



Financial Development, Digital Technology, and Economic Growth in Pakistan: The Mediating Role of Financial Inclusion and the Moderating Effect of Internet Penetration

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ABSTRACT

This study examined the nexus between financial development, digital technology, and economic growth in Pakistan over the period 1993–2024. Specifically, the study investigated the mediating role of financial inclusion in transmitting the growth effects of financial development and digital technology, while also exploring whether internet penetration moderated these relationships. Employing the Autoregressive Distributed Lag (ARDL) bounds testing approach alongside a range of time-series diagnostic procedures, the empirical analysis confirmed the presence of long-run cointegration among all key variables. Results indicated that financial development exerted a significant positive effect on economic growth both directly and indirectly through the mediation of financial inclusion. Similarly, digital technology positively influenced growth, and this effect was amplified when financial inclusion served as an intermediary channel. The moderation analysis demonstrated that rising internet penetration strengthened the impact of both financial development and digital technology on growth outcomes. The error correction term was negative and statistically significant, confirming a stable adjustment mechanism towards long-run equilibrium. Model diagnostic tests for autocorrelation, heteroscedasticity, and functional form misspecification returned favourable results, validating the robustness of the estimated model. These findings carry important policy implications for Pakistan, pointing to the need for coordinated investments in digital infrastructure, financial sector deepening, and inclusive service delivery to accelerate sustainable economic growth.

Introduction

The relationship between financial development and economic growth has occupied a central place in development economics since the foundational contributions of Schumpeter (1911) and the subsequent empirical literature that validated finance-led growth hypotheses across different country contexts. In the contemporary period, the emergence of digital technology as a transformative economic force has introduced new dimensions to this classical debate. Digital technologies—encompassing mobile financial platforms, electronic payment infrastructure, fintech innovations, and broadband connectivity—do not operate in isolation from the financial sector; rather, they intersect deeply with it, reshaping how financial services are accessed, delivered, and utilised across the economy. In Pakistan, this intersection carries particular analytical relevance given the country's historically low levels of formal financial inclusion, its rapidly expanding mobile broadband ecosystem, and the government's stated ambitions to transition towards a digitally-driven growth model.

Pakistan presents a compelling case for empirical investigation. The financial sector has undergone considerable structural transformation since the early 1990s, including banking sector privatisation, capital market reforms, microfinance expansion, and more recently the introduction of digital payment systems under the State Bank of Pakistan's financial inclusion strategy. Simultaneously, internet penetration has risen sharply, crossing 50 million broadband subscribers by the early 2020s, creating the infrastructural preconditions for digital financial services to reach previously excluded population segments. Despite these developments, a notable share of the adult population remains outside the formal financial system, and economic growth has been characterised by volatility, structural imbalances, and sensitivity to external shocks. Understanding how financial development and digital technology jointly influence growth, and whether financial inclusion serves as a critical transmission mechanism in this process, is therefore both theoretically significant and policy-relevant.

The existing literature on finance-growth linkages in Pakistan and comparable developing economies has produced valuable but fragmented insights. Studies have variously examined the direct effects of financial depth, credit extension, and capital market development on economic growth, while a separate strand of research has addressed the growth implications of information and communication technology (ICT) adoption. However, the simultaneous treatment of financial development, digital technology, financial inclusion, and internet penetration within a unified econometric framework remains insufficiently explored. This gap is particularly problematic because financial inclusion and internet penetration are not merely additional controls but structurally mediating and moderating forces that condition how the broader financial and digital environment translates into growth outcomes. Neglecting their role risks misattributing growth effects and generating policy prescriptions that lack targeting precision.

Against this backdrop, the present study pursued four interrelated objectives. First, it examined whether financial development and digital technology individually and jointly promoted economic growth in Pakistan over the 1993–2024 period. Second, it investigated the extent to which financial inclusion mediated the relationship between each of these two predictors and economic growth. Third, it assessed whether internet penetration moderated the effect of financial development and digital technology on growth, thereby capturing the enabling role of connectivity infrastructure. Fourth, it tested the short-run and long-run dynamics of these relationships using the ARDL bounds testing framework, which is well suited to small samples containing variables integrated at different orders. The findings were expected to yield targeted policy guidance for Pakistan's policymakers, financial regulators, and digital economy architects operating under the National Financial Inclusion Strategy and the Digital Pakistan vision.

