

The impact of digital financial infrastructure on regional economic development and SME financing

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DOI: [10.29180/978-615-6886-25-5_2](https://doi.org/10.29180/978-615-6886-25-5_2)

Abstract

Driven by globalization and the rapid expansion of the Internet, mobile payments have transformed the financial environment. Traditional economies are influenced by these shifts. In addition to boosting economic growth in a variety of countries, the establishment and expansion of digital financial infrastructure have facilitated globalization and economic relations. The growth and extension of digital financial infrastructure have substantially enhanced economic development, diversity and potential. However, it has also generated problems, particularly in less developed regions where infrastructure issues and slow growth have caused local economies to lag behind, exacerbating economic disparity among the regions. Many small and medium-sized enterprises around the world face high interest rates and financing concerns, and the uncertainty surrounding development has forced many commercial banks to tighten their lending conditions. One reason for the lack of a complete system is the flawed finance guarantee mechanism, which means big banks are reluctant to lend to small enterprises. The rise of digital financial infrastructure, particularly the acceptance of digital currencies, affects the funding of small and medium-sized enterprises. The rapid expansion of Internet banking and peer-to-peer lending platforms has allowed the financial services sector to provide a wider range of services to small and medium-sized enterprises. Big data and model testing have made peer-to-peer lending easier for these enterprises, enabling commercial banks to fund them more quickly and effectively. In light of these issues, this study will explore the impact of digital financial infrastructure on regional development, with a particular focus on the financing of small and medium-sized enterprises. It will demonstrate how the creation of digital financial infrastructure improves regional economic development, financial inclusion, transaction costs, cross-border trade, financial innovation, and the financing of small and medium-sized enterprises.

Keywords: Digital Financial Infrastructure Development, Regional Economic Development, SME Financing

JEL classification: R11

Introduction

Background Information

As a rapidly evolving technology sector, digital financial infrastructure has become a critical driver and enabler of economic growth across many regions. Digital financial infrastructure refers to the set of platforms, systems, and technologies that facilitate the digitization of financial services

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(Neves, Oliveira et al. 2023). These infrastructures encompass various regulatory frameworks, policy support, and both hardware and software facilities. The primary elements include:

- Digital payment systems, such as digital wallets, mobile payments, bank transfers, and other payment instruments, are essential components of the digital financial infrastructure. These systems support international cross-border transactions and guarantee secure and efficient money transfers.
- Platforms for the exchange and transmission of financial data and information are known as financial data exchange platforms. (Sayogo, Pardo et al. 2014) Financial organizations can exchange information and deliver more effective and convenient financial services by utilizing these platforms. For example, such platforms support fund clearing and interbank settlements.
- Identity identification systems are vital for ensuring the security of user identity in the digital financial ecosystem. Through the use of biometrics, digital certificates, and two-factor authentication, these systems safeguard financial transactions and protect consumer privacy (Vinayagam and Dilip 2024).
- Blockchain technology is gaining traction in digital finance, especially in the areas of digital currency, cross-border payments, and decentralized finance (DeFi). By using decentralized distributed ledger technology, blockchain reduces reliance on traditional financial intermediaries and enhances security and transparency. (Tripathi, Ahad et al. 2023)
- Big Data and Artificial Intelligence technologies support financial institutions in credit evaluation and decision-making by analyzing large volumes of transactional data. (Bhat, AlQahtani et al. 2023) AI also plays a critical role in automating services, managing risks, and performing credit assessments, etc.
- Cloud computing platforms offer scalable and cost-effective infrastructure for storing and processing financial data. These platforms enhance operational efficiency by providing flexible computing resources tailored to digital financial services.
- Financial regulatory technology (RegTech) helps financial regulators address emerging risks associated with digital finance. By employing AI, machine learning, and other advanced tools, RegTech enables real-time monitoring, compliance verification, and risk alerting, thereby increasing regulatory effectiveness.

In conclusion, digital financial infrastructure is an integrated system that encompasses payment, data, regulation, security, and other areas. It is multi-layered, cross-disciplinary, and holistic in nature—far more than a mere aggregation of tools and technologies. It encourages the innovation and modernization of the global financial system while supporting the digital economy.

