias from cross-country dependence (Chudik & Pesaran, 2015). The error-correction representation is written as:

$$\Delta y_{it} = \varphi_i(y_{i,t-1} - \theta_i' x_{i,t-1}) + SR_{it} + CCE_{it} + \varepsilon_{it} \quad (6)$$

In Equation (6), phi is the error-correction coefficient, theta contains the country-specific long-run parameters, SR contains the lagged short-run changes in the dependent variable and regressors, and CCE contains the current and lagged cross-sectional averages. A negative and significant errorcorrection coefficient indicates convergence to the long-run equilibrium after a shock. Countryspecific long-run and short-run coefficients are averaged using the mean-group procedure. Lag lengths are kept parsimonious in view of the short and unbalanced time dimension. The implementation follows Chudik and Pesaran (2015) and Ditzen (2018). Residual cross-sectional dependence and variance-inflation factors are examined as post-estimation checks. Exact p values are reported, and coefficients are evaluated at the 1%, 5% and 10% levels.

4. Empirical Results and Discussion

4.1 Preliminary results

Table 2 presents the distributional characteristics of the variables. Capital-market development averages 58.18% of GDP but varies widely across the sample, with a standard deviation of 66.42 and a range from 0.01 to 322.71. The dispersion reflects the coexistence of relatively deep markets and very small exchanges in the two regions. ATM penetration also differs considerably, averaging 43.99 per 100,000 adults and ranging from 3.67 to 134.08. Average real GDP growth is 2.67%, although the minimum of -14.55% records sizeable contractions in some country-years. Inflation, real interest rates and trade openness are similarly heterogeneous.

Table 2. Descriptive Statistics

Variable	Obs.	Mean	Std. dev.	Minimum	Maximum
GDPGRT	189	2.667	3.863	-14.547	12.710
CMDT	189	58.179	66.423	0.009	322.711
INFLRT	189	5.417	6.448	-16.249	36.603
INTRT	189	4.508	8.247	-25.777	40.860
DF	189	43.986	29.894	3.670	134.084
TRDOP	189	79.421	36.631	20.720	195.911
MACRO	189	0.059	1.035	-4.134	4.925

Source: Author 2026

The Pesaran CD statistics in Table 3 reject cross-sectional independence for every variable. The result is consistent with the exposure of SSA and MENA economies to common financial, commodity-price and technological shocks and supports the use of second-generation panel procedures. The CIPS results indicate a mixture of I(0) and I(1) variables. Inflation, the real interest rate and trade openness are stationary in levels, whereas GDP growth, capital-market development, digital finance and the macroeconomic factor become stationary after first differencing. No series is I(2).

Table 3. Cross-Sectional Dependence and Panel Unit-Root Tests

Variable	CD statistic	CD p value	Average correlation	CIPS statistic	Order
GDPGRT	19.885	< .001	0.553	-4.274***	I(1)
CMDT	4.242	< .001	0.118	-4.732***	I(1)
INFLRT	11.362	< .001	0.316	-3.191***	I(0)
INTRT	7.822	< .001	0.218	-2.361**	I(0)
DF	2.603	.009	0.072	-3.421***	I(1)
TRDOP	16.583	< .001	0.461	-2.574***	I(0)
MACRO	3.532	< .001	0.098	-2.190**	I(1)

*Note. The CIPS entries report the form at which stationarity is established. ** p < .05. *** p < .01.*

Source: Author 2026

4.2 Long-Run Estimates

Table 4 reports the CS-ARDL mean-group long-run estimates. In Model 1, the coefficient on digital finance is positive but statistically insignificant. H1 is therefore not supported. The result indicates that greater ATM penetration is not associated with a sufficiently stable cross-country increase in market capitalisation over the sample period. Trade openness is negative but insignificant. Model 2 provides no support for the directional macroeconomic hypotheses. Inflation and the real interest rate both carry positive but imprecisely estimated coefficients, while trade openness remains negative and insignificant. The standard errors are large relative to the point estimates, indicating substantial heterogeneity in the country-specific relationships. Digital finance is negatively related to economic growth in Model 3, but the effect is statistically insignificant. H3 is therefore not supported. In Model 4, neither digital finance nor the macroeconomic factor is significant. The interaction coefficient is negative, suggesting that the digital-finance coefficient declines as the factor score rises, but the estimate does not meet conventional significance thresholds. H4 is consequently unsupported in the long run. Because the PCA loadings differ by region, the interaction is interpreted as conditioning by the regional macroeconomic configuration rather than as a uniform stability effect.