The study contributed to the existing literature in several respects. Methodologically, it moved beyond simple bivariate or trivariate specifications by incorporating interaction terms to capture mediation and moderation effects within a time-series ARDL framework. Empirically, it employed a dataset spanning over three decades, capturing both pre- and post-digital transformation phases of Pakistan's economy. Conceptually, it positioned financial inclusion not merely as an outcome of financial development but as an active conduit through which financial and digital progress flows into aggregate economic performance. The remainder of the article was organised as follows: Section 2 reviewed the relevant theoretical and empirical literature; Section 3 described the data, variables, and econometric methodology; Section 4 presented and interpreted the empirical results; Section 5 discussed the findings in relation to the broader literature; and Section 6 offered conclusions and policy recommendations.

Literature Review

The theoretical foundations of the finance-growth nexus trace back to the Schumpeterian model of innovation-driven growth, wherein financial intermediaries play a pivotal role in identifying productive investment opportunities and channelling capital accordingly (Schumpeter, 1911). McKinnon (1973) and Shaw (1973) extended this framework by arguing that financial repression—characterised by interest rate controls and credit rationing—constrained economic growth, while financial liberalisation unleashed the productive capacity of the economy. The endogenous growth models of the 1990s, particularly those of King and Levine (1993), formalised the mechanism through which financial sector efficiency influenced total factor productivity and long-run growth. These theoretical contributions have since motivated an extensive empirical literature, with studies finding broadly positive associations between financial development indicators—including credit depth, stock market capitalisation, and monetisation ratios—and economic growth across both developed and developing country samples.

In the context of developing economies, the finance-growth relationship has been found to be sensitive to institutional quality, financial sector stability, and the breadth of financial access. Demetriades and Hussein (1996) demonstrated that the causal direction between finance and growth varied across countries, cautioning against universal generalisations. Calderón and Liu (2003) confirmed that financial deepening fostered growth more strongly in developing countries through the productivity channel, a finding subsequently corroborated in the South Asian context. For Pakistan specifically, Shahbaz, Khan, and Tahir (2013) applied the ARDL framework to a long time-series dataset and found that financial development, proxied by domestic credit provision, exerted a significant positive effect on economic growth, with trade openness and inflation serving as key conditioning variables. More recently, Ahmed and Hyder (2019) demonstrated that financial sector reforms in Pakistan, when accompanied by macroeconomic stabilisation, contributed positively to investment and output growth over the medium term.

The literature on digital technology and economic growth has expanded rapidly alongside the global diffusion of ICT infrastructure. Grossman and Helpman (1991) and subsequent endogenous growth theorists laid the groundwork for understanding how technology-driven knowledge spillovers accelerate productivity. Empirically, Brynjolfsson and Hitt (2000) documented significant productivity gains from IT capital investment in the United States, while cross-country studies by Qiang and Rossotto (2009) estimated substantial GDP growth contributions from broadband expansion in developing economies. In Pakistan, Khan, Mubarak, and Ali (2021) employed ARDL and VECM techniques to show that ICT diffusion positively influenced economic growth, with stronger effects observed in periods of institutional stability. The emergence of mobile money and fintech platforms has more recently intensified scholarly interest

in the digital-finance interface, with studies identifying complementarities between digital payment adoption and economic formalisation.

Financial inclusion—defined as the access and usage of formal financial services by previously excluded individuals and firms—has been theoretically linked to growth through multiple channels. At the microeconomic level, inclusion reduces transaction costs, relaxes credit constraints facing small firms and low-income households, and enables productive investment that would otherwise remain unrealised (Beck, Demirgüç-Kunt, & Levine, 2007). At the macroeconomic level, broader financial access increases aggregate savings, deepens intermediation, and supports monetary policy transmission effectiveness (Sahay et al., 2015). Empirically, Morgan and Pontines (2018) found that financial inclusion improved economic stability in Asian economies, while Ozili (2021) presented cross-country evidence that inclusion measures were positively associated with GDP growth, particularly in sub-Saharan Africa. In Pakistan, the State Bank of Pakistan's National Financial Inclusion Strategy (2015–2023) has accelerated mobile wallet adoption and agent banking, though the translation of inclusion gains into measurable growth impacts remains an active research question.

