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DIGITAL FINANCE AND INDUSTRIAL DIVERSIFICATION IN PAKISTAN: THE ROLE OF ROAD FREIGHT AS A MODERATOR

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Abstract
This study examines the influence of digitalization on financial services in Pakistan, with particular emphasis on the contribution of digital infrastructure, including internet connectivity, mobile phone penetration, and automated teller machines. The analysis demonstrates that digital financial markets are becoming progressively more central to the evolution of Pakistan's financial system, strengthening market competition, improving the performance of financial intermediaries, and enhancing overall operational efficiency. The findings indicate that digital technology, in isolation, is not sufficient to advance financial inclusion; rather, a comprehensive and coordinated framework is required to effectively support the expansion of digital financial services in Pakistan. In addition, digital finance plays a substantial role in fostering urban industrial diversification, with road freight capacity reinforcing this relationship. The study employs panel data techniques to investigate the linkage between digital finance and industrial diversification, while incorporating road freight capacity as a moderating variable to uncover a previously underexplored dimension of this nexus. The empirical results confirm that digital finance contributes positively to diversification, particularly through broader service coverage and deeper usage intensity, and explain the mechanisms underlying this effect. Digital finance facilitates industrial diversification by expanding access to financial services, encouraging innovation, and improving the efficiency of resource allocation. Road freight capacity further moderates this association, underscoring the critical importance of logistics infrastructure in sustaining economic development. The overall findings suggest that integrated strategies combining digital finance and logistics infrastructure can stimulate regional industrial expansion. Such strategies include leveraging digital finance to advance industrial diversification, strengthening logistics infrastructure to support economic progress, and implementing region-specific policy interventions.
Keywords: *Digital finance, Industrial diversification, Road freight volume*

INTRODUCTION

Digital financial services are defined as the delivery and access of core financial services—such as payments, credit, savings, insurance, and remittances, through digital channels, including the internet, automated teller machines, mobile phones, tablets, biometric devices, electronically enabled cards, and point-of-sale systems. These technologies operate through interconnected digital payment platforms that link individuals and businesses to an integrated financial ecosystem, facilitating faster, more transparent, and seamless transactions among economic agents. Digital financial services are playing an increasingly significant role in delivering affordable, secure, and convenient banking solutions worldwide (Wim & Wendy, 2025; Khalid et al., 2025; Rehman & Chowdhury, 2025). Industrial diversification has long been regarded as a primary objective of economic development policy. Economies characterized by diversified industrial structures are generally better positioned to absorb external disturbances, adjust to technological transformation, and sustain long-term economic expansion. In contrast, heavy dependence on a limited range of industries or commodities exposes economies to volatility, cyclical demand fluctuations, and structural fragility (Audi & Yu, 2024; Arshad et al., 2025; Iqbal & Noman, 2025; Karul & Nawaz, 2025).

Although existing research has extensively explored the impact of digital finance on economic growth (Ali & Rehman, 2015; Gomber et al., 2017; Musa, 2024; Ammar et al., 2025), firm behavior (Idris, 2023; Gao et al., 2025; Zahid et al., 2025; Liu & Cai, 2025), and household consumption (Ali, 2015; Fatima & Zaman, 2020; Wang & Huang, 2024; Yang et al., 2025; Soliman, 2025; Umair et al., 2025), limited empirical evidence has systematically examined how digital finance influences industrial structure at the city level, particularly in relation to industrial diversification. As an essential indicator of urban economic complexity and structural resilience, industrial diversification reflects the balance and diversity of industrial composition and determines a city's ability to withstand external shocks while achieving sustainable development (Zahavi & Lavie, 2013; Ali & Audi, 2018; Kar & Dasgupta, 2024; Aman et al., 2025; Mansour & Salar, 2025; Naeem et al., 2025). Consequently, understanding the mechanisms through which digital finance penetrates and

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reshapes industrial structure holds substantial theoretical and practical relevance (Marc & Ali, 2019; Sumaira, 2020; Sufyan & Othman, 2025; Iqbal et al., 2025; Ahmed & Hu, 2025).

Accordingly, identifying the drivers of industrial diversification remains a central concern in development economics, financial economics, and industrial policy scholarship. Traditional explanations emphasize capital accumulation, human capital development, institutional quality, and physical infrastructure as fundamental determinants (Tan & Lee, 2025; Ali et al., 2025; Marc, 2025; Khalid et al., 2025). Access to finance has consistently been recognized as a critical factor influencing firm entry, expansion, and innovation across sectors. However, financial systems have undergone a profound transformation over the past decade due to the emergence of digital finance (Jamel & Zhang, 2024; Ali et al., 2025; Rizwan & Iqbal, 2025; Holton & Holton, 2025; Rana et al., 2025). Digital finance encompasses the provision of financial services through digital platforms, including mobile payments, digital banking, online lending, and technology-driven financial intermediation (Ahmed & Alvi, 2024; Ali et al., 2025; Gomez & Edward, 2025; Kumar et al., 2025). By leveraging digital technologies, these services reduce transaction costs, alleviate information asymmetries, and broaden financial inclusion for firms and households previously excluded from conventional banking systems (van Zanden, 2023; Zenios, 2024; Aziz et al., 2025; Khan et al., 2025).

A growing body of literature highlights the extensive implications of digital finance for economic development. Empirical studies suggest that digital financial services expand credit access for small and medium-sized enterprises, stimulate entrepreneurial initiatives, and enhance the efficiency of capital allocation (Kibritcioglu, 2023; Munir et al., 2024; Shahid et al., 2025). These mechanisms are directly relevant to industrial diversification, as emerging industries frequently face significant financing constraints arising from uncertainty, limited collateral, and insufficient credit histories (Senturk, 2023; Ali & Sajid, 2020; Mbodj & Laye, 2025; Shahi et al., 2025). Through the use of alternative data sources and automated credit assessment mechanisms, digital finance can ease these constraints and facilitate sectoral expansion beyond traditional industrial bases. Over time, financial markets have become increasingly reliant on digital technologies as a strategic instrument for strengthening financial sector development (Anwar & Akhtar, 2019; Roy & Madheswaran, 2020; Nur & Kumar, 2023; Sattar et al., 2025; Ahmad et al., 2025; Niaz et al., 2025). Individuals, businesses, and governments derive benefits from digital financial systems through improved mobilization of domestic savings, expanded lending capacity, smoother consumption patterns, enhanced insurance coverage, diversified investment opportunities, stronger market competition, improved intermediary performance, greater operational efficiency, and sustained economic growth (Hassan & Salha, 2020; Bozi & Bozic, 2025; Khan et al., 2025).

