Does Digital Financial Inclusion Enhance The Economic Growth in Indian States?

Ms. Priyanka Jena[1*], Dr. Sanjaya Kumar Lenka[2]

[1*]Research Scholar (Commerce) School of Economics & Commerce, Kalinga Institute of Industrial Technology (KIIT Deemed to be) University, Bhubaneswar, Odisha, India. Pin Code- 751024 mail ID: priyankajena7157@gmail.com

[2]Assistant Professor II (Economics) School of Economics & Commerce, Kalinga Institute of Industrial Technology (KIIT Deemed to be) University, Bhubaneswar, Odisha, India. Pin Code- 751024 Email ID: sanjaya.iitindore19@gmail.com ORCID ID: https://orcid.org/0000-0001-9353-6872

Abstract

Economic growth is a strength for the country with prosperity and develops the public welfare. Growth empowered with digital financial inclusion enhance the living standard of people by converting the unbanked population into digital banking activities, expand the economic activities and a crucial pathway towards achieving the sustainable development. Among the growing nations, India now taking the limelight in world-wide due to its expansion of economy with innovative strategy. This study empirically examines the effect of Digital Financial Inclusion (DFI) on the economic growth of 20 major Indian states, using panel data over the period 2014-2024. A multidimensional index of DFI is constructed based on the dimensions like financial accessibility, financial depth, digital penetration and government initiatives by using PCA (Principal Component Analysis) method. The econometric estimation procedures, such as FE (Fixed Effect), RE (Random Effect), PCSEs (Panel Corrected Standard Errors) and GMM (Generalized Method of Moment) estimates have been followed to find the result. The empirical findings of these panel regression models indicate that DFI exerts a positive and statistically significant impact on state-level GDP even after considering regional variations and possible endogeneity. Digital penetration enhances the inclusivity in access and usage to financial services through multiple channels, which brings the economic prosperity for the country. Regulatory, in turn, Capital formation, fiscal discipline and urbanization help the economic performance, whereas inflation, inadequate R&D expenditure, and low literacy levels are detrimental to growth. Overall, the results indicate that DFI is a powerful engine of economic growth in India; thus, to have a better, more inclusive, and robust economy, the policy needs to be directed towards the enhancement of digital infrastructure, better financial and digital literacy, and innovation.

Keywords: DFI Index, Digital banking, Digital Penetration, Economic Growth, Inclusive Economy
JEL Codes: G00, O1, O3, O4

1. INTRODUCTION

Digital Financial Inclusion (DFI) refers to the process of providing access to formal financial services through digital means (mobile banking, online banking, digital wallets, and Fintech-based services). It goes beyond regular financial inclusion and applies technology to make financial products cheaper, more available, and efficient, particularly to the disadvantaged groups (Jagani and Patra, 2017; Kandpal and Mehrotra, 2019).Initiated by the Pradhan Mantri Jan Dhan Yojana (PMJDY) and the JAM Trinity (Jan Dhan Aadhaar mobile) and the Unified Payments Interface (UPI), both have started DFI in India and have brought a change in financial accessibility and transparency (Jaiswal and Singh, 2023; Singh and Singh, 2024).As (Hegde and Guruprasad 2024) puts it, DFI involves availing savings, credit, insurance, and payment systems on digital platforms and will cut down on the cost of conducting transactions and will reduce the divide between financial institutions and marginalized communities. On the same note, (Sreenu 2023) refers to DFI as a transformative process that makes people and microenterprises collectively financially empowered by bringing them into the formal digital economy. According to (Abouraia and Morsey 2020), access is not the only pillar of DFI; the effective and sustainable use of financial products is as well; hence, technology is a key pillar of inclusion. DFI is important to India because it curbs the problem of structure such as remote geographical areas, innocence of physical banking operations, and excessive operation expenses in rural locations. With the help of digital technologies like mobile

money and UPI, even the low-income households can engage in the financial operations that they could not previously (Patnam and Yao, 2020; Averineni et al., 2024). The connection which exists between DFI and economic growth has been well researched both at the global and Indian levels. DFI, theoretically, increases growth by increasing resource allocation, credit expansion, savings, and access to finance by small businesses more effectively (Pradhan and Sahoo, 2021; Hossain et al., 2024). The e-tools like UPI have been proved to have a direct impact on the increase of the GDP through the efficiency and transparency of the transaction in India (Kohli et al., 2023; Dubey and Purnanandam, 2023). These linkages have empirical evidence. The recent work of (Ghosh, 2011) was one of the first to demonstrate that the state-level growth in India is greatly stimulated by financial outreach. The more recent papers like (Purushotham 2023; Gupta, 2025) theorize that the retail digital payments contribute to economic growth in the long run. In the same way, (Sreenu, 2025) show that the introduction of digital finance enhances the growth of microbusinesses, whereas (Pandey et al. 2022) emphasize that it can support sustainable development in case it is supplemented by financial literacy.

DFI also empowers household resilience and alleviation of poverty. Patnam and Yao (2020) discovered that mobile money usage increased the ability of the household to mitigate shock, whereas (Shamim et al., 2024) revealed that digital financial access benefited savings behavior of low-income households. In addition, digital microfinance has played an important role in empowering women entrepreneurs, thus ensuring inclusive growth (Banik and Shil 2023; K. and Aithal, 2024). Research points out inequalities at the state level, as states with strong growth interconnections are the high-income and urbanized ones, as opposed to the rural and less-developed ones (Jaiswal and Singh, 2023; Nandru et al., 2023). Its potential advantages are also limited due to cybersecurity threats and digital illiteracy (Kandpal and Mehrotra, 2019).