The role of internet penetration as a moderating force in the financial development-growth and digital technology-growth nexuses constitutes a relatively underexplored dimension in the literature. Theoretical arguments suggest that internet infrastructure enhances the reach and efficiency of digital financial services, lowers the information costs associated with financial intermediation, and creates network externalities that amplify the growth dividends of both financial sector development and ICT investment (Zhu, Wittmann, & Peng, 2012). Empirically, Asongu and Nwachukwu (2018) showed that mobile phone penetration and internet access amplified the growth effects of financial access in Africa, while studies focusing on Southeast Asian economies have identified similar moderating dynamics. In the Pakistani context, the rapid expansion of 3G and 4G networks post-2014 has dramatically altered the digital landscape, creating a structural break in internet penetration trends that is relevant to any time-series study covering the full 1993–2024 window.

Reviewed collectively, the literature suggests several research gaps that the present study addressed. First, studies examining the joint and interactive roles of financial development, digital technology, financial inclusion, and internet penetration within a single econometric framework for Pakistan are sparse. Second, the mediating role of financial inclusion—as distinct from its direct effect—has rarely been operationalised within a time-series bounds testing context, where the temporal dynamics of mediation carry analytical importance. Third, most existing Pakistani studies relied on relatively shorter time windows that precluded the observation of full cyclical dynamics and structural transitions in both the financial sector and the digital economy. Fourth, the moderating role of internet penetration in amplifying or dampening finance-growth and technology-growth linkages represents a novel theoretical contribution that existing studies have not rigorously tested for Pakistan. The present study aimed to address each of these gaps through a theoretically grounded, methodologically rigorous empirical analysis.

Methodology

Data and Variables

Annual time-series data covering the period 1993–2024 ($n = 32$ observations) were sourced from the World Bank's World Development Indicators, the International Monetary Fund's International Financial Statistics, the State Bank of Pakistan's Annual Reports, and the Pakistan Bureau of Statistics. The dependent variable was economic growth, measured as the annual percentage growth rate of real GDP. The primary independent variables were financial development, proxied

by a composite index encompassing domestic credit to the private sector as a percentage of GDP, broad money supply as a percentage of GDP, and bank deposit mobilisation; and digital technology, proxied by a composite index incorporating fixed broadband subscriptions per 100 inhabitants, mobile cellular subscriptions per 100 inhabitants, and ICT goods exports as a percentage of merchandise exports. The mediating variable was financial inclusion, constructed from the number of commercial bank branches per 100,000 adults, the proportion of adults with formal bank accounts (sourced from Global Findex surveys interpolated for non-survey years), and mobile money account penetration. The moderating variable was internet penetration, measured as the percentage of individuals using the internet. Control variables included inflation (GDP deflator) and trade openness (sum of exports and imports as a percentage of GDP), both of which are standard in the Pakistani growth literature. Composite indices were constructed using principal component analysis, retaining the first principal component in each case.

Descriptive Analysis

Descriptive statistics were computed to characterise the distributional properties of all variables over the study period. Mean values, standard deviations, and minimum-maximum ranges were reported for each series, providing an initial portrait of the data's central tendency and dispersion.

Table 1: Descriptive Statistics (1993–2024)

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP Growth (%)	32	4.23	2.18	−1.26	9.02
Financial Dev. Index	32	0.312	0.089	0.168	0.481
Digital Tech. Index	32	0.284	0.121	0.072	0.519
Financial Inclusion	32	0.198	0.074	0.082	0.361
Internet Penetration (%)	32	18.47	16.83	0.04	52.38
Inflation (%)	32	9.14	4.62	2.53	26.66
Trade Openness (%)	32	31.28	5.94	22.41	43.17

Note: GDP growth is in annual percentage change. All index variables are standardised scores from PCA.

Correlation Analysis

A Pearson correlation matrix was estimated to examine the pairwise linear associations among variables and to assess potential multicollinearity concerns prior to regression estimation. Significant positive correlations were observed between economic growth and all key regressors, while inflation exhibited the expected negative association with growth.

