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Constructing a Composite Index: Assessing Digital Financial Inclusion in India

***Sharma Ajay Dinesh**
*Corresponding Author
Research scholar
Department of Economics
Central University of Rajasthan

Dr. Satyanarayanamurthy Dogga
Assistant professor
Department of Economics
Central University of Rajasthan
.

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***** Corresponding author

Abstract: *Financial inclusion has been an essential area of focus of the modern-day government. Financial inclusion means providing financial services to each section of society that demands it at an affordable cost. Nowadays, along with the efforts made by traditional financial institutions, the amalgamation of digital technology with finance, called* digital finance, *has significantly improved the base and coverage of financial inclusion. In India, the coverage of financial services has expanded after the introduction of the JAM (Jan Dhan-Aadhar- Mobile) trinity and the Unified Payment Interface (UPI). The increased internet penetration in the country has also expanded the scope of digital financial services. During demonetisation and the Covid-19 pandemic, digital financial services became a saviour for people and got a boost in its growth in India. The focus of this paper is to measure the level of digital financial inclusion in India. We have constructed a Digital Financial Inclusion Index for India using Principal Component Analysis (PCA). We have included the 'Access' (covers the supply side) and 'Usage' (covers the demand side) dimensions for this. The data from RBI and the National Payments Corporation of India (NPCI) has been used for the study. The study stresses the increasing role of digital finance in financial inclusion in India. This will guide the policy formulators to take key steps to improve the financial inclusion levels to achieve the goal of sustainable economic growth.*

Keywords: Financial inclusion, Digital financial inclusion, Measuring digital financial inclusion, DFI Index.

Introduction

A well-functioning financial system is essential for a nation's socioeconomic development, as it plays a key role in mobilizing savings and channelling them into productive resources. The creation of an inclusive financial system has become a significant policy priority because access to finance has long been recognized as a critical indicator of economic advancement. The World Bank defines financial inclusion as ensuring that individuals and businesses can access financial products and services—such as payments, savings, credit and insurance—that are both useful and affordable, delivered in a sustainable and responsible manner. In a diverse country like India, financial inclusion is a vital aspect of the development process. Since gaining independence, successive governments along with businesses and civil society, have worked together to expand financial inclusion across the nation.

Since independence of India, institutions like the Reserve Bank of India (RBI) and National Bank for Agriculture and Rural Development (NABARD) have worked in the path of promoting financial inclusion in the country by providing remote areas with the services of bank branches, implementing schemes like Kisan Credit Cards (KCC), increasing credit facilities and insurance cover for marginalized sections of the societies.

Despite notable progress in advancing inclusive finance, millions of individuals in both developed and developing countries remain underserved by financial services, even at the level of basic personal accounts (Hasan et al., 2020). The most effective tool for addressing this gap has been digital finance. In recent years, alongside traditional financial service providers like banks, cooperative societies, and post offices, digital technology has emerged as a key player in delivering these services. Digital Financial Services (DFS), driven by technological innovations, have become a crucial element in promoting financial inclusion in emerging economies (Sahay et al., 2021).

Earlier, a number of studies have been carried out to measure the reach of the traditional methods of financial inclusion, but with the introduction of Fintech, the scope of financial inclusion has completely changed and thus a comprehensive measure of digital financial inclusion is required in light of the concerted efforts which are being made to advance financial inclusion in order to efficiently track the development of the legislative measures launched to do so. Therefore, it is important to create a Digital Financial Inclusion Index

(DFI-Index) that measures the level of digital financial inclusion and takes into account factors such as availability, ease of access, usage, inequality and a lack of services, level of financial literacy, consumer protection and the growth of the banking, investments, insurance, postal, and pension sectors.

Mainly, due to the unavailability of data, past researchers have not focused on this 'digital' aspect of financial inclusion. Therefore, we intend to construct an index for the measurement of Digital Financial inclusion in India. We have constructed this index taking into consideration two dimensions out of three, as suggested by Sarma (2012). The goal of the study is to create the Digital Financial Inclusion (DFI) index for India. To construct this DFI index, the Principal Component Analysis (PCA) has been used.