Furthermore, there is a close relationship between digital financial infrastructure and regional economic development. In addition to being the fundamental backbone of contemporary economic activity, digital financial infrastructure plays a significant role in fostering regional economic expansion and boosting competitiveness (Zhang, Wang et al. 2024). The expansion of regional economies has increasingly demonstrated a pattern of reliance on digital financial platforms and infrastructure due to the rapid development of digital technology. This connection is noticeable in several respects. First, by improving access to financial services within an area, digital financial infrastructure directly contributes economic variety and vibrancy. In traditional economies—especially in remote or underdeveloped regions—access to financial services is often limited by geography and resource constraints. However, the spread of digital financial tools such as online financing, digital banking and mobile payments means that businesses and individuals can now more easily access the financial services they require. This has made regional economies more dynamic (Song, Li et al. 2020). Digital payment platforms, for instance, can help consumers

and small businesses overcome the limitations of the conventional banking system and facilitate transaction liquidity, boosting regional market competitiveness and corporate profitability. The second benefit of the digital financial infrastructure is that it lowers transaction costs, which is crucial for regional economic development (Yang, Lin et al. 2024). Interregional financial flows typically incur high transaction costs. This is particularly the case for cross-border business and financial transactions, where traditional payment methods and fund transfers are often complicated and expensive. However, by offering inexpensive payment and fund transfer channels, digital financial infrastructures drastically minimize these transaction costs and enable faster and less expensive money transfers within regions. This cost-efficiency enables businesses to increase the scope of their operations and the range of services they provide, which also boosts the competitiveness of the local economy.

The expansion of digital financial infrastructure has facilitated financial inclusion in regional economies. It has made it possible for more low-income individuals and micro and small businesses to engage in economic activity, especially in areas with limited access to traditional financial services (Johri, Asif et al. 2024). Financial services are now accessible to everyone through channels such as peer-to-peer lending platforms, digital money, and mobile payments, thereby promoting equitable growth and wider participation in local economies. Digital financial infrastructure can provide small and medium-sized enterprises (SMEs) with flexible access to financing, enabling them to overcome funding shortages and boost innovation and productivity. Lastly, while promoting regional economic growth, digital financial infrastructure also makes international collaboration and cross-border trade easier. As more regions undergo digital transformation, long-standing obstacles to global trade are being removed. Using digital currencies and blockchain technology makes it much easier and more transparent to send money across borders. It has also reduced the financial risks and problems associated with doing business across borders, fostering economic cooperation and interaction between regions. This is yet another reason why it is impossible to ignore the contribution that digital financial infrastructure makes to regional economic growth. In addition to providing regional economies with more effective financial services, it also lowers transaction costs, encourages financial inclusion, and makes cross-border commerce and economic cooperation easier. A robust digital financial infrastructure is essential for the sustainable growth of regional economies in the current era of economic globalization and digital transformation.

Research Content

This study will focus on the impact of developing digital financial infrastructure on regional economies, with particular emphasis on its role in the financing of SMEs. It will also explore strategies for constructing a reasonable digital financial infrastructure that supports enterprise financing and economic development.

The construction of digital financial infrastructure is a critical element in modernizing financial services and significantly affects the sound growth of the local economy. The development of a superior, more practical, and affordable payment system, data exchange platform, and information security guarantee system would benefit local businesses, improve market liquidity, and encourage the efficient use of resources (Ye, Zhou et al. 2022). The development of digital financial infrastructure in the regional economy allows information and capital to transcend geographic boundaries, facilitating regional collaboration and resource sharing. Therefore, this study also aims to analyze how the development of digital financial infrastructure shapes local economic performance.

SMEs are vital to the local economy, but because of a lack of financial sources, they frequently struggle to raise the funds they require. Digital financial infrastructure provides SMEs with additional funding options, particularly through the increased popularity of digital payment platforms, peer-to-peer (P2P) lending platforms, and digital currency financing channels (A. Basha, Elgammal et al. 2021). Therefore, analyzing the effects and function of the development of digital financial infrastructure in financing SMEs is therefore essential, as it gives SMEs more financial freedom in addition to expanding their funding options. Accordingly, the main goal of this study is to examine how the growth of digital financial infrastructure affects regional development, particularly the financing of SMEs. The study will consider how different regions have varying levels of Internet access, modern payment methods, and types of digital currency. Additionally, it will evaluate how the advancement of digital financial infrastructure contributes to and influences regional economic growth.

Literature Review

A review of the literature and research indicates that numerous scholars have examined the influence of digital financial infrastructure on economic development. However, the majority of existing studies tend to focus on how digital finance and digital currency can stimulate economic growth. There has been relatively insufficient research into how digital financial infrastructure can promote regional economic growth, particularly with regard to SME financing. This study will examine current research and successful case studies to demonstrate how digital financial infrastructure can help small and medium-sized businesses overcome the problems with the existing financial system and discover alternative funding opportunities through technological innovations such as peer-to-peer lending and big data credit assessment. More broadly, the study will look at how the growth of digital financial infrastructure affects regional economic growth, including its role in providing access to finance, reducing transaction costs, accelerating cross-border trade, fostering new financial practices, and facilitating SME loan access.