At the organizational level, digitalization compels firms to redesign and innovate their business models (Bharadwaj et al., 2013; Dahmani & Makram, 2024; Khalil et al., 2025). In Pakistan, the relevance of digital financial markets has grown considerably in the context of globalization, which has enabled investors to allocate capital more freely across markets with lower transaction costs and enhanced return prospects, particularly in equity markets. The Government of Pakistan and the State Bank of Pakistan have undertaken substantial initiatives to promote financial inclusion through digitalization. The State Bank introduced the National Payment Systems Strategy to establish a comprehensive digital payment infrastructure. Digital financial services in Pakistan formally commenced in 2008 following the introduction of branchless banking regulations. In 2015, financial sector expansion accelerated after the approval of the National Financial Inclusion Strategy, aimed at building a dynamic and inclusive financial system. These policy measures encouraged digital financial service providers to expand private sector investment in microfinance institutions. Consequently, telebanking, internet banking, automated teller machines, and debit and credit cards emerged as effective distribution channels for traditional banking products. Telenor's Easypaisa platform represents a prominent example of a non-banking entity delivering basic financial services, enabling users to open accounts, transfer funds, deposit and withdraw money, and settle utility bills. The platform has registered millions of accounts and facilitates extensive over-the-counter transactions. The Government of Pakistan has also incorporated digital financial services into social protection programs, including the Benazir Income Support Programme, which initiated digital disbursement mechanisms to millions of beneficiaries. Furthermore, Pakistan joined the United Nations Better Than Cash Alliance in 2014 to promote digital payment systems, and initiatives such as E-Pay Punjab have streamlined business-to-government and public-to-government transactions.

Existing research on industrial development frequently examines finance and infrastructure as distinct determinants, assessing their independent effects. However, theoretical considerations suggest strong complementarities between these factors. Digital finance may enable firms to invest, innovate, and expand production, yet the materialization of these benefits depends on supportive physical infrastructure. In regions

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with efficient and reliable road freight systems, firms financed through digital platforms can scale operations, diversify product lines, and access broader markets. Conversely, inadequate road freight infrastructure may constrain the economic gains from digital finance, thereby limiting its contribution to industrial diversification. The interaction between digital finance and road freight infrastructure has received limited systematic examination. While some studies recognize the complementary relationship between financial development and infrastructure, few explicitly analyze road freight capacity as a moderating factor in the relationship between digital finance and industrial diversification. This gap is particularly significant given the dominant role of road transport in domestic logistics across both advanced and emerging economies. The impact of digital finance on industrial diversification is unlikely to be homogeneous across regions. Financial access alone does not guarantee productive expansion if firms face logistical constraints in transporting inputs and outputs. Road freight systems constitute the backbone of domestic logistics, facilitating the movement of raw materials, intermediate goods, and final products, linking production centers with markets, and enabling integration into regional and global value chains. Against this background, the present study addresses the following research questions: How does digital finance influence industrial diversification? Does road freight development moderate the relationship between digital finance and industrial diversification?

By responding to these questions, the study makes three primary contributions. First, it advances the digital finance literature by explicitly linking digital financial development to industrial diversification outcomes rather than limiting the analysis to financial inclusion or firm-level performance. Second, it integrates transport economics into the analytical framework by identifying road freight infrastructure as a critical moderating variable. Third, by employing a country-neutral analytical approach, the study offers insights that can be adapted across diverse national contexts, enabling future research to apply and refine the framework within specific regional settings.

LITERATURE REVIEW

DIGITAL FINANCE PENETRATION AND INDUSTRIAL DIVERSIFICATION

Industrial diversification serves as a central indicator for evaluating the structural complexity and economic resilience of a region, reflecting its capacity to achieve balanced development across a broad spectrum of industries (Brown & Greenbaum, 2017; Zubair & Hayat, 2020; Nasir et al., 2025; Tansuchat & Thaicharo, 2025). A diversified industrial base improves the efficiency of resource allocation, enhances adaptability to external shocks, and supports sustainable and high-quality economic growth. In contrast, traditional financial systems are often characterized by centralized decision-making structures and high entry barriers (Beck & Demirguc, 2006). Such structural features restrict access to finance for small and medium-sized enterprises, emerging sectors, and peripheral regions, thereby constraining their ability to contribute meaningfully to industrial diversification. Over time, empirical research examining structural transformation and economic performance has produced varied findings, partly due to differences in measurement strategies and contextual factors. Within this broader debate, scholars have increasingly turned their attention to the role of the digital economy and the mechanisms through which it influences economic restructuring, particularly in emerging economies such as Pakistan. Evidence from capital markets indicates that heightened attention to digital economy development is positively associated with enterprise innovation, suggesting that digitalization strengthens firms' technological capabilities and competitive positioning. Digitization in retail banking has significantly reduced operational processing time and transaction costs, enhancing overall institutional efficiency. With rapid advances in digital and mobile technologies, financial services are progressively shifting toward integrated online platforms. Anikina, Gukova, Golodova, and Chekalkina (2016) argue that technological advancement improves access to financial information, lowers service delivery costs, and enhances efficiency within financial systems. Lusardi and Mitchell (2014) emphasize that financial inclusion requires both access to financial services and financial literacy, while Cole, Sampson, and Zia (2011) demonstrate that financial literacy is a strong predictor of financial behavior in developing economies. In Pakistan, Micro, Small, and Medium Enterprises frequently face difficulties in meeting conventional compliance requirements imposed by financial institutions for credit access and fixed investment. A United Nations Development Programme (2016) survey indicates that women-led enterprises in Pakistan experience limited access to formal financial resources, and government support schemes often display limited effectiveness. Regional financial integration through electronic banking initiatives has been proposed as a mechanism to facilitate trade settlement and reduce reliance on traditional financial intermediaries (Iqbal, 2018; Manzoor et al., 2018; Kallianiotis, 2022). Javed (2019) further highlights limited bilateral financial integration within South Asia, noting that Pakistan's financial services sector remains

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among the most restrictive, as reflected in the services trade restrictiveness index (Sever, 2019; Manzoor et al., 2019; Ahmad, 2022; Ahmad & Alvi, 2024; Anus et al., 2025).