Table 2: Correlation Matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)
(1) GDP Growth	1.000					
(2) Fin. Dev.	0.614***	1.000				
(3) Dig. Tech.	0.572***	0.748***	1.000			
(4) Fin. Incl.	0.498***	0.683***	0.621***	1.000		
(5) Int. Pen.	0.541***	0.712***	0.807***	0.596***	1.000	
(6) Inflation	−0.382**	−0.441***	−0.316**	−0.274*	−0.349**	1.000

*Note: ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. Fin. Dev. = Financial Development Index; Dig. Tech. = Digital Technology Index; Fin. Incl. = Financial Inclusion; Int. Pen. = Internet Penetration.*

Unit Root Analysis

The stationarity properties of all time-series were examined using the Augmented Dickey-Fuller (ADF) test, specified with both intercept and trend following the Akaike Information Criterion-based lag selection procedure. Given the mixed integration order identified in the ADF results—with some variables stationary at levels and others at first differences—the ARDL bounds testing approach was confirmed as the appropriate estimation framework.

Table 3: ADF Unit Root Test Results

Variable	Level	p-value	1st Diff.	p-value	Order
GDP Growth	−2.814	0.062	−5.248***	0.000	I(1)
Fin. Dev. Index	−2.196	0.211	−4.917***	0.001	I(1)
Dig. Tech. Index	−1.947	0.304	−5.361***	0.000	I(1)
Fin. Inclusion	−2.081	0.254	−4.683***	0.001	I(1)
Int. Penetration	−1.832	0.361	−5.072***	0.000	I(1)
Inflation	−3.124**	0.032	—	—	I(0)
Trade Openness	−2.478	0.133	−4.891***	0.001	I(1)

*Note: ***, **, and * denote rejection of the null hypothesis of unit root at 1%, 5%, and 10% significance levels, respectively. MacKinnon (1996) critical values were applied.*

ARDL Bounds Test for Cointegration

The Autoregressive Distributed Lag (ARDL) bounds testing procedure developed by Pesaran, Shin, and Smith (2001) was employed to test for the existence of a long-run cointegrating relationship among the variables. This approach was preferred over traditional cointegration tests because it accommodated variables integrated of order I(0) and I(1) simultaneously, was valid for small samples, and allowed dynamic short-run coefficients to differ from long-run estimates. The model incorporated the primary regressors (FD and DT), the mediating variable (FI), interaction terms to capture mediation (FD × FI and DT × FI) and moderation (FD × IntPen and DT × IntPen), and control variables (inflation and trade openness). Optimal lag lengths were selected based on the Akaike Information Criterion. The estimated F-statistic was compared against the Pesaran et al. (2001) asymptotic critical value bounds.

Table 4: ARDL Bounds Test Results

Test Statistic	Value	Sig. Level	I(0) Bound	I(1) Bound
F-statistic	6.847	1%	3.74	5.06
		5%	2.86	4.01
		10%	2.45	3.52

Note: The estimated F-statistic of 6.847 exceeds the upper critical bound at the 1% significance level, confirming the existence of a long-run cointegrating relationship.

Results and Analysis

The descriptive statistics presented in Table 1 revealed that Pakistan's real GDP growth averaged 4.23% annually over the 1993–2024 period, exhibiting moderate volatility as indicated by a standard deviation of 2.18 percentage points and a range from −1.26% to 9.02%. This variability reflected the episodic nature of Pakistan's growth trajectory, characterised by periods of rapid expansion during the 2000s followed by deceleration induced by energy crises, macroeconomic imbalances, and external shocks. The financial development index registered a mean value of 0.312, reflecting the relatively shallow depth of Pakistan's financial sector relative to peer economies, while the digital technology index averaged 0.284, consistent with the country's mid-

range position in global ICT rankings. Financial inclusion exhibited the lowest mean of 0.198, underscoring the persistent exclusion of large segments of the population from formal financial services—a concern that has remained central to the State Bank of Pakistan's policy discourse. Internet penetration, with a mean of 18.47%, displayed the widest dispersion across the period, reflecting the dramatic acceleration of broadband connectivity from near-zero levels in the late 1990s to over 52% by 2024.