Advancement of digital financial infrastructure

The evolution of digital financial infrastructure is unfolding parallel with the ongoing information technology revolution and the spread of globalization (He, Mu et al. 2024). Rapid advancements in Internet technologies, mobile communication, cloud computing, big data, and blockchain have profoundly reshaped the traditional financial service paradigm, leading to the emergence and swift expansion of digital financial infrastructure. Digital financial infrastructure has become a crucial component of the digital economy and a significant driver of global economic modernization that enhances the accessibility and efficiency of financial services (Xia, Baghaie et al. 2024).

The concept of digital financial infrastructure can be delineated over multiple dimensions. It encompasses payment systems, financial information processing platforms, financial data interchange and storage systems, digital identity identification, and information security assurance technologies (Ratna, Saide et al. 2024). Digital financial infrastructure is merely a collection of different technologies; it represents a multi-tiered, interconnected system that transcends the limitations of the current financial system. It facilitates the flow of money and optimizes the use of resources by offering quick, inexpensive, transparent, and secure financial services. The advancement of digital payment systems is a crucial element of digital financial infrastructure. Due to the proliferation of smartphones and advancements in Internet infrastructure, mobile payments have emerged as a dominant mode of daily financial transactions in numerous countries worldwide. In China, India, and Southeast Asia, for example, the popularity of mobile platforms such as Alipay,

WeChat Pay, and Apple Pay have become extremely popular, significantly advancing the development of digital financial infrastructure. These payment methods facilitate cross-border transactions, internet commerce, financial services, and other activities, prompting a surge in financial technology (FinTech) advancements worldwide (Ayade, Ayade, 2024). Technological advancements in the financial sector have enabled the development of digital financial platforms, particularly for the exchange, storage, and processing of financial data. Big data technology enables financial institutions to collect, process, and analyse large volumes of data from consumers and marketplaces in real time, improving credit risk assessment and enabling personalized service provision (Specialist, n.d.). The integration of Artificial Intelligence (AI) and machine learning has further transformed digital financial services, enabling higher levels of automation and intelligent decision-making. It has also made it easier to customize and adapt financial products for different markets. This is a significant advancement in the evolution of digital financial infrastructure. Simultaneously, the development of digital financial infrastructure is increasingly intertwined with blockchain technology. As a decentralized distributed ledger, blockchain technology plays a transformative role in digital currencies (such as Bitcoin and Ethereum) and financial transactions (Javaid, Haleem et al. 2022). Blockchain technology makes financial transactions safer and reduces intermediary costs by making data more open and immutable. It also accelerates innovation in cross-border payments, digital asset trading, and other global financial activities. Furthermore, the use of cloud computing significantly improved the scalability and adaptability of digital financial infrastructure (Khayer, Talukder et al. 2020). Cloud platforms enable financial organizations to utilize robust computing and storage capabilities at reduced costs, facilitating the swift deployment and worldwide scaling of financial services. In developing countries, cloud computing has mitigated the deficiencies of the traditional banking infrastructure, offering enhanced and widespread access to financial services.

Progress in digital financial infrastructure has been a remarkable success around the world. It has made financial services more accessible and enabled the digital transformation of economic activity. As technology advances and the range of applications broadens, digital financial infrastructure will play an increasingly significant role in the global economy. The development of digital financial infrastructure is progressing from mature markets to emerging and developing countries, offering significant momentum for the equitable advancement of the global economy (Haoran, Wenlong et al. 2024). Understanding the evolution of digital financial infrastructure and its implementation in various regions is of both theoretical and practical importance, particularly for assessing its influence on regional economic growth, and its potential for funding SMEs.

The Role of SMEs in Regional Economic Development

SMEs are integral to regional economic development. They play a fundamental role in the economy, fostering innovation and employment while making a significant contribution to social stability, regional economic diversification, and global competitiveness. Despite regional variations in economic conditions and developmental stages, the global impact of SMEs is undeniable.

In numerous countries, particularly developing ones, SMEs have become a major source of employment and a key driver of labour market integration and unemployment reduction. According to the World Bank around 90% of firms worldwide are SMEs, which has a significant influence on the job market in various countries and regions. In Europe and the United States, SMEs account for approximately 60% of total employment; however, in certain emerging economies in Africa and Asia, this percentage may be even higher (Ongbali, Omotehinse et al. 2024). Consequently,