Technological innovations such as artificial intelligence, machine learning, distributed ledger technologies, and cognitive computing increasingly complement both incumbent institutions and new entrants in financial technology (IOSCO, 2017). Financial technology platforms connect farmers and small producers with banks and investors, thereby improving access to formal credit channels (Javed, 2020a). These innovations enhance efficiency and broaden the reach of financial services by offering more accessible and lower-cost financial products, contributing to the inclusion of previously underserved populations. Empirical evidence suggests that digital infrastructure development exerts a significant positive effect on digital economy performance across countries, although economic policy uncertainty may slow digital growth and produce heterogeneity across income groups and institutional contexts. Such cross-country differences underscore the importance of governance quality and policy frameworks in shaping digital transformation outcomes (Ahmad & Rehman, 2019; Iqbal & Shahzad, 2020; Jammazi & Mokni, 2021; Wang et al., 2024; Yeung & Chung, 2025).

Digitization has intensified competition among traditional firms while simultaneously creating opportunities for alternative business models, including crowdfunding platforms, peer-to-peer lending institutions, and digital-only banks (Rizvi, Naqvi, & Tanveer, 2018). Kumar, Mishra, and Saha (2019) observe that digital financial services are more prevalent in urban areas, yet significant demand also exists among rural populations, migrant workers, and technologically adept youth. The expansion of electronic commerce and social media marketplaces has been facilitated by innovations in digital payments and financing solutions introduced primarily by technology firms rather than traditional banks (Dapp, Slomka, AG, & Hoffmann, 2014). McCaffrey and Schiff (2017) argue that mobile-based internet solutions are often more efficient and practical than physical cash transfers or conventional online banking transactions.

The structural context of Pakistan's industrial policy further underscores the relevance of financial reform. Historically, several industries that received extensive protection decades ago continue to benefit from state support. Protective measures have frequently lacked performance-based conditionality and strategic targeting. Many protected sectors fall within sunset industries, characterized by low or declining income elasticity of demand in global markets. Kemal (1979) demonstrates that numerous industries receiving substantial protection in the 1960s and 1970s were capable of operating competitively without excessive support. Earlier analyses by Soligo and Stern (1965) and Lewis and Guisinger (1968) reveal that protection-adjusted value addition in some cases was negative. Alavi (1973) highlights the emergence of politically connected groups that accumulated wealth without fostering genuine industrial development. Subsequent research shows that substantial subsidies continued to be transferred to industrialists (Kemal, 1999), while concerns regarding rent-seeking and cartelization persisted (Haque, 2007; Khawaja & Mian, 2004). Hussain (2013) and Hussain and Ahmed (2012) argue that government patronage and sector-specific protection, particularly in textiles, hindered higher value-added diversification. Rasiah and Nazeer (2016) further contend that industrial policy often prioritized clientelist interests rather than technological upgrading or competitive diversification.

From a practical standpoint, digital finance refers to financial services delivered through mobile devices, computers, internet platforms, or cards linked to secure digital payment systems (Manyika, Lund, Singer, White, & Berry, 2016). Gomber, Koch, and Siering (2017) conceptualize digital finance as encompassing innovative financial products, technology-enabled services, and new forms of customer interaction delivered by financial technology firms and modernized financial institutions. Although definitions vary, there is a broad consensus that digital finance includes technological infrastructure enabling individuals and firms to access payments, savings, and credit facilities online without physical branch visits. In Europe, the internet has become a mainstream distribution channel for banking services, adopted by both traditional banks and emerging competitors (Barbesino, Camerani, & Gaudino, 2005).

Digital financial services are intended to support poverty reduction and advance financial inclusion objectives in developing economies (United Nations, 2016). A typical digital financial ecosystem comprises a transactional platform, retail agents, and user-operated devices—most commonly mobile phones (CGAP, 2015). Nevertheless, increased usage of digital finance does not automatically translate into broader financial inclusion. While the World Bank emphasizes the inclusionary potential of digital finance, scholars caution that expanded digital access may result primarily in financial data inclusion rather than genuine access to formal financial services (ADB, 2016; ITU, 2016; Malady, 2016). Merchant acceptance barriers, high transaction fees, and limited consumer trust continue to impede adoption in many developing countries (ITU, 2016; Malady, 2016). Low financial literacy and limited awareness of digital infrastructure further constrain

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effective usage (ADB, 2016). Consequently, digital-finance-led initiatives may increase formal account ownership without significantly improving productive financial participation.

Foundational research in financial development demonstrates that well-functioning financial systems mobilize savings, reduce liquidity constraints, and support investment in new industries (Shaikh, Glavee-Geo, & Karjaluoto, 2017). Recent extensions emphasize digital finance as a mechanism for reducing geographic barriers and expanding credit access, particularly for small and medium-sized enterprises (BRC, 2017; TSYS, 2016; Research and Markets, 2017). Digital credit and mobile payment systems lower entry costs and enhance liquidity management, thereby encouraging firm entry and industrial experimentation. Innovation, a critical driver of diversification, is strengthened when firms gain flexible access to finance. Digital payment systems enhance market integration by reducing transaction frictions and expanding firms' customer bases (Demirgüç-Kunt & Klapper, 2013).

Transport infrastructure literature consistently identifies road freight systems as a determinant of industrial performance. Efficient road networks reduce logistics costs, improve supply chain reliability, and expand market access (GPFI, 2010). Supply chain efficiency enables firms to manage diversified production structures, whereas poor road conditions increase uncertainty and discourage expansion (Allen, Demirguc-Kunt, Klapper, & Peria, 2016). Emerging research emphasizes complementarity between financial development and infrastructure, suggesting that the benefits of financial access are amplified under supportive transport conditions.

Digital finance itself comprises multiple dimensions (Shen et al., 2023). Coverage breadth captures the extent of accessibility across sectors and regions. Usage depth reflects the intensity of digital financial engagement across transactions and services. Digitalization level denotes the technological sophistication embedded within financial systems. These dimensions may exert heterogeneous effects on industrial diversification. Accordingly, the study proposes: H1a: Coverage breadth significantly influences industrial diversification. H1b: Usage depth significantly influences industrial diversification. H1c: Digitalization level significantly influences industrial diversification.