Digital Financial Inclusion in India

India has witnessed impressive economic growth in recent years, surpassing many other developing nations. However, a significant portion of the population remains outside the formal banking system. A World Bank report from 2017 revealed that over half of India's population still lacks access to financial services. Addressing this issue, the current Indian government has made it a priority to include the marginalized segments of society in the financial system. To achieve this, the government aims to leverage digital technology to promote both economic and social progress. The launch of the Pradhan Mantri Jan Dhan Yojana (PMJDY) in 2014 marked a key milestone in this effort. The scheme was designed to ensure every Indian has access to a bank account, along with essential financial services like remittances, insurance, and pensions.

The government has integrated this initiative with Aadhar cards and mobile phones, creating the JAM (Jan Dhan-Aadhar-Mobile) trinity, which aims to boost financial literacy among the general population. In July 2015, the Government of India launched the 'Digital India' initiative to promote the use of digital technologies among the masses. During this time, internet accessibility in the country also grew significantly, rising from just 19% to 47%. This increased internet access has expanded the potential for digital finance.

Unified Payment Interface (UPI) was launched in 2016. Since then, it has become easier to perform digital transactions. This service lets the user make payments directly from their

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bank accounts. This service provides a cheaper payment facility by using a Virtual Payment Address (VPA) which is also connected to the bank account and cell phone number of the recipient.

The government has also given apt chances for the fintech companies to grow in India. Companies like Paytm, PhonePe, Mobikwik and BharatPe have led the expansion of digital payments in India. These companies handle Peer to Peer and retail payments using mobile wallets or UPI, as well as technology firms like Pine Labs and Mswipe that offer hardware and POS devices for digital payments.

The demonetisation announced on November 8, 2016, has also pushed the common masses to use digital finance. Several of these payment fintech companies' pre-paid wallets were among the biggest winners from demonetisation. Since there was often not enough cash to go around, even modest financial transactions had to be done digitally. This was a big push element to get users of a digital service who had access to it but hadn't used it before.

The COVID-19 pandemic also high lightened the social disparities. The part of the population that was underbanked was the one who got most adversely affected by the pandemic. The pandemic also resulted in the greater acceptance of digital methods of transactions by people as people were forced to conduct contactless transactions.

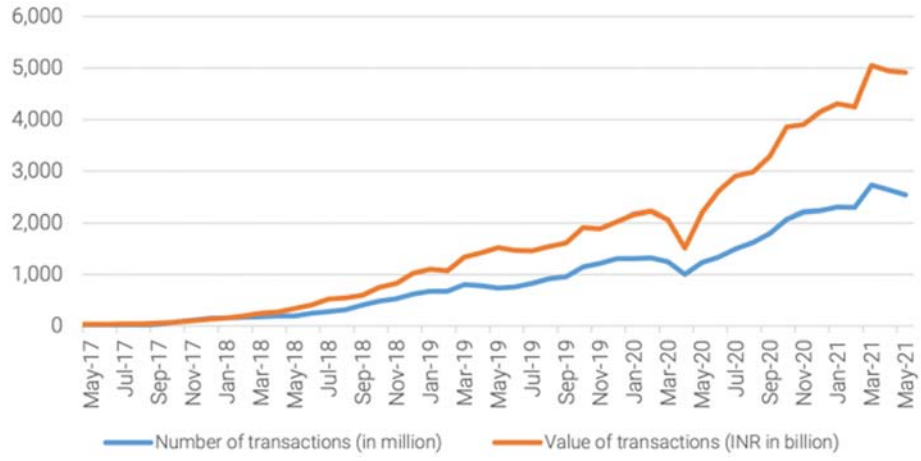

Figure 1: (UPI- Trend in number and value of transactions. Source: NPCL)

It is clearly evident from figure 1, that the value and volume of UPI transactions had increased drastically from March 2020, the month when a strict lockdown was imposed in India.

The government had already implemented the Direct Benefit Transfer (DBT) system for citizens prior to the COVID-19 pandemic, but the crisis spurred the widespread adoption of digital platforms like UPI. This shift not only met the immediate need for contactless transactions but also established lasting habits among individuals, leading to continuous growth in usage. Given India's large population, the demand for financial services is steadily increasing. While some private entities offer digital financial services, the broader concept of achieving financial inclusion through digitalization is still in its early stages. However, there is significant potential for future growth, both in India and globally.