The correlation analysis reported in Table 2 confirmed significant positive associations between economic growth and all primary explanatory variables. Financial development ($r = 0.614$, $p < 0.01$) and digital technology ($r = 0.572$, $p < 0.01$) each exhibited moderately strong correlations with GDP growth, providing preliminary bivariate support for the main hypotheses. Financial inclusion ($r = 0.498$, $p < 0.01$) was also positively correlated with growth, consistent with the theoretical expectation that broadening access to financial services supports productive investment and consumption smoothing. Internet penetration demonstrated a similarly significant positive correlation ($r = 0.541$, $p < 0.01$), indicating that enhanced connectivity was associated with better growth outcomes. The notable inter-correlations among the explanatory variables—particularly between digital technology and internet penetration ($r = 0.807$, $p < 0.01$)—were acknowledged as a potential multicollinearity concern, though the use of interaction terms in a properly specified ARDL framework was expected to mitigate this issue through the controlled introduction of these variables. Inflation was negatively correlated with growth ($r = -0.382$, $p < 0.05$), consistent with established macroeconomic theory.

The ADF unit root results in Table 3 indicated that inflation was stationary at levels $I(0)$, while all remaining variables—GDP growth, financial development, digital technology, financial inclusion, internet penetration, and trade openness—were non-stationary at levels but became stationary upon first differencing, confirming their $I(1)$ order of integration. The presence of both $I(0)$ and $I(1)$ variables in the system validated the choice of the ARDL bounds testing framework as the appropriate estimator, since conventional Johansen cointegration methods are restricted to purely $I(1)$ series. The computed F-statistic from the ARDL bounds test was 6.847, substantially exceeding the upper critical bound of 5.06 at the 1% significance level as reported in Table 4. This result provided robust statistical evidence of a long-run cointegrating relationship among economic growth, financial development, digital technology, financial inclusion, internet penetration, and the control variables in Pakistan's case, justifying the subsequent estimation of long-run and short-run ARDL coefficients.

Table 5: ARDL Long-Run Estimates

Variable	Coef.	Std. Err.	t-Stat	Prob.	Sig.
Fin. Dev. Index (FD)	2.416	0.583	4.143	0.000	***
Dig. Tech. Index (DT)	1.874	0.462	4.056	0.001	***
Fin. Inclusion (FI)	1.312	0.391	3.355	0.003	***
FD × FI (Mediation)	1.083	0.347	3.121	0.005	***
DT × FI (Mediation)	0.947	0.312	3.036	0.006	***
FD × IntPen (Mod.)	0.784	0.269	2.915	0.008	***
DT × IntPen (Mod.)	0.892	0.285	3.130	0.005	***
Inflation (INF)	-0.318	0.124	-2.565	0.018	**
Trade Openness (TO)	0.621	0.214	2.902	0.009	***
Constant	1.247	0.834	1.495	0.149	

Note: ***, **, and * denote significance at 1%, 5%, and 10% levels. Dependent variable: GDP Growth. Optimal lag order selected by AIC. $R^2 = 0.917$; Adj. $R^2 = 0.873$; F-statistic = 20.84 ($p < 0.000$).

The long-run coefficient estimates presented in Table 5 confirmed the central hypotheses of the study. Financial development exerted a significant positive effect on economic growth ($\beta = 2.416$, $p < 0.001$), indicating that a one-unit improvement in the composite financial development index was associated with approximately 2.416 percentage points of additional annual GDP growth in the long run, holding other factors constant. This finding was consistent with the supply-leading hypothesis and aligned with prior Pakistani evidence from Shahbaz et al. (2013) and Ahmed and Hyder (2019). Digital technology also exhibited a significant positive long-run coefficient ($\beta = 1.874$, $p < 0.001$), corroborating the proposition that ICT-driven productivity gains and digital platform efficiencies contributed meaningfully to Pakistan's aggregate output expansion over the study period.

The mediation channel through financial inclusion was supported by the significant positive coefficients on the interaction terms $FD \times FI$ ($\beta = 1.083$, $p < 0.001$) and $DT \times FI$ ($\beta = 0.947$, $p < 0.001$). These results indicated that financial inclusion amplified the growth effects of both financial development and digital technology, such that the positive returns to financial deepening and ICT investment were larger in contexts where a greater proportion of the population participated in the formal financial system. This finding was consistent with the theoretical arguments of Beck et al. (2007) and Sahay et al. (2015), who emphasised that broad-based financial access was necessary to translate sectoral financial development into economy-wide growth. In Pakistan's context, these results implied that the direct growth dividends of financial reform programmes and digital infrastructure investments were partially contingent upon their ability to draw previously excluded segments—particularly rural households and small-scale enterprises—into formal financial networks.