Objectives and Rationale of the Study

This research study attempts to examine the impact of Digital Financial Inclusion on the economic growth. The paper tries to assess whether DFI has a meaningful effect on economic growth within the Indian states and which dimensions coverage, utilization and digitalization have most applicable role. It then evaluates the strength of the DFI-growth relationship by means of econometric models which consider the endogeneity and unobserved heterogeneity. True to these objectives, the study hypothesis is that DFI has a statistically significant and positive impact on state-level GDP per capita, that every single sub-index of DFI has a positive impact on economic growth, and that these rates are similar in model settings. Moreover, control variables like FDI, openness to trade, and investment of science and technology are also likely to increase the positive effect of DFI on economic growth.

Secondly, the research suggests a practical and holistic method of examining the quality of economic growth in the Indian states based on a DFI index that has a set of nine characteristics. In contrast to the past where most studies focus on economic measures only, the current framework combines social, cultural, and environmental aspects to provide a better assessment of the quality of growth (Xi and Wang, 2023).

Through this research, it has also filled the gap by coming up with an index that looks at nine areas dealing with the Indian States. This provides a better, more wholesome view of the true growth of their economies not only numerically speaking, but also in terms of quality. Our results have far-reaching policy implications of encouraging long-term and well-controlled growth in digital financial inclusion, which facilitates high-quality economic growth. These findings are very evident that the more individuals possess access to digital financial instruments, it increases the entire health and quality of economic development in a steady manner. It is not merely the faster dealings it is the creation of more inclusive and powerful economies.

The following parts of the article are structured subsequently: Section 2 is dedicated to the related literature review. Section 3 provides the conceptual framework under which we make our analysis. Section 4 outlines the methodology adopted to determine the quality of economic growth, the sources of data and the econometric models. In Section 5, the author introduces the most significant findings and explores how digital financial inclusion is related to the quality of the economic growth. Section 6 provides the final thoughts, whereas Section 7 provides the general policy implications of the study.

2. LITERATURE REVIEW

Digital financial inclusion (DFI) and its interlinkage with economic growth have turned out to be a core issue in development economics, especially in the Indian context. Since digital tools are transforming the nature to the access and usage of financial services by people, the role they play in overall economic development has never been more topical. Initial research like (Ghosh 2011) has developed the fact that banking outreach and credit penetration had a positive contribution to the state-level growth, which served as a foundation to subsequent research that would concentrate on digital channels. As India was shifting to the digital era, researchers started paying greater attention to the transformational power of mobile banking, digital payment systems, and microfinance as the means of

promoting economic growth. Recent researches have continuously confirmed the optimistic role of DFI on growth indicators. As (Sreenu 2023) showed, the directly positive effect of access to digital finance is related to GDP growth in terms of lowering transaction costs and increasing financial access. Equally, (Hegde and Guruprasad 2024) developed a composite measure of digital financial inclusion of Asian nations and affirmed a robust positive relationship with GDP per capita and India topped the list as a prime example of digital-based inclusion. The authors (Pradhan and Sahoo 2021) employed panel data to demonstrate that mobile telephony and financial inclusion have a robust relationship with growth, but the scale of this association is different in each state. One of the most obvious sources of digital inclusion has been mobile banking. According to (Patnam and Yao 2020), after demonetization, mobile money adoption enhanced the economic robustness of households and sales made by firms. In (Jagani and Patra 2017) the authors investigated the use of Jan Dhan Yojana and discovered that mobile internet banking encouraged the financial inclusion but emphasized the obstacles of literacy and access. The article (Jaiswal and Singh 2023) showed that mobile apps using UPI were faster in enhancing inter-state digitalization, though the uptake was more in developed states such as Maharashtra and Karnataka than in the laggard states such as Bihar and Odisha. Surveys like (Singh and Singh 2024) also revealed that mobile banking by the urban poor helped them increase income and minimize vulnerability but the use of digital literacy and distrust still limited the use. In line with the penetration of FinTech practices such as, digital payment systems mobile banking have revolutionized the financial landscape of India and improve inclusiveness (Saini and Saha 2024). It was shown in (Kohli et al., 2023) that digital payments emerged as a source of growth following the process of demonetization and played an important role in boosting GDP by improving transparency and efficiency. (Dubey and Purnanandam 2023) took the opportunity of the use of UPI in a quasi-experimental design and discovered that cashless payments decreased the borrowing limitation and facilitated the small business. Averineni et al. (2024) have also documented the fact that UPI has enabled the growth and transparency of small and medium enterprises, with (Gupta 2025) also noting that, during COVID-19, digital payments have ensured continuity of the economy. The relevance of digital payment to the economy was further emphasized as (Purushotham 2023) indicated a long-run interconnection between the retail digital payment and the growth of the GDP. Along with these advantages, (Kandpal and Mehrotra 2019) identified issue of cyber fraud and security risks, which without addressing, may compromise inclusive benefits. Scholarly interest has also focused on digital microfinance (K. and Aithal 2024; Patel et al., 2024) have argued that digital microfinance empowers marginalized peoples by lowering the cost of conducting a transaction and enhancing the accessibility of funds in a form of a loan through mobile-based systems. The article (Dorfleitner et al., 2021) utilized survey information of microbusinesses and validated that the digital adoption of microfinance increases credit access and sustenance of business. The study by (Pandey et al., 2022) emphasized the mediating nature of financial literacy in guaranteeing the fact that digital microfinance will result in sustainable development. All these studies demonstrate that digital microfinance does not only alleviate poverty but it also enhances economic activities of women and community development. Nevertheless, (Jagani and Patra 2017) and subsequent research discovered that the non-advisory services, microinsurance, and infrastructure lapses decrease beneficiary satisfaction, specifically in less developed states. Although there are strong signs that digital financial inclusion is positive, scholars keep pointing out that the inclusion is not equal among the Indian states. According to (Abouraia and Morsey 2020), the low-income areas with lags in infrastructure and internet penetration had less adoption. It was shown that socio-economic factors, including gender, education, and income, have a substantial effect on digital adoption (Nandru et al., 2023). A study by (Shamim et al., 2024) established that the low-income households and women cannot use digital finance because of the lack of literacy. According to (Sinha 2024), COVID-19 has increased the pace of digital payments and expanded access in addition to accentuating urban-rural disparities. The importance of the policy support and infrastructure on the level of the state to shape the outcomes of adoption was highlighted by researchers such as (Sreenu and Verma 2024) and (Jaiswal and Singh 2023). The obstacles to digital financial inclusion are infrastructure disparities, digital illiteracy, cyber safety, and socio-economic disparities. Poor digital infrastructure observed in rural states led (Abouraia and Morsey 2020) and (Sindakis and Showkat 2024) to conclude that they were lagging. The (Kandpal and Mehrotra 2019) and (Alfityani et al., 2024; Adejumo and Ogburie 2025) have sounded the warning that the digital financial systems are not able to develop in a sustainable way due to the cybersecurity threat and the lack of strict regulations. Conversely, such enablers as the JAM trinity, Digital India, and UPI are government initiatives. It was demonstrated in (Dinesh and Dogga 2024) that policy innovations increase the range of digital payments, and in (Garg et al., 2024) it was also stated that joint actions of government, private companies, and non-governmental organizations are essential. (Rohith et al., 2025) considered embedded finance and stated that it