SMEs not only facilitate labour absorption but also contribute to sustained socio-economic growth by developing the talents and professional attributes of workers. Secondly, SMEs are essential in fostering innovation and competitiveness within regional economies. Unlike large firms, SMEs are more flexible and innovative, enabling them to react swiftly to market demand fluctuations and secure competitive advantages in certain industries or locations. SMEs in high-tech, service, and creative sectors frequently serve as catalysts for technological innovation and new product development. SMEs are central to the growth of numerous technology start-ups and digital platforms, particularly in technology hubs like Silicon Valley. Through autonomous innovation and swift market adaptation, they not only boost the regional industrial chain but also foster economic diversification and bolster the region's global competitiveness. Moreover, SMEs play a crucial role in the diversification of regional economies. In numerous developing countries and growing markets, economic progress has historically relied on a single industry, such as agriculture or resource extraction. The creation and expansion of SMEs, however, contributes to the dismantling of this uniform industrial framework. By offering a variety of goods and services, SMEs can foster synergistic growth across multiple industries and improve the overall competitiveness of regional economies. SMEs in some Southeast Asian and Latin American countries are shifting from manufacturing to services and from traditional to modern farming technologies (Abe 2009). This makes the regional economy less dependent on a single industry and more resistant to risks. As globalization intensifies, cross-border commerce and investment are increasingly emerging as significant catalysts for economic growth. Due to their adaptable operational frameworks and inventive potential, small and medium-sized enterprises can penetrate global markets sooner, thereby significantly contributing to the economic development of their regions. In growing markets like Asia, Africa, and Latin America, SMEs have consistently increased their participation in the global supply chain, contributing positively to global commerce, bolstering regional economic collaboration, and increasing foreign trade export capabilities.

In conclusion, SMEs play a variety of roles in regional economic development. As well as being significant contributors to job creation and economic growth, they also act as catalysts for globalization, industrial diversification, and regional innovation. To fulfil their potential, relevant governments and policymakers must create a favorable business environment for the expansion of SMEs by adopting appropriate policy measures, such as financial support, tax incentives, and innovation incentives. By encouraging the sustainable growth of SMEs, they can further contribute to the stability and prosperity of the regional economy and raise the region's overall competitiveness.

The role of digital finance in facilitating the financing of SMEs

Excessive interest rates and difficulty obtaining financing are two major problems for SMEs worldwide. Due to factors such as insufficient collateral and imperfect credit history, SMEs are frequently excluded from the formal financing systems or unable to obtain support from traditional financial institutions, particularly in developing countries and emerging economies (Wang 2016). Consequently, inadequate funding is one of the obstacles impeding the growth of SMEs. SMEs are vital for economic growth, innovation, and job creation. However, due to their perceived high risk and small size, traditional banks often struggle to provide them with sufficient financial support.

The history and importance of financing SMEs

The origins of SME financing can be traced back to the Industrial Revolution, when traditional banks began providing financial assistance to small businesses, thereby establishing the framework

for the current economic system (Cull, Davis et al. 2006). However, SMEs have encountered rising funding thresholds because of the transformation of the banking sector, particularly the increasingly strict rules of commercial banks regarding capital allocation and risk control. Typically, commercial banks require that businesses submit comprehensive financial accounts, asset guarantees, and other documents – a process that is both expensive and time-consuming. The primary goal of these stringent documentation requirements on the part of banks is to reduce loan default risk (Danisman and Demirel 2019). As SMEs often suffer from limited financial transparency and insufficient asset reserves, banks must undertake thorough and cautious evaluations to assess their creditworthiness and operational risk before extending loans.

However, SMEs typically do not benefit from this conventional funding strategy. High loan interest rates and collateral requirements can have a severe financial impact on businesses, especially during periods of market volatility or economic downturn. SMEs sometimes struggle to pay exorbitant finance costs, which impact their growth and operations. This underscores the pressing need for SMEs to identify more cost-effective and accessible financial resources.

The role of digital financial infrastructure in facilitating SME financing

Traditional approaches to SME financing are undergoing significant transformation due to the rise of digital financial infrastructure. This evolution includes the use of technologies such as big data analytics, digital payment systems, and peer-to-peer lending platforms. By eliminating the complicated paperwork and high interest rates associated with traditional bank loans, digital financial platforms have simplified the loan process for small businesses and provided them with more options. The emergence of digital currencies and decentralized finance (DeFi) enables SMEs to diversify their financing sources reducing their dependency on banks and intermediaries while improving financing flexibility and efficiency (Chen and Bellavitis 2020). One notable advancement is the use of P2P lending systems, which provide SMEs with more direct and accessible funding. By digitally connecting investors and borrowers directly, these platforms eliminate the need for traditional financial institutions to act as intermediaries. P2P lending platforms can typically offer lower interest rates and more flexible loan terms than traditional bank loans. In addition to bypassing the unduly strict vetting processes of traditional banks for borrowers, these platforms use big data and artificial intelligence technologies to evaluate the creditworthiness of borrowing organizations. This results in faster, more transparent, and cost-effective financing for SMEs.