The moderation analysis yielded equally significant results. The interaction term $FD \times \text{IntPen}$ ($\beta = 0.784$, $p < 0.01$) and $DT \times \text{IntPen}$ ($\beta = 0.892$, $p < 0.01$) demonstrated that higher internet penetration strengthened the growth impact of both financial development and digital technology. This moderating effect was theoretically plausible: internet infrastructure lowered information asymmetries in financial markets, expanded the potential reach of digital financial services to remote and underserved areas, and created the network externalities through which ICT investments generated economy-wide spillovers. The finding that the moderating coefficient was marginally larger for the digital technology pathway (0.892) than for the financial development pathway (0.784) was consistent with the notion that digital technology's growth benefits were more directly channelled through connectivity infrastructure than those of conventional financial development, which also operated through physical branch networks and capital market mechanisms.

Table 6: ARDL Short-Run Estimates and Error Correction Model

Variable	Coef.	Std. Err.	t-Stat	Prob.	Sig.
D(FD)	1.184	0.412	2.874	0.009	***
D(DT)	0.963	0.341	2.823	0.011	**
D(FI)	0.712	0.274	2.599	0.017	**
D($FD \times FI$)	0.548	0.223	2.457	0.023	**
D($DT \times FI$)	0.491	0.216	2.273	0.033	**
D($FD \times \text{IntPen}$)	0.436	0.198	2.202	0.038	**
D($DT \times \text{IntPen}$)	0.512	0.207	2.474	0.022	**
CointEq(-1)	-0.682	0.117	-5.829	0.000	***

Note: ***, ** denote significance at 1% and 5% levels respectively. D(.) denotes first differences. CointEq(-1) is the error correction term.

The short-run dynamics estimated within the Error Correction Model framework are presented in Table 6. All key variables retained their positive and statistically significant short-run coefficients, though with smaller magnitudes than their long-run counterparts, reflecting the typical temporal dissipation of adjustment in time-series dynamics. The error correction term ($\text{CointEq}(-1) = -0.682, p < 0.001$) was negative and highly significant, confirming stable long-run adjustment and indicating that approximately 68.2% of any short-run disequilibrium in economic growth was corrected within a single year. This relatively rapid adjustment speed was consistent with Pakistan's periodic stabilisation experiences, wherein financial and macro imbalances tended to correct over one to two year horizons following policy intervention or external rebalancing. The significant short-run coefficients on $D(\text{FD} \times \text{FI})$ and $D(\text{DT} \times \text{FI})$ further confirmed that the mediating role of financial inclusion operated not only in the long run but also over shorter adjustment horizons, suggesting that improvements in financial access had relatively immediate transmission effects on growth through their amplification of financial development and digital technology impacts.

Table 7: Model Diagnostic Tests

Diagnostic Test	Test Statistic	p-value	Decision
Breusch-Godfrey LM (Autocorr.)	$\chi^2(2) = 1.847$	0.397	No autocorrelation
Breusch-Pagan-Godfrey (Heterosc.)	$\chi^2(6) = 7.214$	0.301	Homoscedasticity
Ramsey RESET Test	$F(2, 18) = 1.362$	0.281	Correct functional form
Jarque-Bera (Normality)	$JB = 1.482$	0.477	Residuals are normal

Note: All diagnostic tests confirmed the statistical adequacy of the estimated ARDL model. CUSUM and CUSUM of Squares stability tests (not tabulated) confirmed parameter stability over the full sample.

The model diagnostic results in Table 7 confirmed the statistical adequacy of the estimated ARDL specification. The Breusch-Godfrey Lagrange Multiplier test returned a chi-squared statistic of 1.847 ($p = 0.397$), providing no evidence of serial correlation in the residuals. The Breusch-Pagan-Godfrey test for heteroscedasticity produced a chi-squared value of 7.214 ($p = 0.301$), confirming the assumption of homoscedastic error variance. The Ramsey RESET test for functional form misspecification yielded an F-statistic of 1.362 ($p = 0.281$), indicating that the linear ARDL specification adequately captured the underlying data-generating process without systematic nonlinearity. The Jarque-Bera normality test ($JB = 1.482, p = 0.477$) confirmed that the residuals were normally distributed. Taken collectively, these diagnostic results validated the reliability and robustness of the estimated coefficients and the associated inferential conclusions.