could also result in the increased accessibility of financial services, yet it should be supported with robust infrastructure and governance. The chronological progression of the literature is reflected in beginning with the traditional banking literature like (Ghosh 2011), moving to the exploration of digital banking early on in the mid-2010s, and then finally to large-scale empirical investigation of UPI, mobile banking and microfinance since 2016. Most recent studies include 2022-2025 and use more precise methods of quantifying impacts, in terms of advanced econometric models, structural equation modelling, and composite indices (Hegde and Kavyashree 2024; Dinesh and Dogga 2024; Barik and Lenka 2022). Such methodological improvements develop the knowledge but also indicate the gap of region-specific and longitudinal studies that can reflect the fluctuations of the state-level.

To conclude, current studies put forward a strong argument that digital financial inclusion is one of the major components to economic growth in India. It is increasing possibility for enabling more people to be involved in the economy, whether through mobile banking, digital payments, or microfinance platforms, and which is driving more inclusive and sustainable development. These mechanisms are beneficial in the growth of GDP, promoting small business, strengthening households, and empowerment of marginalized communities. Nevertheless, the adoption is not equal among states, and the availability of infrastructure, the lack of digital literacy, and socio-economic disparities are limiting it. There is consensus among scholars that recommends region-based policies, enhanced digital education, cybersecurity measures, and system of governance to make digital finance a driver of equitable and sustainable growth in all the states of India.

3. DATA & METHODOLOGY

This paper uses panel data of 20 states in India from the years 2014 to 2024 in order to examine a how Digital Financial Inclusion (DFI) can be instrumental in the increase of economic growth among the states of India. The states were considered based on the consistent availability of data related to key variables across the study period. To ensure authenticity, data were sourced from a wide range of reputable government data sources, which includes National Institute for Transforming India (NITI) Aayog Reports and Reserve Bank of India (RBI) database. Along with the dependent variable as well as independent variable, various control variables have also briefly explained in this section, to analyze the combined effect of multiple factors including digital financial inclusion on economic growth in Indian states. Subsequently, this section will discuss about the conceptual framework along with theoretical background, on which this study is aligning and lastly the econometric tools, which have been adopted to understand the linkage between digital financial inclusion and economic growth in Indian States. The details of all the variables have been briefly assembled in the next table 1, with their measurement units and the exact data sources.

Table 1: Variables' Descriptions

Variables	Abbreviation	Description	Measurement Units	Data Sources
Economic Growth (Dependent variable)	GSDP	Total money value of produced goods and services by states.	in Lakh	Ministry of statistics & Programme Implementation
Digital Financial Inclusion Index (Main Independent Variable)	DFI	Index developed by using basic financial inclusion variables and digital aspects.	Index value	Ministry of Electronics & Information Technology, Ministry of Finance, Reserve Bank of India, Department of Financial Services
Capital Formation	CF	Process of a state's increase in economic stocks	in Lakh	Ministry of statistics and Programme Implementation
Inflation	INF	State-wise value of increment in Consumer price index	in Percentage	Ministry of Statistics and Programme Implementation
Fiscal Deficit	FD	Difference between a state's total expenditure and total revenue	in Crore	RBI

Expenditure on R & D	R&D	State-wise spendings on research and development	in Crore	Ministry of Science and Technology
Urban Population	UP	State-wise percentage of population living in urban areas	in Numbers	RBI
Literacy Rate	LR	State-wise education literacy rate of age 7 years and more.	in Percent	Ministry of Statistics and Programme Implementation
Unemployment	UM	Percentage of unemployed people of total working population	in Percentage	RBI

Source: Authors' Preparation

The table demonstrates the detailed explanation of all the data, which have been used in this study, including their descriptions, measurement units and data sources. It is showing a clear picture that, the data are authentic and extracted from multiple reports published by Indian ministries and RBI. The detailed explanation of all the variables has also given in next.