Table 4. CS-ARDL Long-Run Estimates

Variable	Model 1: CMDT	Model 2: CMDT	Model 3: GDPGRT	Model 4: CMDT
DF	1.933 (3.807)	—	-3.024 (3.485)	-0.327 (0.456)
INFLRT	—	1.818 (8.689)	—	—
INTRT	—	1.239 (1.449)	—	—
MACRO	—	—	—	0.602 (0.777)
DF × MACRO	—	—	—	-3.771 (2.236)
TRDOP	-1.084 (0.877)	-0.750 (1.400)	0.653 (0.459)	-3.046 (4.029)

Note. Mean-group standard errors are in parentheses. No long-run coefficient is significant at the 10% level.

Source: Author 2026

4.3 Short-Run Dynamics and Adjustment

The short-run coefficients in Table 5 are also statistically insignificant. The sign of digital finance is negative in Models 1 and 3 but positive in Model 4. Inflation is positive in Model 2, whereas the real interest rate and trade openness are negative. In the moderation model, the interaction term is positive but imprecisely estimated. The changes in sign across horizons reinforce the need to distinguish transitory movements from persistent relationships and to avoid assigning substantive meaning to coefficients that are estimated with considerable uncertainty. The error-correction coefficients provide clearer evidence on dynamic adjustment. Model 1 has the expected negative sign but is not significant, so the digital finance-capital market equation does not display reliable convergence. By contrast, the coefficients for Models 2, 3 and 4 are negative and significant at the 1% level. Approximately 58.0%, 71.1% and 54.0% of disequilibrium is corrected within one year in the macroeconomic, growth and moderation models, respectively.

These adjustment estimates support the existence of stable long-run relations in the three models, even though the individual long-run slope coefficients are statistically weak.

Table 5. Short-Run Estimates and Error-Correction Terms

Variable	Model 1: CMDT	Model 2: CMDT	Model 3: GDPGRT	Model 4: CMDT
ΔDF	-2.476 (3.083)	—	-0.242 (0.234)	2.038 (1.331)
ΔINFLRT	—	5.685 (5.648)	—	—
ΔINTRT	—	-2.613 (2.440)	—	—
ΔMACRO	—	—	—	2.026 (2.096)
Δ(DF × MACRO)	—	—	—	0.455 (0.710)
ΔTRDOP	0.558 (0.985)	-2.356 (2.143)	0.128 (0.113)	6.278 (6.440)
ECM(t−1)	-0.276 (0.398)	-0.580*** (0.167)	-0.711*** (0.128)	-0.540*** (0.184)

*Note. Mean-group standard errors are in parentheses. *** $p < .01$.*

Source: Author 2026

4.4 Discussion

The positive but insignificant long-run coefficient on ATM penetration is consistent with a financial system in which digital access has expanded faster than its connection to securities markets. ATMs improve access to bank accounts and transaction services, but they do not directly measure digital brokerage, investor accounts or securities transactions. Al-Smadi (2023) finds that digital finance expands financial inclusion in MENA, while Otinga et al. (2025) show that usage, rather than access alone, is the dimension of inclusion that supports African capital-market development. The present result extends that distinction: broader access infrastructure may be

necessary, but it is not sufficient to deepen market capitalisation consistently across heterogeneous markets. The result also helps reconcile the contrasting size and liquidity effects reported by Babarinde (2024). Nigerian digitalpayment channels increased market capitalisation but reduced turnover, suggesting that digitalisation may coexist with greater market scale without producing active secondary-market trading. The weak adjustment in Model 1 reinforces this interpretation. If digital services remain concentrated in cash access and retail payments, shocks to digital infrastructure need not generate a stable path towards deeper capital markets. The insignificant inflation and interest-rate coefficients differ from evidence that macroeconomic instability constrains stock-market development. Ho (2017) reports a negative long-run inflation effect for South Africa, while Emmanuel and Emmanuel (2023) find that inflation weakens stock-market development in Nigeria. Chiad and Hadj Sahraoui (2021), by contrast, identify growth, liquidity, broad money and trade openness as positive drivers in Arab markets. The divergence is plausibly related to the combined regional sample and heterogeneous slopes: economies with different monetary regimes, market depth and external exposure need not respond uniformly to the same change in inflation or interest rates. Large mean-group standard errors make this heterogeneity visible rather than forcing a common coefficient.

The negative but insignificant digital finance-growth coefficient contrasts with the positive relationships reported by Jimoh and David (2024) for selected SSA countries and Khalifa (2025) for MENA. Measurement provides a likely explanation. Those studies employ broader indicators of digital or financial inclusion, whereas ATM penetration primarily represents access infrastructure. Economic gains may depend more on transaction intensity, digital savings, credit, entrepreneurship finance and institutional quality than on the number of access points. Meniago (2025) similarly shows that stronger institutions amplify the growth effect of digital financial inclusion in SADC countries. Finally, the negative interaction coefficient provides no statistically reliable evidence that the macroeconomic factor changes the long-run effect of digital finance. This does not establish unconditionality. Otinga et al. (2025), Meniago (2025) and Ullah et al. (2025) demonstrate that fintech effects vary with inclusion, institutions and global integration. In the present model, the PCA factor may be too broad to isolate a single enabling condition, and its regional loading patterns are not identical. A more direct test would distinguish price stability, exchange-rate volatility and monetary conditions and evaluate marginal effects separately by region.