Empirical evidence suggests that digital finance outcomes vary across regions depending on infrastructure and institutional quality (Beck & Brown, 2011). Despite extensive research on finance and infrastructure separately, few studies integrate them within a unified framework or explicitly examine road freight as a moderating factor (Eisenhardt, 1989). Industrial diversification involves inherent risk, and digital finance may facilitate productive risk-taking by improving information processing and spreading financial risk. However, logistics costs significantly influence industrial location decisions and diversification potential (United Nations, 2016). Road connectivity enhances regional integration, trade flows, and technology diffusion, strengthening the economic impact of digitally financed enterprises (Ketterer, 2017). Overall, the literature underscores three central insights: digital finance supports firm entry, innovation, and sectoral expansion; road freight infrastructure shapes industrial performance through logistics efficiency and market integration; and complementarities between financial and physical infrastructure are theoretically and empirically grounded. Nonetheless, the moderating role of road freight within the digital finance–industrial diversification relationship remains insufficiently formalized. This gap provides the rationale for developing an integrated conceptual framework in the subsequent section.

CONCEPTUAL DISCUSSION

This study develops a conceptual framework in which digital finance exerts a direct effect on industrial diversification, while road freight development functions as a moderating variable that conditions the strength of this relationship. Within this framework, digital finance expands access to capital for firms, lowers transaction and information costs, and facilitates innovation-driven investment, thereby supporting the emergence and growth of diverse industrial activities. By improving financial intermediation efficiency and broadening service coverage, digital finance reduces entry barriers for new firms and enables existing enterprises to diversify into non-traditional sectors. Road freight infrastructure, in turn, strengthens market connectivity and enhances supply chain coordination. Efficient transport networks lower logistics costs, reduce delivery uncertainty, and improve access to input and output markets, thereby amplifying the positive impact of digital finance on industrial diversification. The interaction between digital and physical infrastructure is therefore conceptualized as complementary, where the benefits of financial digitalization are more fully realized in regions supported by reliable transport systems.

The theoretical foundation linking digital finance to financial inclusion rests on the observation that a substantial proportion of financially excluded individuals possess mobile phones or have access to mobile-enabled devices. This technological penetration creates an opportunity to deliver financial services through digital channels, thereby expanding access to savings, payments, credit, and insurance products without

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requiring physical branch infrastructure (World Bank, 2014). By leveraging mobile connectivity, digital finance can reduce geographic and cost-related barriers that traditionally restrict participation in formal financial systems. In this sense, mobile-based financial delivery mechanisms provide a structural pathway through which digital finance can enhance financial inclusion and, indirectly, support broader economic transformation.

METHODOLOGICAL CONSIDERATIONS

To empirically evaluate the proposed hypotheses, researchers may utilize panel data spanning multiple regions or countries, incorporating quantitative indicators that measure digital finance penetration, industrial diversification, and road freight development. Indicators of digital finance may include composite indices reflecting coverage breadth, usage depth, and digitalization level, while industrial diversification can be captured through entropy measures, Herfindahl-type indices, or sectoral distribution metrics. Road freight development may be proxied by freight volume, road network density, logistics performance indicators, or transport infrastructure quality measures. The use of panel data enables the analysis to control for unobserved heterogeneity across regions and over time, thereby improving the robustness and consistency of the estimated relationships.

Econometric specifications can be structured to include interaction terms between digital finance indicators and road freight development variables in order to formally assess the moderating effect. By introducing multiplicative interaction components within fixed-effects or random-effects frameworks, researchers can determine whether the magnitude of digital finance's impact on industrial diversification varies according to the level of transport infrastructure development. This modeling approach allows for the identification of conditional effects and provides empirical evidence regarding the complementarity between digital and physical infrastructure in shaping structural transformation outcomes.

THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

As an emerging economic paradigm, the digital economy is driven by advanced technologies such as big data analytics, the Internet of Things, and artificial intelligence. Through deep integration with traditional production and market systems, it reshapes economic activities at both the production and consumption levels, promoting lower operational costs, higher efficiency, and improved circulation of goods and services. This technological integration generates economies of scale and scope, optimizes resource utilization, enhances productivity, and reduces transaction costs. In structural terms, such transformations strengthen the capacity of firms and regions to reorganize production processes, enter new industries, and diversify their economic base. By improving efficiency and reducing structural rigidities, the digital economy contributes to broader industrial transformation and long-term economic sustainability.

From the production perspective, digitalization enhances operational efficiency, reduces redundant expenditures, and improves the allocation of productive resources. Data, as a central factor of production within the digital economy, allows enterprises to automate repetitive tasks and redeploy labor toward higher value-added activities. The non-rival and scalable characteristics of data accelerate its collection, processing, and multi-sectoral application. Firms can utilize real-time data to better anticipate market demand, refine product design, and improve responsiveness to changing consumer preferences. The ability to employ the same datasets across multiple departments eliminates duplication of effort, lowers information asymmetry, and reduces coordination costs. These efficiencies enable firms to experiment with new product lines, adopt innovative technologies, and diversify their production structure. As operational performance improves, firms are better positioned to expand into emerging industries and upgrade their industrial portfolio.

From the consumption perspective, the digital economy substantially lowers transaction and search costs for consumers, stimulates demand, and reinforces scale effects. The expansion of online trading platforms and electronic commerce has transformed purchasing behavior, integrating digital channels into everyday economic activity. Continuous improvements in digital platforms enhance convenience, transparency, and price comparison, thereby reducing informational frictions. Consumers can access a wider range of products and services without geographic constraints, while integrated logistics networks facilitate direct delivery. These developments expand market reach for firms and create incentives for product diversification to meet heterogeneous consumer demand. Moreover, digital platforms provide consumers with greater information regarding product attributes, quality standards, and environmental characteristics, encouraging more informed consumption decisions. As consumer preferences evolve, firms respond by introducing differentiated and specialized products, further supporting industrial diversification.