Economic Growth (Dependent variable)

To assess how Digital Financial Inclusion (DFI) influences economic growth, this study has used Gross State Domestic Product (GSDP) at constant price with the base year 2011, as the proxy to measure economic growth across the Indian states as the key outcome variable. This data collected on 20 Indian states, spanning the years 2014 to 2024. This GSDP data has been sourced from Ministry of statistics & Programme Implementation, ensuring consistency and credibility across the sample.

Digital Financial Inclusion (Main Independent Variable)

To measure the depth of Digital Financial Inclusion (DFI), this study tried to build a composite index using Principal Component Analysis (PCA), which was introduced and developed by Pearson in 1901 and Hotelling in 1993 respectively (Lenka and Sharma 2020; Croutzet and Dabbous 2021; Udeagha and Ngepah 2023). The quantitative data associated to digital financial inclusion, have been extracted from multiple Indian state-wise database, such as, RBI, Ministry of Electronics & Information Technology, Ministry of Finance, Department of Financial Services etc. The graphical representation of Digital financial inclusion has been depicted through the next picture.

This composite indicator brings together several key indicators: Distribution of offices of Scheduled commercial banks (SCBs), Automated Tellor Machines (ATMs) Per sq. km, Number of Deposits account in SCBs per 1000 population, Amount of deposits in SCBs per 1000 population, Amount of Credits in SCBs per 1000 population. These indicators are measuring the financial inclusion accessibility and depth among the individuals of states. E-transactions per 1000 population taken as a proxy for digital penetration as a contributor to the traditional financial inclusion. Lastly, Pradhan Mantri Jan Dhan Yojana (PMJDY) accounts per 1000 population & PMJDY Deposits per 1000 population data have taken to represent government initiatives to enhance the inclusivity of individuals with financial activities through digitalization. The selected variables containing different measurement units. To normalize the data, the following z-score standardization procedure has been followed before the development of Index (Ali and Faraj 2014; Barik and Lenka 2022; Song et al., 2025).

$$\textbf{\textit{Standardization}}=\frac{X-Mean}{SD} \quad Eq\ (1)$$

Where, mean value of each data series has been subtracted from each element and the overall value is divided by the standard deviation of that particular series. The benefit of this process makes the data unit free and provide the appropriate result. To verify the sample adequacy and appropriateness of the dataset for Principal Component Analysis (PCA), it has been conducted the Kaiser-Meyer-Olkin (KMO) test to assess sampling adequacy, which has been demonstrated through the next table.

Table 2: KMO and Bartlett's Test Result

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.620
Bartlett's Test of Sphericity	Approx. Chi-Square	1499.792

	df	28
	Sig.	0.000

Source: Authors' Calculation

This table resulted a KMO value of 0.62, which is a strong indication that the variables were well-suited for constructing the index. Also, the Bartlett's test of sphericity suggests an existence of strong correlation among the variables with chi-square value of 1499.79. The overall KMO and Bartlett's Test reveals that, the samples are adequate for the construction of DFI index. The scree plot (Figure 2) of the eigen values incorporated in appendix section. The functional form of Digital Financial Inclusion index using PCA method has been demonstrated below.

$$\boldsymbol{DFI = \sum Wi * Ci} \qquad Eq\ (2)$$

In Eq 2 (Sarma 2008, 2015; Song et al., 2025), the DFI denoted as Digital Financial Inclusion, which has been calculated by the overall summation of multiplying the weights assigned for each variable (Wi) based on the eigen values with the original value of the variables (Ci).

Other Control variables

For control variables, to measure the impact of DFI on economic growth, other variables have considered such as; Capital Formation, Fiscal Deficit, Inflation, Expenditure on R&D, Urban Population, Literacy Rate & Unemployment. The data have been collected from various reliable sources including the annual reports provided by Ministry of Statistics & Programme Implementation, RBI, Ministry of Finance, Department of Financial Services & Ministry of Science & Technology and so on. The next segment talks about the theoretical background, on which the current study is aligning, followed by the econometric models' specifications, which were used to identify the relationship between DFI and economic growth.

The extracted variables have been normalized by using

Theoretical Background and Model Specification

This research explores how Digital Financial Inclusion (DFI) shapes economic growth across Indian states 20 Indian states over the period 2014 to 2024, employing a panel data approach. This study aligns with the theoretical background Schumpeter Theory, which demonstrates how economic development takes place through the innovation (Bittencourt 2012; Schumpeter 2021). This theory explains the significant role of technological innovation improve the economic development status of the country. The theoretical equation has been shown below.

$$Y_t = \beta_0 + \beta_1 DFII_t + X_t^* + \mu_t \qquad (Eq\ 3)$$

In the above equation, Y is the Gross State domestic product, has been used as a proxy to show the economic growth, as a dependent variable in this study. X^* denotes as the combination of all the control variables used in this study, which have been extracted based on the previously conducted studies. Lastly, μ_t denoted as the error term with the time period t. The full version of the equation has been expanded below.

$$GSDP_{it} = \beta_0 + \beta_1 DFII_{it} + \beta_2 CF_{it} + \beta_3 FD_{it} + \beta_4 INF_{it} + \beta_5 R\&D_{it} + \beta_6 UP_{it} + \beta_7 LR_{it} + \beta_8 UM_{it} + \mu_{it} \qquad (Eq\ 4)$$

In the proposed equation, GSDP represents the state-level GDP of the selected Indian states and serves as the dependent variable, while DFII denotes the Digital Financial Inclusion Index, The primary independent variable in this analysis. To ensure robust analysis, the model also incorporates several control variables, including Capital Formation, Fiscal Deficit, Inflation, Expenditure on R&D, Urban Population, Literacy Rate & Unemployment. The stochastic disturbance is denoted by μ, and the subscript (it) reflects the panel data structure, where i corresponds to the 20 Indian states and t refers to the time period from 2014 to 2024.