The application of big data analytics and advanced credit assessment technologies has significantly enhanced the ability of digital financial platforms to evaluate the creditworthiness of SMEs. These platforms collect and analyse a large amount of unstructured data (such as transaction records, social media activity, etc.) to create credit evaluation models that are more thorough than those used for traditional bank loans, which depend on financial statements and collateral (Wang, Jiang et al. 2024). This not only reduces the risk of information asymmetry but also opens up funding options for SMEs that the conventional banking system finds challenging to serve. Furthermore, blockchain technology and digital currencies improve the ease and transparency of SME funding. Businesses can bypass the traditional banking system and obtain funding directly from investors or customers by issuing digital currencies or tokens. For example, several SMEs have been able to swiftly raise the money they require by making initial coin offerings (ICOs) or participating in tokenized asset financing. (Fisch 2019). This not only diversifies their financing options but also reduces intermediary fees and enhances the efficiency of capital allocation.

Contributions of commercial banks to the development of digital financial infrastructure

Commercial banks have also begun to adjust to new financing requirements and offer more creative financing services for SMEs as part of the broader process of developing digital financial infrastructure. They have simplified the loan application, approval, and disbursement processes by introducing digital lending solutions in collaboration with fintech firms. These banks usually use big data technology to evaluate SMEs' creditworthiness, make swift loan approval decisions, and provide flexible repayment plans throughout the loan process. This digitalised lending approach not only increases the operational effectiveness of banks, but it also enables SMEs to obtain funding more swiftly.

Enhancement of the financial guarantee system

While digital finance has expanded the financing options available to SMEs, a reliable financing guarantee system is still required to facilitate the process. By implementing guarantee arrangements, risk pooling, and policy support, the government and financial institutions can reinforce the protection of SME finance (Bai, Ba et al. 2020). For example, by creating guarantee funds and loan risk compensation procedures, the government can assist SMEs in obtaining additional financial support on digital financial platforms. Furthermore, banks and other financial organizations should conduct more research into the financing requirements of SMEs and offer tailored financial products to meet their various financing needs.

Finally, the growth of digital financial infrastructure, particularly the use of technologies such as digital currencies, big data analytics, and peer-to-peer lending platforms, is having a significant impact on how small businesses access funding. In addition to solving the problems of costly and difficult financing for SMEs, digital finance is breathing new life into the sustainable growth of the global economy by offering more flexible and affordable financing channels.

The Kenyan Case study: M-Pesa

The development of M-Pesa, a well-known and significant digital financial platform in Kenya, has not only disrupted established financial services but also offers valuable insights to other countries and regions. (Ndung'u 2018). M-Pesa is a mobile payment and financial services platform that uses mobile communication technology to provide easy-to-use financial tools to the unbanked or those excluded from traditional financial institutions. M-Pesa has transformed the way the regional economy and financial system function and addressed the issue of many individuals lacking access to financial services, particularly in developing countries. M-Pesa's accessibility and popularity are its main advantages. By collaborating with telecom companies, M-Pesa leverages Kenya's extensive mobile network, which many people rely on instead of traditional bank accounts, to enable users to easily perform basic financial transactions such as money transfers, bill payments, deposits, and withdrawals (FasterCapital., n.d. 2024). In addition to being a payment instrument, M-Pesa has evolved to offer a variety of financial services such as overseas remittances, insurance, and microfinance, all of which have significantly improved financial inclusion in Kenyan society. M-Pesa serves as a vital financial instrument for the unbanked effectively bridging the gap between traditional financial institutions and marginalized populations.

From an economic standpoint, M-Pesa has significantly influenced Kenya's growth. Firstly M-Pesa reduces transaction costs while providing SMEs with straightforward payment and settlement options. Secondly, it has promoted regional economic integration and increased the liquidity of Kenya's domestic and international trade. Furthermore, by digitizing traditional

banking services, M-Pesa has encouraged financial inclusion within the country, allowing a greater number of low-income individuals to actively participate in economic activity. The success of M-Pesa has prompted other developing countries and regions to examine the viability of digital financial services (Tay, Tai et al. 2022). M-Pesa's adaptable business strategy and technological innovation are key factors in its success. It removes the constraints of conventional banking and financial service models and establishes a new digital financial ecosystem by working with a variety of partners, including financial institutions, retailers, and telecommunications firms. By boosting market competitiveness, capital liquidity, and the local economy, this ecosystem's operation supports the long-term expansion of the regional economy.

Conclusion

This review has focused on the construction and evolution of digital financial infrastructure and its application in the financing of SMEs. It has also examined the role of digital finance in the local economy and how cutting-edge technological platforms can be used to support the financing needs of SMEs. Examining pertinent examples and literature allows us to draw the following conclusions. First, the growth of digital financial infrastructure has significantly boosted the efficiency and popularity of international financial services. Modernization of payment system, advancements in Internet technology, and the use of cutting-edge technologies such as blockchain and big data have not only increased the security and accessibility of financial services but also decreased transaction costs and boosted local economies. This shift has further promoted financial inclusion by improving the economic engagement of low-income groups and remote areas.