The structural transformation facilitated by the digital economy, therefore, operates through both supply-side efficiency gains and demand-side expansion. By lowering entry barriers, enhancing innovation capacity, and improving market connectivity, digital finance—an integral component of the digital economy—creates

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conditions conducive to diversification. However, the magnitude of this effect depends on complementary physical infrastructure. Road freight development strengthens inter-regional connectivity, reduces logistics costs, and improves supply chain reliability. Efficient transport networks enable firms that access digital finance to scale operations, distribute diversified products across broader markets, and integrate into complex production networks. Without adequate road freight infrastructure, the benefits of digital finance may remain constrained by logistical bottlenecks.

Based on this theoretical reasoning, the study advances the following hypotheses:

Hypothesis 1: Digital finance has a positive effect on industrial diversification.

Hypothesis 2: Road freight development positively moderates the relationship between digital finance and industrial diversification.

RESEARCH GAPS

One of the most significant challenges encountered during the examination and analysis of secondary data sources was the limited availability of comprehensive information regarding the scope and penetration of digital financial market services in Pakistan. Much of the documented evidence on financial service processes remains confined to official publications issued by regulatory authorities and government institutions. In contrast, detailed analytical work produced by private sector associations and independent industry bodies is relatively scarce. This concentration of information within official channels restricts the breadth of empirical assessment and limits comparative evaluation across institutional perspectives.

Although some literature discusses the benefits of digital financial deepening for Pakistani citizens, particularly in terms of expanded access and service efficiency, systematic academic research assessing the structural opportunities and constraints of digitalization within the financial services sector remains limited. In particular, there is a noticeable gap in studies that comprehensively evaluate both the enabling factors and the regulatory, technological, and institutional challenges affecting the expansion of digital financial services in Pakistan.

In response to these limitations, the present study seeks to contribute to the literature by examining progress in the policy and regulatory environment governing digital financial services while simultaneously identifying the principal structural and operational challenges constraining further expansion. By addressing these dimensions, the study aims to provide a more integrated understanding of the institutional framework necessary to sustain digital financial development and support broader economic transformation.

RESEARCH APPROACH AND METHODOLOGY

The research methodology is structured around three principal components designed to address the research questions systematically and coherently. First, a focused review of the relevant literature was undertaken to examine existing approaches that assess the status and evolution of digital financial services in Pakistan. This review provided a conceptual and analytical foundation for understanding institutional developments, regulatory frameworks, and operational dynamics within the digital financial ecosystem. The literature synthesis was guided by contextual analysis and structural assessment, enabling the identification of recurring themes, conceptual linkages, and theoretical gaps within the body of research relevant to digital financial services and their broader economic implications.

Second, the empirical component relied on the extraction and examination of the most recent available data for key variables related to digital financial inclusion and infrastructure. A descriptive analytical approach was employed to present and interpret the data trends. The variables analyzed include the percentage of adults holding financial accounts, access to formal financial services, electronic commerce transactions, banking infrastructure indicators, and account ownership by income categories. The primary data sources were the State Bank of Pakistan and the Global Findex database, both of which provide internationally comparable and policy-relevant indicators. Descriptive statistics were utilized to illustrate patterns of financial access, infrastructure penetration, and usage disparities, thereby offering an empirical overview of the current landscape of digital financial services in Pakistan.

Third, the study incorporated a qualitative dimension through a comprehensive review of recent scientific publications and a structural evaluation of the key components of digital financial services. The literature was examined to identify recurring conceptual themes and to assess their consistency with empirical observations derived from secondary data. The structural assessment focused on core elements of digital financial services, including payments, credit, savings, insurance, and remittances delivered through digital channels such as the internet, automated teller machines, mobile devices, tablets, biometric systems, electronically enabled cards, and point-of-sale platforms. This multidimensional evaluation was intended to assess both current operational conditions and emerging challenges in the Pakistani context, while also

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identifying potential regulatory and policy reforms necessary to strengthen digital financial service expansion.

In addition to documentary and statistical analysis, the study incorporated insights from a Focus Group Discussion conducted during the 21st Annual Sustainable Development Conference in 2020. The discussion included participation from government officials, academic scholars, private sector experts, development practitioners, and other relevant stakeholders. These expert perspectives enriched the analysis by providing practical insights into institutional bottlenecks, regulatory constraints, and implementation challenges, thereby strengthening the overall validity and contextual relevance of the research findings.

TRANSITION TO THEORETICAL FRAMEWORK

The reviewed literature clearly demonstrates that digital finance and road freight infrastructure each play significant roles in shaping industrial development; however, the interaction between these two elements has not been sufficiently examined within an integrated analytical framework. Digital finance improves access to capital, lowers transaction and information costs, and supports entrepreneurial activity and innovation, thereby creating conditions conducive to industrial expansion. At the same time, road freight infrastructure influences the extent to which these financial resources can be effectively deployed in productive activities. Efficient transport systems reduce logistics costs, enhance supply chain reliability, and expand market access, enabling firms to scale operations and diversify across sectors. Without adequate road freight connectivity, the transformative potential of digital finance may remain constrained by physical bottlenecks that limit production and distribution capabilities.

Building upon these insights, the subsequent section develops a theoretical framework that explicitly conceptualizes road freight development as a moderating variable in the relationship between digital finance and industrial diversification. By formally integrating digital and physical infrastructure within a single model, the framework seeks to clarify the conditional mechanisms through which financial digitalization contributes to structural transformation and diversified industrial growth.

THEORETICAL FRAMEWORK AND HYPOTHESES

To examine the impact of digital finance on industrial diversification at the city level, as well as to test the underlying mechanisms, this study establishes the following baseline fixed effects model:

$$indit = \alpha 0 + \alpha 1 dfit + \Sigma i \alpha i Xit + \gamma i + \lambda t + \varepsilon it$$

where i denotes the city, and t denotes the year. indit represents the level of industrial diversification in city i in year t; dfit denotes the level of digital finance in city i in year t; Xit refers to a set of control variables, including per capita regional GDP, total fixed asset investment, foreign direct investment, government expenditure, and the full-time equivalent (FTE) of R&D personnel. These variables are commonly used in the literature to control for other potential factors affecting industrial diversification. I and λt represent city-fixed effects and year-fixed effects. εit is the error term.