Conceptual Framework of Digital Financial Inclusion and Economic Growth

Digital Financial Inclusion (DFI) means the greater availability of financial services with the help of the implementation of digital technologies as online mobile banking, wallets, ATM, and credit cards. This is simply because DFI seeks to access individuals who have no include and marginalized by the formal banking system to access convenient and affordable methods of managing money, saving, borrowing, and making payments, particularly, those who live in underserved or remote regions. They are financial services tailored to the specific needs of underserved communities, and the price is affordable both to the service providers and the users (Rahman et al., 2024). Digital financial inclusion is very broad in terms of services provided, including mobile payments and loans, insurance, and online fund transfers, and it has made daily financial transactions more accessible and affordable. Internet has facilitated more access to financial services and enhanced financial system, especially in poor locations with few resources (Hasan et al., 2022; Xi and Wang, 2023). Figure 1 illustrates the hypothetical connections among financial inclusion in digital format and economic development. The framework starts off with enabling the DFI by using the variables like, Distribution of Offices of SCBs (no), ATM (per sq

km), Number of Deposits Account in SCBs per 1000 Population, Amount of Deposits in SCBs per 1000 Population), Amount of Credits in SCBs per 1000 Population), e-transactions per 1000 population, PMJDY accounts per 1000 population and PMJDY deposits per 1000 population The availability of more will foster usage and the quality services will bring reliability and credibility.