Review of Literature

Financial inclusion refers to a broad range of financial services and products that are available to low-income, unbanked individuals who are primarily located in rural areas (Hasan et al., 2020). The original goal of financial inclusion is to draw attention to the ongoing development of the financial system and the accessibility of financial services in order to offer more affordable and convenient financial services to people from all walks of life, particularly those who live in underdeveloped or economically disadvantaged areas (Guo et al., 2019). Financial Inclusion is widely seen as a crucial factor in determining a nation's economic development. As a result, it is now the focus of economic policymaking on a global scale (Agur et al., 2020; Nguyen, 2021; Sahay et al., 2021).

Financial services offered through mobile devices, personal computers, the internet, mobile wallets, e-wallets, and credit and debit cards are all considered part of digital financial inclusion (Manyika et al., 2016). All items that enable people and businesses to access payments, savings, and credit facilities online without having to physically visit bank branches or interact with financial service providers are considered to be part of the field of "digital financial inclusion" (Ozili, 2020).

The majority of previous studies focus on traditional financial inclusion, which is made possible by financial institutions like banks (Sahay et al., 2021). These studies have not

included the component of digital finance in their analysis due to certain reasons like unavailability of data. Since now we have entered into the age of digitalisation, and digital financial technologies are now proving their worth in this area, it is now difficult and unfair to exclude them from the analysis. In today's time, digital finance can be said as the 'grease to the wheels' of economic activities as it makes using banking services affordable (Radcliffe & Voorhies, 2012) and thus, it is the need of the hour to focus on it.

There isn't yet a standardised technique to quantify or assess an economy's financial inclusion level (Nguyen, 2021), and the same is true for digital financial inclusion. The existing literature has consistently neglected the role of digital technologies in expanding the base of financial inclusion. The earlier studies have tried to capture the traditional channels of financial inclusion. Demirguc-Kunt and Klapper (2012); have offered a group of metrics to gauge the amount of adult global savings, borrowing, payments, and insurances. It is a collection of individual indicators that were created using data from interviews of around 150,000 randomly chosen national representatives in 148 economies who were at least 15 years old.

Although FI is a multifaceted concept, specific measures like bank account ratios and the number of automated teller machines (ATMs) cannot fully represent it (Cáamara & Tuesta, 2014). Since the use of technology is on the rise and the fintech industry is also continuously experiencing growth in India, this study will focus only on the digital aspect of financial inclusion and is an effort to assess the growth of digital financial inclusion in India.

To measure the growth of the inclusiveness of digital finance, a digital financial inclusion index (DFI- Index) has been constructed using the Principal Component Analysis (PCA) method. The existing studies on the construction of an index of financial inclusion emphasises only the traditional components of financial inclusion, and also they have arbitrarily considered the weights for the indicators, and no specific methodology for determining the weights has been used in the construction of the index. Gupte et al. (2012) and Sarma (2012) have also developed an index of financial inclusion for India, and in doing so, they have considered four dimensions- outreach, usage, ease of transactions and cost of transactions. However, they have assigned weights to all variables and dimensions based on

the authors' experience, which implies that all factors have the same effect on FI (Nguyen, 2021).

Amidzic et al. (2017) created a FI index using a composite of characteristics from the outreach, usage, and quality aspects. Every measure is first normalised, then statistically confirmed for each dimension, and finally aggregated using mathematical weights. Also, Cáamara and Tuesta (2014) have constructed a financial inclusion index with three dimensions, namely usage, access and barriers and have used a two-stage PCA for the same. In these studies, the weights have been determined from the available data and are not dependent on the researcher's discretion.

From the above-discussed literature review, it is quite evident that some efforts were made to develop a composite Financial Inclusion index. However, most of them have focused only on the traditional channels of financial inclusion and have neglected the digital channels. Also, the determination of weights has not been through a defined method but merely depends on the researcher's discretion.

Sources of data

This study constructs the Digital Financial Inclusion Index (DFII) using secondary data obtained from the National Payments Corporation of India (NPCI) and the Reserve Bank of India (RBI) covering the period from April 2016 to May 2022. This period is particularly significant as it aligns with the introduction of the Unified Payments Interface (UPI) in April 2016, signifying the onset of a substantial transition towards digital payment systems in India.

The NPCI, as the central authority for digital payment infrastructure, supplies essential data regarding the volume and value of UPI transactions and the quantity of UPI-enabled banks. Simultaneously, the RBI provides extensive data essential for index creation, encompassing the volume of credit and debit card issuances and the accessibility of Point of Sale (POS) machines, which indicate the financial system's potential to facilitate digital inclusion.