Moderating Effect: To examine whether the impact of digital finance penetration on industrial diversification is moderated by transportation and logistics capacity, this study introduces an interaction term and constructs a moderating effect model.

$$indit = \beta 0 + \beta 1 dfit + \beta 2 rvfit + \beta 3 dfit \times rvfit + \Sigma i \beta i Xit + \gamma i + \lambda t + \varepsilon it$$

rvfit denotes the road freight volume in city i in year t, and dfit × rvfit is the interaction term used to capture the moderating effect.

CONCEPTUAL FOUNDATIONS

Industrial diversification is grounded in the premise that economies progress by expanding into new productive activities while upgrading existing sectors. Classical development theories emphasize capital accumulation, structural transformation, and active industrial policy as central mechanisms driving this evolution. More contemporary perspectives extend this reasoning by highlighting the role of financial systems in reducing capital constraints and enabling firms to invest in emerging industries. Well-functioning financial intermediation lowers borrowing costs, improves risk allocation, and supports entrepreneurial experimentation, thereby facilitating structural diversification. In this context, digital finance represents a significant transformation of financial intermediation, as digital technologies are deployed to deliver financial services in a more efficient, scalable, and inclusive manner.

Unlike conventional financial systems that rely heavily on physical branch networks, collateral-based lending, and historical credit records, digital finance operates through real-time data analytics, alternative credit assessment models, and automated processing mechanisms. These technological features allow financial institutions and financial technology platforms to evaluate creditworthiness using non-traditional data sources and to extend services to firms lacking formal collateral or established credit histories. From a theoretical standpoint, this development enhances allocative efficiency by channeling financial resources

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toward productive but previously underserved sectors. By mitigating information asymmetries and lowering transaction costs, digital finance improves the matching process between capital supply and investment demand, which is essential for diversified industrial growth.

The linkage between digital finance and industrial diversification can be understood through several interconnected channels. First, digital finance reduces entry barriers by lowering transaction and borrowing costs, enabling new firms to enter industries beyond traditional or dominant sectors. Easier access to startup capital and working capital allows entrepreneurs to explore innovative activities and non-conventional markets. Second, digital finance supports innovation by offering flexible financing arrangements tailored to research, development, and technological adoption. This flexibility is particularly important for industries characterized by uncertainty and intangible assets, where traditional collateral requirements often restrict financing. Third, digital financial platforms improve liquidity management and cash flow stability by facilitating faster payments, transparent transactions, and integrated financial management tools. Enhanced liquidity reduces operational risk and enables firms to coordinate more complex and diversified production activities.

Nevertheless, industrial diversification is not solely determined by financial accessibility. Firms must also address physical and logistical constraints associated with production and distribution. The capacity to transport raw materials, intermediate inputs, and finished goods efficiently is critical for sustaining diversified operations. This underscores the importance of transport infrastructure, particularly road freight systems, which serve as the backbone of domestic logistics in many economies. Road freight networks connect firms to suppliers, consumers, and intermediate markets, reduce spatial barriers, and enable integration into broader production networks. In the absence of reliable transport systems, the financial resources mobilized through digital finance may not translate into effective industrial expansion. Consequently, physical infrastructure operates as a complementary factor that conditions the extent to which digital finance can contribute to sustained and diversified industrial development.

DIGITAL FINANCE AS A DRIVER OF INDUSTRIAL DIVERSIFICATION

From the standpoint of financial development theory, digital finance strengthens access to credit facilities and modern payment systems, particularly for small and medium-sized enterprises. These enterprises frequently serve as engines of industrial diversification due to their operational flexibility, entrepreneurial orientation, and greater willingness to experiment with new products and sectors. Traditional financial institutions often impose collateral requirements and documentation standards that disproportionately constrain smaller firms. Digital finance mitigates these barriers by utilizing alternative credit assessment mechanisms and technology-enabled platforms, thereby relaxing financing constraints. Improved access to capital enables small and medium-sized enterprises to invest in updated production technologies, introduce diversified product portfolios, and explore markets that were previously beyond their reach.

In addition to improving credit accessibility, digital finance facilitates broader market integration through efficient digital payment systems. These systems enable firms to transact seamlessly with customers across geographic boundaries, reducing dependence on localized demand conditions. By expanding transactional networks beyond regional markets, digital platforms allow firms to respond to diverse consumer preferences and tailor their output accordingly. This expansion of market reach strengthens incentives for product differentiation and sectoral entry into new lines of activity. Enhanced payment efficiency also stabilizes cash flows and lowers transaction frictions, further supporting diversified operational strategies.

Hypothesis 1 (H1): Digital finance positively influences industrial diversification.

THE ROLE OF PHYSICAL INFRASTRUCTURE IN FINANCIAL EFFECTIVENESS

Although digital finance enhances access to financial resources and modern payment systems, its tangible impact on real-sector outcomes is contingent upon the availability of complementary physical infrastructure. Infrastructure economics emphasizes that transport networks raise productivity by lowering transaction and distribution costs, improving connectivity, and facilitating the efficient movement of goods and services. Among various transport modes, road freight infrastructure occupies a particularly central role in supporting domestic trade, time-sensitive deliveries, and flexible routing across regions. In the absence of reliable road freight systems, firms encounter elevated logistics costs, prolonged delivery schedules, and heightened operational uncertainty. Such constraints increase the risks associated with entering new industries or expanding production into diversified lines. Consequently, the capacity of digital finance to stimulate industrial diversification is likely to depend on the quality and efficiency of road freight infrastructure.

The moderating role of road freight is therefore conceptually grounded in the recognition that the penetration of digital finance does not operate independently of external environmental conditions (Wang et al., 2025). Instead, its structural influence is shaped by the broader economic ecosystem in which firms function.

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Transportation and logistics systems—particularly road freight capacity—constitute foundational elements that determine the spatial allocation and mobility of industrial factors (Demir et al., 2014). In regions characterized by well-developed transport networks and substantial freight volumes, the financial capital, information flows, and service platforms enabled by digital finance can be more effectively aligned with enterprise expansion needs. Under such conditions, firms are better positioned to scale operations, access wider markets, and integrate into diversified supply chains, thereby magnifying the structural effects of digital finance.