Second, the traditional financial system has historically presented significant barriers and expenses for SMEs, despite their status as a major force in the regional economy. SMEs now have more affordable and flexible financing options thanks to the rise in digital finance, particularly the use of P2P lending platforms and digital currencies. These innovations have improved SMEs' market accessibility and allowed them to secure capital via non-traditional channels. Big data and artificial intelligence technologies have also increased the accuracy of credit evaluation in digital finance, which has made it simpler for SMEs to obtain funding.

Lastly, the success of the digital finance platform M-Pesa illustrates how digital finance is not only a product of technological innovation, but also a powerful tool for transforming traditional financial systems. By making mobile payments and financial services widely available, M-Pesa has helped many unbanked individuals with their financial needs, fostering economic growth and financial inclusion. The successful example of M-Pesa in Kenya demonstrates the potential of digital financial infrastructure for regional economic development and serves as a key benchmark for other developing countries.

Furthermore, it is evident that the construction and development of digital financial infrastructure is crucial for improving the effectiveness of financial services and reducing transaction costs. It also increases the number of financing options available to SMEs and encourages the internationalization and diversification of local economies. As technological innovation continues to evolve, digital finance will play a significant role in driving economic growth on a global scale.

Methodology

Data Sources and Variable Descriptions

This study investigates the impact of digital financial infrastructure on regional economic development and SME financing using data from six representative countries: China, the United States, Germany, India, Saudi Arabia, and Kenya. These countries were selected based on their varying levels of economic development, maturity of digital financial infrastructure, and regional influence, thereby ensuring a comprehensive analysis of diverse economic environments.

Variables and Their Definitions

1. Digital Payment Penetration Rate (%):

- Definition: The percentage of the population that has made or received digital payments in the past year.
- Unit: Percentage (%).
- Relevance: This variable reflects the adoption and integration of digital payment systems, which are key aspects of digital financial infrastructure. It is crucial for understanding the accessibility and utilization of financial technology.

2. Internet Penetration Rate (%):

- Definition: The proportion of the population with access to the internet.
- Unit: Percentage (%).
- Relevance: Internet access is a fundamental enabler of digital financial services, facilitating the use of online payment systems, e-commerce, and other digital platforms.

3. Gross domestic product growth Rate (%):

- Definition: The annual percentage growth rate of a country's Gross Domestic Product (GDP).
- Unit: Percentage (%).
- Relevance: It serves as a primary indicator of economic performance and allows for the assessment of regional economic development influenced by digital financial advancements.

4. Employment Rate (%):

- Definition: The percentage of the working-age population (15 years and over) that is employed.
- Unit: Percentage (%).
- Relevance: It highlights the health of the labor market and its interaction with economic growth and digital financial accessibility.

5. Net National Income per Capita (USD):

- Definition: The net income per person in a country, adjusted for population size.
- Unit: US Dollars (USD).
- Relevance: It reflects the economic well-being of individuals and their ability to access and utilize digital financial services.

These five indicators were chosen to provide a comprehensive view of economic and digital financial dynamics in different regions. Together, they provide a multidimensional view of how digital financial infrastructure contributes to regional economic growth and SME financing.

Time Frame and Country Selection

The data spans six years from 2015 to 2020. These countries were selected for their unique characteristics:

- China: A global leader in digital payment adoption, as evidenced by platforms such as Alipay and WeChat Pay (World Bank, 2022).

- United States: A mature economy with robust digital infrastructure and well-established financial systems (Pew Research Center, 2021).
- Germany: A European country with high internet penetration but more conservative digital payment adoption (Eurostat, 2021).
- India: A rapidly developing country where government-led initiatives such as Digital India are promoting financial inclusion (Choppala & Meka, 2024).
- Saudi Arabia: A high-income country that is adopting digital financial systems as part of Vision 2030 (Khan & Alhadi, 2022).
- Kenya: Known for its successful mobile payment systems (e.g., M-Pesa), which are a model for financial inclusion in developing countries (Wang et al., 2018).

These countries were selected to ensure a balanced representation in terms of economic maturity, regional diversity, and levels of digital financial adoption. Their inclusion also helps to mitigate potential biases that could arise from focusing exclusively on either developed or developing economies, thereby enhancing the generalizability of the study's findings.

Analytical Methods

Data Processing

1. Data Collection:

- Data was sourced from authoritative global databases, including the World Bank, the International Telecommunication Union (ITU), and national statistics offices (World Bank, 2022).
- Missing values were addressed using linear interpolation, ensuring continuity in the time series.