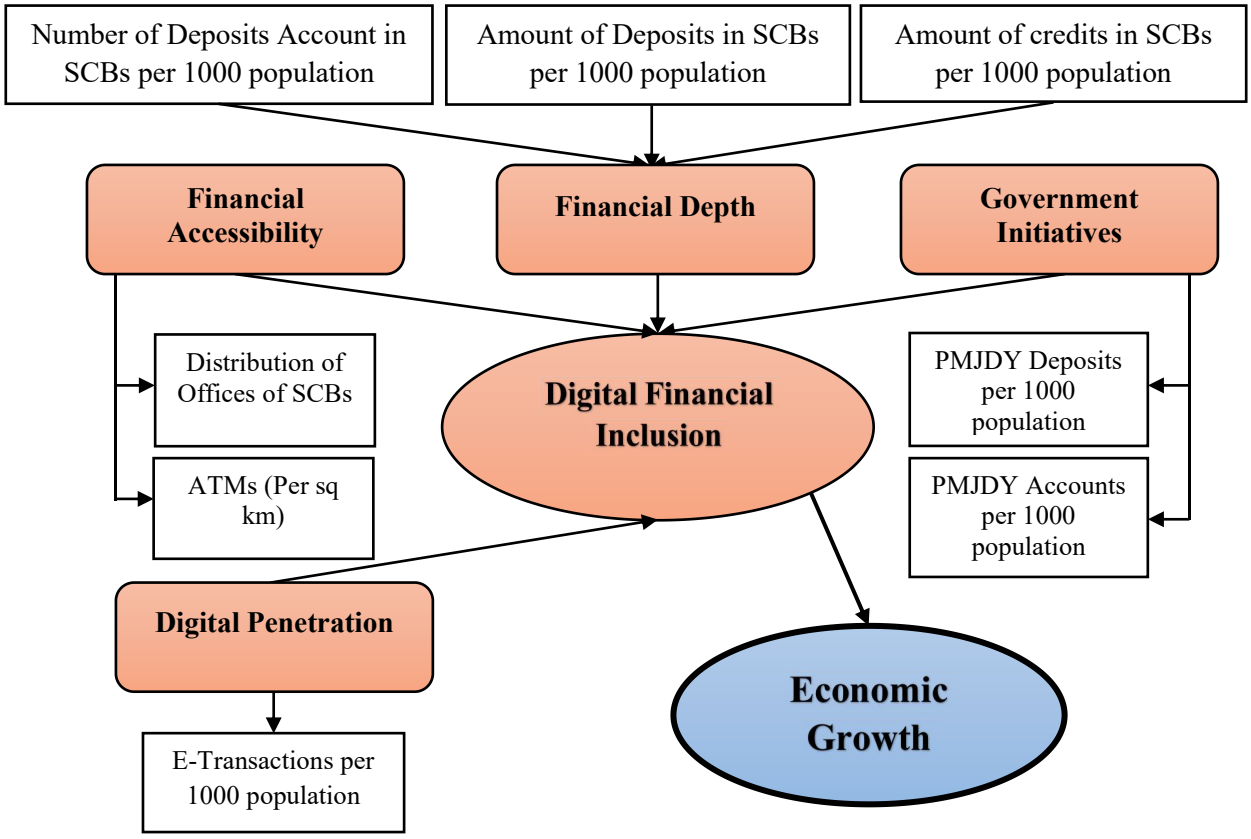


Figure 1: Conceptual Framework of DFI and Economic Growth

Source: Authors' Preparation

All these aspects work together towards a higher degree of digital financial inclusion that facilitates the growth of economies through better financial participation, efficiency, and productivity of transactions. It is argued that the digital financial inclusion enhances entrepreneurial activity and diversifies the market demand, which translates into the emergence of new businesses (Liu et al., 2021). Digital financial inclusion enables depositors to easily move to a different bank, which compels financial institutions to offer quality services or lose customers to their competitors (Ozili, 2018). Digital Financial Inclusion enhances accessibility and usage, and quality of financial services through digital platforms thereby enhancing economic growth through financial participation, efficiency, and competition. It gives power to underserved groups, promotes entrepreneurship, and compels institutions to deliver improved services, which make it a highly needed tool of inclusive development.

Econometric Models

To attain the aim of this research paper, different econometric models have been embraced to attain the strong outcome. To start with, a table of descriptive statistics has been prepared in order to get an overview of the fundamental statistical properties of all the data that was employed in the

analysis. In the second step, the performance of the correlation between the variables has also been computed to establish the presence of a linear relationship between the variables. Thirdly, prior to the analysis of final regression models, to check the stationarity of the dataset, two types of unit root tests such as, Levin-Lin-Chu and Fisher type tests have conducted (Maddala & Wu 1999; Choi 2001; Chaitip et al., 2008). Lastly, in the final panel regression models, Fixed Effect (FE), Random Effect (RE) models (Barik and Lenka 2022) have used to satisfy the objective of the study. Again, for the better result, Panel Corrected Standard Errors (PCSEs) model has been adopted (Mwambuli 2019; Barik & Lenka, 2022), which provide a robust result by removing autocorrelation and heteroscedasticity

among the dataset. The analysis has been concluded by conducting Generalized Method of Moments (GMM) model (Anderson & Hsino 1981; Blundell et al., 2004), which solves the issue on presence of endogeneity within the model. Each Models' results have been depicted in the next section.

4. EMPIRICAL RESULT ANALYSIS

To validate the model and better understand the underlying data, the current section of the study accommodates descriptive statistics to summarize the key characteristics of the variables and correlation analysis to examine the degree of association among them prior to estimate the regression models. These preliminary analyses provide insights into data patterns, potential multicollinearity issues, and the overall suitability of the dataset for econometric modeling. The descriptive statistics table has been depicted below.

Table 3: Descriptive Statistics

Variables	Observations	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
GSDP	220	7.845921	0.40251	6.470315	8.647639	-0.9071	4.2565
DFI	220	31.1434	12.23885	6.319114	69.63309	0.8190	3.3798
CF	220	2758214	3208313	4400.833	2.48e+07	2.9607	15.7289
FD	220	30582.95	23015.64	-20627	96020	0.8255	3.2758
INF	220	5.115333	1.591181	1.1	13	0.6184	5.1437
R&D	220	454.7413	23.47917	263.6	543.49	-5.4850	48.3741
UP	220	20683.16	15213.22	1113	61334	0.9654	3.1815
LR	220	79.60768	7.47944	57.1	95.6	-0.0094	2.9258
UM	220	5.178977	2.430633	1.083333	12.93333	0.5266	2.8302

Source – Authors' Calculation

The above table explicates the basic statistical information regarding the extracted variables to conduct this study, which showing the interlinkage between Digital financial inclusion and economic growth. The panel dataset comprises 220 observations, covering 20 Indian states over a period of 10 years (2014–2024). Along with that, the average mean, standard deviation, followed by the minimum and maximum values, skewness and kurtosis values also incorporated through this table. The next table depicts the strength and direction of the associated variables used for the study.

Table 4: Correlation Analysis

	GSDP	DFI	CF	FD	INF	R&D	UP	LR	UM
GSDP	1.0000								
DFI	0.0032	1.0000							
CF	0.6291	-0.0720	1.0000						
FD	0.7623	0.0297	0.5194	1.0000					
INF	0.0007	0.0065	0.0359	0.1711	1.0000				
R&D	0.1546	-0.0407	0.0762	0.1562	0.0396	1.0000			
UP	0.7810	-0.2339	0.5563	0.6402	0.0009	0.0919	1.0000		
LR	-0.1580	-0.1186	0.1053	-0.0141	0.0976	-0.2218	-0.0327	1.0000	
UM	-0.3016	-0.5724	-0.3615	-0.3150	-0.1174	-0.1232	-0.2241	0.1190	1.0000

Source: Authors' Calculation

The above table suggests a positive association between digital financial inclusion and economic growth. Simultaneously, Capital formation, fiscal deficit, inflation, expenditure on research and development and urban population are going forward with the same direction towards economic growth. Only two variables such as; literacy rate and unemployment have a negative association with the economic growth. After calculating the correlation among the variables, the next step has been demonstrated through the unit-root tests, which talks about the stationarity and suitability of the dataset for further panel regression models.