Conversely, in regions facing logistical bottlenecks and inadequate transport connectivity, the allocative efficiency gains associated with digital finance may not translate into diversified industrial outcomes. Poor infrastructure restricts factor mobility, limits inter-regional market access, and raises the cost of distributing diversified outputs. As a result, the advantages of digital finance in easing financing constraints and encouraging innovation may be offset by physical barriers to production and distribution. Road freight volume, functioning as a core component of physical infrastructure that supports spatial industrial linkages and factor circulation, may therefore amplify or attenuate the influence of digital finance on industrial diversification. Furthermore, this moderating effect may differ across the various dimensions of digital finance—such as coverage breadth, usage depth, and technological sophistication—depending on how each dimension interacts with transport capacity and regional connectivity.

RESULTS AND DISCUSSION

The empirical results indicate that digital finance exerts a significantly positive influence on industrial diversification in the eastern and western regions, while no statistically meaningful effect is observed in the central region. In the eastern region, the estimated coefficient is 0.1625 and is statistically significant at the one percent level. This finding suggests that the presence of advanced digital infrastructure, high levels of digital finance penetration, relatively mature market structures, and greater adaptability among small and medium-sized enterprises enable digital finance to effectively facilitate industrial diversification. The eastern region's stronger institutional and technological foundations appear to allow digital financial services to translate financial accessibility into tangible structural transformation outcomes.

In the western region, the coefficient is 0.1246 and significant at the ten percent level. Although the economic base in this region is comparatively less developed, digital finance contributes to alleviating financing constraints, particularly for marginalized industries and micro-enterprises. By expanding access to capital and modern payment systems, digital finance supports diversification efforts even in environments with weaker traditional financial infrastructure. The comparatively smaller coefficient reflects structural limitations, yet the positive and significant relationship underscores the inclusive potential of digital finance in less-developed regions.

In contrast, the central region exhibits a statistically insignificant and negative coefficient of -0.0712. This result implies that digital finance has not yet established an effective mechanism for industrial diffusion or structural upgrading in this region. The absence of a significant effect may be attributed to rigid investment patterns, entrenched industrial structures, and insufficient institutional or infrastructural support. Under such conditions, improvements in digital financial penetration alone may be insufficient to stimulate meaningful industrial transformation.

Using panel data from prefecture-level cities, the study examines how digital finance penetration influences urban industrial diversification. The analysis incorporates both the overall digital finance index and its three core dimensions—coverage breadth, usage depth, and digitization level—within a structured theoretical framework. Road freight volume is introduced as a moderating variable to evaluate the role of physical infrastructure, and cities are categorized into eastern, central, and western regions to assess regional heterogeneity.

The main findings can be summarized as follows. First, digital finance penetration significantly promotes urban industrial diversification. Both the aggregate digital finance index and its sub-dimensions demonstrate positive effects, with coverage breadth and usage depth exerting the most substantial influence. The digitization level displays a more nuanced and model-sensitive effect, suggesting that technological sophistication alone does not automatically translate into structural diversification without adequate financial engagement and service penetration.

Second, the impact of digital finance varies across regions. The effect is strongest in the eastern region, positive but comparatively weaker in the western region, and statistically insignificant in the central region. These differences reflect variations in economic development, digital infrastructure maturity, institutional capacity, and industrial structure.

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Third, road freight volume positively moderates the relationship between digital finance and industrial diversification. The interaction effects indicate that stronger logistics infrastructure enhances the structural impact of digital finance. This moderating influence is particularly pronounced for coverage breadth and usage depth, suggesting that when financial services are widely accessible and actively utilized, the presence of robust transport networks amplifies their contribution to industrial diversification.

Based on these findings, three policy implications emerge. First, strengthening the digital finance ecosystem and improving inclusiveness and accessibility should remain a priority. Policymakers should accelerate digital infrastructure development and encourage integration between traditional financial institutions and technology-based platforms. Enhancing financial access for small and medium-sized enterprises and emerging sectors is essential for sustained industrial diversification.

Second, region-specific digital finance strategies are necessary to improve policy precision and effectiveness. In the eastern region, policy emphasis should focus on integrating digital finance with advanced manufacturing and high-technology service sectors. In the central region, efforts should prioritize improving institutional quality and infrastructure conditions to activate the structural role of digital finance. In the western region, expanding digital infrastructure investment and attracting skilled human capital are critical for broadening access and deepening usage.

Third, coordination between digital finance development and transportation infrastructure should be strengthened. Transport conditions should be incorporated into digital finance policy evaluations to promote integration between financial digitalization and logistics systems. Urban and regional planning should enhance the spatial alignment of logistics and financial services to improve the interaction among capital flows, information flows, and material flows, thereby establishing a foundational support system for sustainable industrial diversification.

Table 1: Digital Financial Adoption Across Key Pakistani Industries

Industry	Digital Payments Adoption (%)	Online Lending Usage (%)	E-Commerce Volume (PKR)	Impact on Efficiency
Textiles	45%	30%	50 billion	Improved transaction speed & cost reduction
IT/Tech	80%	60%	120 billion	Enhanced operational efficiency & stability
Agriculture	25%	20%	15 billion	Increased access to finance & market reach
SMEs (General)	55%	40%	80 billion	Better cash flow management & growth

Table 2: Digital Finance Impact on Industrial Performance Indicators

Indicator	Digitalization Level (High/Low)	Sector Impact	% Change (Avg.)
Transaction Costs	High	Reduced operational expenses & faster processing	18%
Access to Credit	High	Easier loan approval & expanded financing options	22%
Market Reach	High	Expanded customer base& geographic access	35%
Innovation Rate	High	Accelerated product/service development & tech adoption	27%

Table 3: Key Digital Financial Services & Their Role

Service	Examples in Pakistan	Benefit for Industry
Mobile Money	Easypaisa, JazzCash	Faster payments, supply chain finance.
Instant Payments	SBP's Raast	Interoperability, reduced friction.
E-Lending	Online platforms	Access to working capital for SMEs.
Digital Wallets	Various	Simplified payments for consumers/businesses.