Variable Standardisation:

- All indicators were normalized as required to ensure comparability across countries and years.

2. Descriptive Statistical Analysis

Descriptive statistics were employed to provide an overview of the variables, highlighting their meaning, standard deviation, and distribution characteristics. This step provides a foundational understanding of the data before deeper analysis.

Correlation Analysis

Pearson correlation coefficients were calculated to assess the linear relationships between the variables. The analysis highlights important relationships that shape how we understand the impact of digital financial infrastructure. Pearson correlation is a widely recognized statistical tool for assessing the strength and direction of linear relationships between two continuous variables (Rodgers & Nicewander, 1988). By using this method, the study identifies nuanced interdependencies between indicators such as digital payment penetration and GDP growth.

Analysis Tools

- Microsoft Excel was used for all computations, including descriptive statistics and correlation analyses. The built-in functions and data visualization tools facilitated efficient and accurate analysis.
- Key formulas include:

$$r = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^n (X_i - \bar{X})^2} \sqrt{\sum_{i=1}^n (Y_i - \bar{Y})^2}}$$

Pearson Correlation Coefficient:

Explanation of Formula Components:

- X_i and Y_i : Individual data points for the two variables being compared.
- \bar{X} and \bar{Y} Mean values of the respective variables.

Summations are used to compute the covariance and variances required for calculating r .

Pearson correlation analysis assumes linearity, absence of outliers, and interval/ratio-level data. Its applicability in this study is supported by the continuous and quantitative nature of the selected indicators (Menard, 2010).

Analytical Framework

Step 1: Descriptive Statistics

Descriptive statistics provided an initial understanding of the distribution and variability of the five key indicators across the six countries over the six-year period. The following parameters were calculated:

- Mean and standard deviation to summarize central tendency and spread.
- Minimum and maximum values to highlight data ranges.
- Distribution characteristics to detect potential outliers.

Step 2: Correlation Analysis

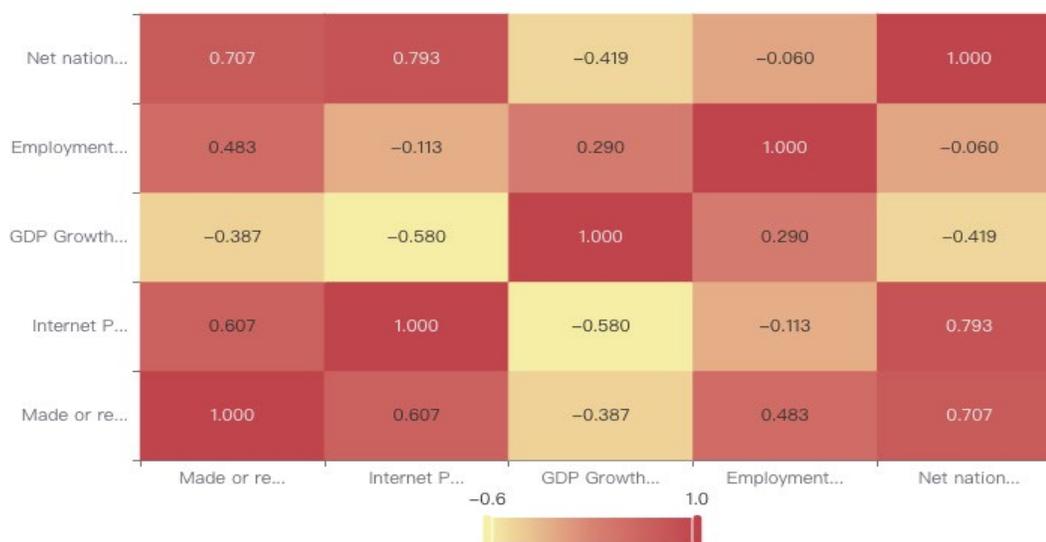


Table 1: Correlation heat map

Source: Initial data were collected by authors from the World Bank (World Bank, 2022).

The Pearson correlation coefficients were calculated for each pair of indicators. This analysis revealed key relationships, such as:

- The association between digital payment penetration and GDP growth.
- The role of internet penetration in enhancing employment rates.

Step 3: Cross-Country Comparisons

A comparative analysis was conducted to examine the heterogeneity among the six countries. Specific attention was given to:

- The relative advancement of digital financial infrastructure.
- Variations in economic development indicators.

Step 4: Interpretation of Results

Key findings were derived from statistical analyses and integrated with existing literature to provide insights into the impact of digital financial infrastructure on regional economic development and SME financing.