Table 5: Unit Root Tests

Variables	Levin-Lin-Chu		Fisher-type	
	At Level	At 1st difference	At Level	At 1st difference
GSDP	6.4051*** (0.000)	6.9470*** (0.000)	1.1061 (0.8657)	4.4813*** (0.0000)
DFI	3.1551*** (0.0008)	2.9105*** (0.0018)	0.5935 (0.7236)	8.6953*** (0.0000)
CF	4.4870***	10.8790*** (0.0000)	0.9511	18.3747*** (0.0000)

	(0.0000)		(0.1708)	
FD	7.4845*** (0.0000)	10.9605*** (0.0000)	5.9913*** (0.0000)	19.0671*** (0.0000)
INF	7.9630*** (0.0000)	6.2934*** (0.0000)	7.3593*** (0.0000)	20.9496*** (0.0000)
R&D	11.5177*** (0.000)	6.8707*** (0.0000)	3.5732*** (0.0002)	3.7041 (0.9999)
UP	2.7963*** (0.0026)	9.1604*** (0.0000)	11.8775*** (0.0000)	1.2943 (0.9022)
LR	2.8177*** (0.0024)	7.5732*** (0.0000)	5.5261*** (0.0000)	24.3760*** (0.0000)
UM	3.7839*** (0.0001)	6.7444*** (0.0000)	6.5326*** (0.0000)	32.8126*** (0.0000)

Source: Authors' Estimation

[Notes: (1) *, **, *** indicates the significance level at 10%, 5% and 1% critical level. (2) Stationarity at Level (Lag 0) and at 1st difference (Lag 1) shown for both LLC and Fisher types test]

Before using advanced econometric methods to get strong and trustworthy results, it's important to find out the process of integration of the variables that are being studied. Evaluating stationarity mitigates the issue of false regression, which may occur when non-stationary time series are incorporated into regression models. This study employed the Levin–Lin–Chu (LLC) test and the Fisher-type unit root test on each variable at both the level form and the first-difference level. These tests provided strong statistical results regarding the stationarity properties of the data which ensured that the variables were duly taken care of before proceeding with other econometric estimates. The analysis has been further done by running the four advanced panel regression models after carrying out the unit root tests.

Table 6: Impact of DFI on Economic Growth from 2014 to 2024

Variables	**Model 1 (FE)**	**Model 2 (RE)**	**Model 3 (PCSEs)**	**Model 4 (GMM)**
DFI	0.0098*** (0.0007)	0.0088*** (0.0008)	0.0058*** (0.0013)	0.0044*** (0.0015)
CF	0.0072*** (0.0217)	0.0095*** (0.0259)	0.0031*** (0.0532)	0.0034*** (0.0074)
FD	0.0444 (0.0286)	0.0086** (0.0342)	0.0644*** (0.0811)	0.0744*** (0.0102)
INF	-0.0064*** (0.0021)	-0.0069*** (0.0025)	-0.0113 (0.0106)	-0.0143 (0.0134)
R&D	-0.0001 (0.0002)	-0.0005 (0.0002)	0.0004* (0.0002)	0.0003 (0.0002)
UP	0.0701 (0.0898)	0.0035*** (0.0101)	0.0001*** (0.0145)	0.0938*** (0.0181)
LR	0.0114*** (0.0013)	0.0096*** (0.0015)	-0.0079*** (0.0014)	-0.0084*** (0.0023)
UM	-0.0172*** (0.0027)	-0.0173*** (0.0032)	0.0209* (0.0113)	0.0170* (0.0094)
Constant	6.7775*** (0.1377)	6.8288*** (0.1685)	7.5025*** (0.1870)	7.6834*** (0.2769)
Observation	220	220	220	220
No. of Years	11	11	11	11
R-square	0.0314	0.2088	0.7939	0.7884
F-statistics	221.48			
Prob. (F-statistics)	0.0000			
Wald $\chi 2$		1201.26	1157.74	937.28
Prob > $\chi 2$		0.0000	0.0000	0.0000
Hausman test	72.59 (0.0000)			
Breusch- Pagan Test	11.00 (0.0009)			
White's Test	119.04 (0.0000)			

No. of States	20	20	20	20

Source: Authors' Calculation

[Notes: (1) Standard errors are incorporated in parentheses. (2) ($*_p$<0.10, $**_p$<0.05, $***_p$<0.01), *, **, *** imply for 10%, 5% and 1% significance level respectively]

Empirical findings indicate that Digital Financial Inclusion (DFI) positively influence economic growth in sampled states in India and the effect is statistically significant as indicated in Table 6. This result suggests that the higher the site of digital financial inclusion, the higher the economic performance, which means that the increase the access to digital financial services has a significant role to play in the overall growth of Indian states. They are supported by evidence presented by (Thaddeus et al., 2020) in 2011-2014 in sub-Saharan Africa that showed a continuum of findings of a positive correlation between digital financial inclusion and economic growth, which further supports the research findings. The sub-indexes empirical validation, namely the financial accessibility and financial depth and the digital penetration and government initiatives prove that Digital Financial Inclusion (DFI) plays a substantial role in increasing the economic growth in the province, as shown by (Ahmad et al., 2021).This fact highlights why the current study needs to come up with a multidimensional DFI Index, which will aim at capturing its wider economic connotations in different country settings. The regression analysis reveals that Digital Financial Inclusion (DFI) has a positive and statistically significant effect on the state-level GDP in most of the models and notable in the PCSEs and GMM estimates that are used to deal with panel-specific errors and endogeneity, respectively. The general models tend to support the fact that DFI is a catalyst of economic growth. Other variables such as capital creation, fiscal deficit and urban population have a strong positive impact which implies their contribution in increasing the contribution of DFI to economic activity. On the other hand, there is a negative relation between inflation, research and development expenditure, and literacy rate, and this indicates potential structural inefficiencies or economic constraints. Our findings are consistent with those of the researches that found statistically significant negative relationship between inflation and economic growth in OECD and APEC countries between 1961 and 1997. In their analysis, it is possible to suggest that the negative impact of inflation on economic growth is greatest at lower levels of inflation (below 10) and decreases with higher levels of inflation, but on average it is negative. They employ the use of instrumental variables in order to show that, these findings are insensitive to any endogeneity issues. The lasting positive effect of the investments in science and technology underlines the importance of innovation in creating the regional development. Among the models, GMM offers the best causal explanation, which confirms the claim stating that digital financial infrastructure is not only associated with, but also promotes, economic development among the Indian states.