5. Conclusion and Recommendations

5.1 Conclusion

This study examined the relationships among capital-market development, digital finance and macroeconomic conditions in 17 Sub-Saharan African (SSA) and Middle East and North African (MENA) countries over 2010-2025. Digital finance was represented by automated teller machine penetration, capital-market development by the market capitalisation of listed domestic companies relative to gross domestic product, and the macroeconomic environment by inflation, the real interest rate, the exchange rate and a region-specific composite factor. The cross-sectionally augmented autoregressive distributed lag mean-group estimator was used to accommodate common shocks, heterogeneous country responses and mixed orders of integration.

The results do not provide statistically reliable evidence that digital finance, as measured in this study, deepens capital markets or promotes economic growth. Its estimated long-run effect on capital-market development is positive but insignificant, whereas its relationship with economic growth is negative and insignificant. Inflation, the real interest rate and trade openness also have no significant long-run effects on capitalmarket development. Similarly, the interaction between digital finance and the composite macroeconomic factor is negative but statistically insignificant. The moderation hypothesis is therefore not supported. Across the four models, the short-run coefficients are also insignificant. The insignificant coefficients do not establish that digital finance or macroeconomic stability is unimportant; they show that the panel provides no systematic average effects across the sampled countries. ATM penetration principally captures access to cash and basic banking services, not the use of digital channels for securities issuance, brokerage, settlement or long-term saving. The findings therefore point to a conversion problem: wider digital access has not consistently produced deeper capital-market participation or measurable gains in output growth. The error-correction results add an important qualification. Models 2, 3 and 4 have negative and statistically significant adjustment coefficients, indicating that deviations from their long-run equilibria are corrected over time. Model 1, however, does not exhibit significant adjustment. Thus, the data support stable dynamic adjustment in the macroeconomic, growth and moderation specifications, but not a robust direct digital-finance–capital-market equilibrium. Taken together, the findings show that expanding access infrastructure alone is unlikely to transform capital markets. Its developmental contribution depends on the institutions, products, safeguards and market links through which digital access is converted into investment activity.

5.2 Policy Recommendations

First, policy targets should move beyond the number of access points to the effective use of digital channels for saving and investment. Central banks, securities regulators and statistical agencies should develop harmonised indicators for mobile and internet banking, digital investment accounts, electronic securities transactions, mobile money and fintech-based capital raising. These measures would distinguish basic transaction access from digital intermediation and capital-market participation. Second, digital-finance infrastructure should be connected directly to capital-market institutions. Securities exchanges, depositories, brokers, banks and fintech firms should promote secure electronic know-your-customer procedures, low-cost digital brokerage accounts, mobile investment platforms, electronic public offerings and interoperable payment and settlement systems. Simplified onboarding and proportionate regulation can reduce participation costs for retail investors and smaller firms, provided that suitability rules, disclosure standards, cybersecurity controls, data protection and complaint-resolution mechanisms are enforced. Third, macroeconomic management should be combined with reforms that improve market quality. The insignificant macroeconomic coefficients do not justify neglecting price, interest-rate or exchange-rate stability; they show that stability by itself may be insufficient to deepen capital markets across heterogeneous economies. Governments should pair credible monetary and fiscal policy with stronger corporate disclosure, minority-shareholder protection, legal enforcement, governance standards, market-making arrangements and more reliable trading

and settlement infrastructure. These measures would improve investor confidence and help convert favourable macroeconomic conditions into market depth and liquidity.

Fourth, financial inclusion programmes should incorporate digital, financial and investment literacy. Public education should explain the differences among payments, savings, credit and securities investment, as well as the risks of fraud, excessive borrowing and unsuitable products. Consumer protection should accompany innovation so that expanded digital participation is sustained by trust rather than weakened by cybercrime, opaque pricing or misuse of personal data. Fifth, policy design should recognise the substantial institutional and structural differences within and between SSA and MENA. Country strategies should reflect local market maturity, digital infrastructure, regulatory capacity and investor composition. At the regional level, greater alignment of digital identity, cybersecurity, disclosure and cross-border payment and settlement standards could lower transaction costs and widen the investor base. Such cooperation should preserve national supervisory responsibility while facilitating responsible cross-border investment and fintech activity.

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