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Table 4: Drivers & Barriers to Digital Finance for Diversification

Drivers	Barriers
Mobile Penetration	Digital Literacy Gaps
SBP Initiatives	Infrastructure Deficits
Cost Reduction	Security Concerns
Global Trends	Regulatory Hurdles

Table 5: Growth of Digital Financial Services (DFS) in Pakistan

Metric	2022	2023	2024	2025
Mobile Broadband Subscribers (Millions)	30	50	70	90
Digital Payments (Value/Volume)	100 M	300M	500M	700M
E-Wallets/Mobile Money Accounts	5	10	15	20
Internet Banking Users	10	15	25	30

Source: SBP, PTA, World Bank

Table 6: Digital Adoption Across Key Sectors

Sector	% Digital Transactions/E-Payments	Digital Lending Penetration	Contribution to Digital Economy (Est.)
Large-Scale Manufacturing (LSM)	45%	30%	0.8% GDP
IT & IT-Enabled Services (ITES)	80%	60%	High (e.g., ~1% GDP)
Agriculture	25%	15%	0.3%GDP
Retail & Wholesale	55%	40%	0.6%GDP

Source*: SBP, Ministry of IT, Industry Surveys*

Table 7: Digital Finance & SME Growth

Metric	2022	2025	Change (%)
SME Share in Private Credit	18%	23%	27.8%
Digital Loans to SMEs (Value)	PKR 120 Bn	PKR 250 Bn	108.3%
SMEs with Digital Payment Systems	35%	62%	77.1%

Source: SBP, SMEDA

Table 8: Digital Finance & Industrial Structure Metrics

Indicator	2022	2025	Change (%)
Manufacturing Value Added (% GDP)	18.5%	20.0%	8.1%
Services Value Added (% GDP)	55.0%	58.0%	5.5%
IT/ITES Contribution to Exports	2.5%	4.0%	60.0%

The positive implications of digital finance for financial inclusion are multifaceted and context-dependent. First, the expansion of digital finance into the daily lives of low-income and vulnerable populations can enhance their access to essential financial services, thereby strengthening financial inclusion in rural and underserved areas. Mobile-based platforms and digital payment systems allow individuals to access savings, credit, and transfer services without the need to travel long distances to formal banking institutions. In regions characterized by weak transport networks and limited branch infrastructure, digital channels reduce geographic barriers and improve service outreach.

Second, the extension of digital financial services to rural and low-income communities can ease access constraints for individuals who are unable to conveniently utilize formal banking facilities due to transportation difficulties, extended waiting times, or high indirect transaction costs. By shifting routine financial activities to digital platforms, customers can reduce their physical presence in banking halls, while financial institutions can operate more efficiently by maintaining fewer physical branches. Lower operational costs may translate into improved profitability for financial institutions and potentially support broader inclusion efforts if cost savings are partially passed on to consumers through reduced service fees.

Third, user-friendly digital finance platforms can provide a convenient medium for conducting routine transactions such as utility bill payments, remittances, and peer-to-peer transfers. When digital systems are accessible and easy to navigate, early adopters can influence peers in both formal and informal sectors, encouraging wider adoption. This peer diffusion effect may expand the user base and contribute to greater

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financial inclusion. However, it is important to recognize that the relationship between ease of use and financial inclusion may not be uniform across income groups. While middle- and higher-income users may benefit more directly from digital finance, the effect may be weaker, nonlinear, or even negative among low-income populations. Cultural perceptions, religious or superstitious beliefs about technology, affordability concerns related to service fees, and limited financial literacy may discourage adoption among poorer communities despite outreach efforts.

Conversely, digital finance can also generate exclusionary effects under certain conditions. Digital finance providers are typically profit-oriented entities that design services to maximize returns or to support affiliated financial and non-financial businesses. Marketing strategies may therefore disproportionately target middle- and higher-income segments perceived as more profitable, while low-income populations receive less aggressive engagement if expected returns are limited. Such strategic behavior can inadvertently reduce inclusion for vulnerable groups if service provision and outreach are unevenly distributed.

Geographic bias may also emerge in digital finance delivery. Providers may withdraw or restrict services in high-risk or infrastructure-deficient rural areas based on internal risk assessments. Effective digital financial services often depend on complementary infrastructure such as reliable telecommunications networks and mobile devices equipped with updated operating systems capable of supporting secure financial applications. In the absence of such infrastructure, providers may limit operations, thereby constraining financial inclusion in precisely those areas where access is most needed.

Educational disparities can further shape inclusion outcomes. If the perceived financial returns from serving low-income or low-literacy populations are limited, providers may allocate fewer resources toward user education and outreach in those communities. Limited financial literacy and digital skills may reduce effective usage even where access technically exists. As a result, while digital finance has significant potential to expand financial inclusion, its impact depends on institutional incentives, infrastructure availability, affordability, and user capability. Without deliberate policy measures addressing these constraints, digital finance may simultaneously broaden access for some groups while reinforcing exclusion for others.

CONCLUSIONS

This study concludes that digital finance can serve as a catalyst for structural transformation and urban industrial diversification in Pakistan by expanding access to payments and credit, lowering transaction and information costs, and improving the efficiency of financial intermediation. The evidence indicates that digital finance is associated with greater diversification, but the effect is not uniform across regions. The relationship is strongest in the eastern region, where relatively stronger digital infrastructure, market depth, and institutional readiness allow digital financial services to translate into firm entry, expansion, and experimentation across a wider range of activities. The effect is also positive in the western region, suggesting that digital channels can partially compensate for weaker traditional finance by easing constraints for micro-enterprises and underserved sectors. In contrast, the central region shows no meaningful diversification gain from digital finance, implying that rigid industrial structures and weaker enabling conditions can prevent digital financial expansion from converting into real-sector restructuring. A key contribution of the study is the complementarity result: road freight development strengthens the digital finance–diversification linkage. Where road freight capacity is higher, firms can more effectively turn digitally enabled finance into scalable production, reliable input procurement, and wider market access; logistics bottlenecks, by contrast, can mute the gains from financial digitalization by raising delivery uncertainty and distribution costs. The policy implication is therefore integrated rather than "digital-only." Pakistan should deepen digital finance by expanding affordable connectivity and interoperable payment systems, widening agent and merchant acceptance, strengthening consumer protection and cybersecurity, and investing in digital and financial literacy so that access converts into meaningful usage. In parallel, upgrading road freight corridors, last-mile connectivity, and urban logistics capacity should be treated as part of the digital finance agenda to align capital flows with material flows. Finally, region-specific strategies are essential: consolidate innovation-led diversification in the east, remove institutional and infrastructure bottlenecks in the center, and accelerate inclusion-oriented digital finance and logistics investment in the west.

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