Altogether, Digital financial inclusion has become one of the key drivers of development in Indian states. State economies usually experience a faster growth even after other regional inequalities are considered provided that more people are able to access and actively use digital financial services. Despite the negative effects of growth caused by inflation and high government spending, trade and foreign investment liberalization, and technological advancement appears to complement these advantages. The results have shown that there is a need to focus a policy on a strong emphasis on the development of digital banking to create a more resilient and equitable economy.

5. CONCLUSION AND POLICY IMPLICATIONS

Conclusion

In order to achieve the goal of this research, a panel data has been selected based on the chosen states in India covering the time interval of 2014-2024. The empirical results of the analysis demonstrate the Digital financial inclusion to be a significant and positive economic growth contributor in the Indian states. Strong estimates prove that when financial services are made more widespread, have greater use, and are digitalized, state economic growth is always boosted through the government support. These findings are consistent with evidence at the international level since they indicate that digital financial inclusion contributes to long-term development. Though capital formation and urbanization boost growth, inflation, low R&D investment and low literacy reduce the performance of the economy. All these findings point to a conclusion that DFI is not only related to, but also promotes economic development. The policy focus on building and expanding digital financial infrastructure and inclusive digital services should, therefore, be at the center of the concerns related to more resilient and equitable economy.

Policy Implications

The results put into focus the need to be sound and take certain policy decisions to harness the growth-enhancing potential of digital financial inclusion in Indian states. Digital financial infrastructure strengthening, particularly in rural and underserved regions, should be the focus of the provision of fair access to digital banking and payment services. To promote the active utilization of digital financial devices, policymakers should invest in the area of financial literacy and digital skill-development as

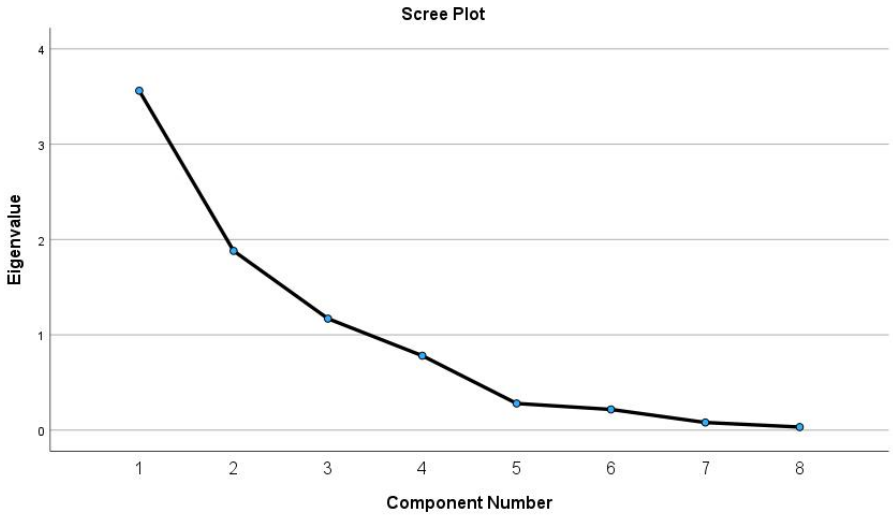
low literacy rates limit the effective use of digital services. The macroeconomic stability should also be maintained as high-inflation undermines the performance of the economy and destroys the faith in the financial system. Additional funding of the basic research, development and technological innovation will continue to contribute to the growth of advanced digital finance solutions. The state-specific strategies are supposed to be created to consider the varied levels of digital preparedness to reduce the gap in the regions. The government, financial institutions, and fintech companies should be encouraged to cooperate, which would accelerate the process of innovation in providing more inclusive and low-cost digital financial products. The decision to invest in the workforce has always led to the appearance of more job opportunities and greater economic success (Ahmad et al., 2021). Finally, policies that foster capital formation, savings, and entrepreneurship will complement the positive impact of digital financial inclusion in helping to build a more resilient, inclusive, and sustainable economic environment across Indian states. Sustained innovation in digital finance not only broadens access, but also propels economic and social progress (Xi and wang, 2023).

Limitations and Future scopes

The empirical evidence of this study reveals a strong and positive impact of digital financial inclusion with economic growth of Indian states. Though the study provides a significant contribution to the previously conducted research and also can play a significant role for future researchers, but some limitations are associated with it. Firstly, this study has been carried forward by considering only twenty selected states of India due to unavailability of data. Future researches can be conducted by taking all the states and union territories of India, if the data will available. Secondly, the digital financial inclusion index has been developed by considering the factors associated with the important dimensions such as, financial access, financial depth, digital penetration and government initiatives. The index can be expanded through the future researches by adopting multiple dynamic dimensions.

6. Appendix

Figure 2: Scree Plot for DFI Index



Source: Authors' Estimation

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Authors' Contribution

PJ prepared the manuscript and analyzed the data. SKL, carried out design of the research and supervise the study.

Data Availability Statement

Data will be available as per the reasonable request.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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