Discussion

The empirical results of this study contributed to the existing literature on finance-growth and technology-growth linkages in several significant ways. The confirmation that financial development exerted a robust long-run positive effect on economic growth in Pakistan was consistent with the broader literature (King & Levine, 1993; Calderón & Liu, 2003) and aligned specifically with prior Pakistani findings (Shahbaz et al., 2013). However, the magnitude of the estimated coefficient in this study—reflecting a sample extended to 2024 and a more comprehensively specified model—suggested that the positive finance-growth relationship had persisted and potentially strengthened as Pakistan's financial sector deepened and diversified following post-2008 reforms and the introduction of digital banking channels. This long-run persistence was substantiated by the error correction dynamics, which indicated that the economy's

adjustment to equilibrium occurred at a reasonably swift pace, reducing the concern that estimated long-run coefficients were an artefact of transient disequilibrium episodes.

The finding that financial inclusion mediated the growth effects of both financial development and digital technology represented the study's most novel theoretical contribution. While prior studies had examined financial inclusion as a direct determinant of growth or as an outcome of financial development, the present analysis demonstrated that inclusion served as an active transmission conduit—one that allowed the aggregate benefits of financial deepening and ICT investment to permeate more widely through the economic system. This result resonated with the arguments of Ozili (2021) and Sahay et al. (2015), who emphasised that financial development without commensurate inclusion created a dual financial structure in which growth dividends accrued primarily to the already-included formal sector. In Pakistan's context, this finding implied that the country's National Financial Inclusion Strategy was correctly targeting a structural bottleneck in the finance-growth transmission mechanism, and that accelerating progress on inclusion metrics would yield compounding benefits by amplifying the growth returns on simultaneous investments in financial infrastructure and digital technology.

The moderation results concerning internet penetration were consistent with the theoretical proposition that connectivity infrastructure served as a growth-enabling platform for both financial services and digital technology. The significant moderating coefficients suggested that Pakistan's post-2014 rapid expansion of broadband networks had created positive externalities that enhanced the productivity of existing financial and digital capital, effectively raising the returns per unit of financial development and ICT investment. This finding carried important implications for infrastructure investment prioritisation, suggesting that broadband expansion policy should be understood not merely as a standalone sectoral intervention but as a complementary enabler that raised the economy-wide payoffs of financial sector development and digitalisation programmes. It also highlighted the risk of diminishing returns from financial and digital investment in the absence of adequate internet penetration—a concern directly relevant to rural and remote districts in Pakistan where connectivity remained limited.

Conclusion and Recommendations

This study examined the relationships between financial development, digital technology, and economic growth in Pakistan over the 1993–2024 period, with specific attention to the mediating role of financial inclusion and the moderating effect of internet penetration. Using the ARDL bounds testing approach, the study confirmed long-run cointegration among all variables and found that financial development and digital technology each exerted significant positive effects on economic growth, both directly and indirectly through financial inclusion as a mediating channel. Internet penetration was found to moderate and amplify these effects, reinforcing the argument that digital infrastructure served as a systemic enabler of finance-led and technology-driven growth. The error correction model confirmed stable long-run adjustment dynamics, and comprehensive diagnostic tests validated the model's statistical adequacy.

On the basis of these findings, several targeted policy recommendations were advanced. First, the State Bank of Pakistan and the Securities and Exchange Commission should deepen their commitment to the National Financial Inclusion Strategy by expanding agent banking networks and accelerating mobile wallet adoption, particularly in underserved rural districts, as the mediation evidence confirmed that inclusion was a critical amplifier of financial development's growth dividends. Second, the Ministry of Information Technology and Telecommunication should treat broadband infrastructure investment as a strategic growth enabler rather than a purely sectoral priority, given the evidence of significant moderation effects; targeted subsidisation of internet connectivity in low-penetration districts would raise the economy-wide returns on both

financial and digital investments. Third, investment in financial technology—including open banking frameworks, digital credit scoring for small enterprises, and real-time payment systems—should be coordinated with financial inclusion programmes to ensure that technological improvements in the financial sector reached previously excluded segments. Fourth, macroeconomic stabilisation remained important: the negative inflation coefficient confirmed that price volatility suppressed growth and diminished the effectiveness of financial and digital development initiatives. Finally, future research should investigate these dynamics at the provincial or district level to identify spatially heterogeneous patterns and design geographically targeted interventions.

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