Results

Summary of Findings

This study explored the relationship between digital financial infrastructure and regional economic development, focusing in six countries: China, the United States, Germany, India, Saudi Arabia, and Kenya. By analysing five key indicators—digital payment penetration rate, internet penetration rate, GDP growth rate, employment rate, and net national income per capita—several significant findings emerged:

Digital Payment Penetration and Internet Penetration:

A strong positive correlation ($r = 0.607$, $p < 0.001$) was observed between digital payment penetration and internet penetration rates, emphasizing the role of internet accessibility in driving digital payment adoption. However, digital payment penetration showed a negative correlation with GDP growth rate ($r = -0.387$, $p < 0.05$), suggesting that other economic factors may moderate this relationship.

Internet Penetration and Income:

Internet penetration showed a strong positive correlation with net national income per capita ($r = 0.793$, $p < 0.001$), highlighting the significant role of technological infrastructure in improving individual economic well-being. In contrast, no statistically significant correlation was found between Internet penetration and the employment rate ($r = -0.113$, $p > 0.05$), suggesting a complex and possibly indirect influence on labor markets.

Economic Growth and Employment:

There was a weak positive correlation between the GDP growth rate and the employment rate ($r = 0.29$, $p < 0.1$), pointing to the possibility of modest job creation alongside economic expansion. However, the negative correlation between GDP growth and net national income per capita ($r = -0.419$, $p < 0.05$) highlights disparities in how economic growth translates into individual income gains.

These results reveal the multifaceted dynamics of digital financial infrastructure and its interplay with regional economic indicators. While technological advancements such as digital payments and internet access significantly impact economic outcomes, their influence varies depending on the context and stage of development.

	Made or received digital payments	Internet Penetration Rate	GDP Growth Rate	Employment Rate	Net national income per capita
Made or received digital payments	1(0.000***)	0.607(0.000***)	-0.387(0.020**)	0.483(0.003***)	0.707(0.000***)
Internet Penetration Rate	0.607(0.000***)	1(0.000***)	-0.58(0.000***)	-0.113(0.510)	0.793(0.000***)
GDP Growth Rate	-0.387(0.020**)	-0.58(0.000***)	1(0.000***)	0.29(0.086*)	-0.419(0.011**)
Employment Rate	0.483(0.003***)	-0.113(0.510)	0.29(0.086*)	1(0.000***)	-0.06(0.727)
Net national income per capita	0.707(0.000***)	0.793(0.000***)	-0.419(0.011**)	-0.06(0.727)	1(0.000***)

Note: ***, **, * represent 1%, 5% and 10% significance levels, respectively.

Table 2: *Pearson correlation analysis coefficient table*

Source: *Initial data were collected by authors from world bank (World Bank, 2022).*

Theoretical and Practical Implications

Theoretical Contributions:

This study enhances our understanding of the relationship between digital financial infrastructure and key economic outcomes by emphasizing the non-linear effects and contextual factors that influence these dynamics. It highlights the need for a multidisciplinary approach to digital financial research, integrating insights from economics, technology, and social development. The findings contribute to discussions about the role of financial inclusion in driving economic equality and sustainable development.

Practical Recommendations:

- **Policy Makers:** Governments should invest in digital infrastructure development, including providing widespread internet access and running digital literacy programs, to enhance financial inclusion and economic productivity.
- **Businesses:** Enterprises in the digital finance sector should focus on creating adaptable solutions that address regional disparities in technology adoption and economic readiness.
- **International Organizations:** Development agencies should prioritize digital finance as a tool to support the growth of SMEs and reduce regional economic disparities. Special attention should be paid to low-income and developing countries where digital financial infrastructure remains underdeveloped.

Limitations and Future Research Directions

Limitations:

- The analysis was based on data from only six countries, which limits the generalizability of the findings to different regional and economic contexts.
- The study period (2015-2020) does not capture long-term trends or the evolving role of digital financial infrastructure in the global economy.
- Correlation analysis reveals statistical relationships but does not prove causation. This restricts the possibility of drawing definitive conclusions about the mechanisms underlying observed patterns.

Future Research:

- Expanding the sample to include more countries with diverse economic and technological characteristics would provide a more comprehensive understanding of global trends.
- Extending the timeframe to include more recent developments, particularly since 2020, would provide insights into the resilience and adaptability of digital financial infrastructure in response to global challenges such as the COVID-19 pandemic.
- Incorporating variables related to government policies, such as digital payment regulations or public investment in technology, would allow us to explore the role of policy interventions in shaping digital financial ecosystems.
- Using advanced econometric methods, such as panel data analysis or structural equation modelling, could help establish causal relationships and uncover underlying mechanisms driving the observed correlations.

Addressing these limitations will enable future studies to build on this research and offer richer and more nuanced insights into the transformative potential of digital financial infrastructure.

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