Utilizing these authoritative sources guarantees that the index is constructed on dependable, policy-aligned data, providing a comprehensive assessment of digital financial inclusion that

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precisely reflects both the adoption and infrastructural support essential for inclusive growth in India.

Methodology

Previous studies have used two methods, namely- *parametric* and *non-parametric methods,* to construct the financial inclusion index. Non-parametric approaches use exogenous weights that are selected based only on the researchers' choices to determine the value of indicators. There is proof that these indices are susceptible to subjective weighting, and even a slight change in the weights can have a big impact on the results, therefore it will be inappropriate to use the non-parametric approach. On the other hand, in order to determine the right weights through parametric method, we create a DFI index using the PCA method.

We have developed a multidimensional DFI index based on Sarma (2015, 2016) by combining the *supply* and *demand* dimensions.

1. **The Supply**

   A sound financial system must be used by as many people as possible, which requires that it be widely available to the people for use. To measure this dimension, we have used the data for *number of banks that are live on UPI per 1crore population*, which shows the availability of UPI services supported by various banks. Also, we have included the data of the *number of POS machines per 1 crore population, number of ATMs per 1 crore population* and *number of credit cards per 1 crore population* in a given time period.

2. **The Demand**

   To measure this dimension, we have used the variables which show the extent of use of the supply of digital financial services provided to the people by the financial institutions. We have used the *volume of transactions through UPI per 1 crore population* and the *value of transactions through UPI per 1 crore population.* Credit cards are also used on POS machines. Therefore data related to it also included the data for the demand for POS machines per 1 crore population. Therefore, the other

two variables are the *volume of transactions through credit cards per 1 crore population and* the *value of transactions through credit cards per 1 crore population.*

Standardisation of Data

Prior to utilizing Principal Component Analysis (PCA) for the construction of the DFII, it is essential to standardize the data for each variable to a uniform scale. The standardization method entails converting the raw values of the chosen indicators into a consistent range of 0 to 1 by min-max normalization. This stage aims to rectify the significant discrepancies in measurement units and magnitudes among the variables in the index.

The min-max normalization formula used in this study is as follows:

$$S_{ij} = \frac{V_{ij} - Min(V_{ij})}{Min(V_{ij}) + Max(V_{ij})}$$

Here S_{ij} is j[th] standardised variable for i[th] year.

V_{ij} is the value of j[th] variable for i[th] year.

This transformation normalizes each indication to a range of 0 to 1, maintaining the relative location of data points and removing distortions from unit discrepancies. The standardized values enable an impartial comparison among indicators, guaranteeing that each variable contributes equitably to the analysis.

Construction of Index

Using the Principal Component Analysis (PCA), we have constructed a DFII. The linear relation between the DFII and the variables is determined as follows

$$DFII_i = \frac{w_1 UPI_i + w_2 POS_i + w_3 ATM_i + w_4 CC_i + w_5 UPIval_i + w_6 UPIvol_i + w_7 CCval_i + w_8 CCvol_i}{\sum_{z=1}^{z=8} w_z}$$

Where $DFII_i$ is composite Digital Financial Inclusion Index of the country i[th] year;

W_z, where z = 1,2…,8 is the relative weights of each dimension,

UPI_i is number of banks live on UPI in ith year

POS_i is number of POS machines in ith year

ATM_i is number of ATM installed in ith year

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CC_i is number credit cards in ith year

$UPIval_i$ is value of transactions through UPI in ith year

$UPIvol_i$ is volume of transactions through UPI in ith year

$CCval_i$ is value of transactions through credit card in ith year

$CCval_i$ is volume of transactions through credit card in ith year

Before using PCA, variables of each domain are standardised to have values ranging from zero and one, where 0 signifies financial exclusion and 1 denotes financial inclusion, to assure that the scales in which they are assessed is irrelevant.

The data for the study has been collected from the National Payments Corporation of India (NPCI) and the Reserve Bank of India (RBI).

Results and discussions

The correlation matrix given below in table 1 shows that the variables have a high correlation and are suitable for the construction of the index. Kaiser- Meyer-Olkin (KMO) test, used to investigate if the factors are suitable for the construction of the index also suggested the same. From table 2, it is also evident that this is significant since the KMO= 0.784 value is greater than 0.5.

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Table 1: Correlation Matrix

Variables	No. of Banks live on UPI	Vol. of UPI	Value of UPI	POS	Credit Cards	ATM	Vol. of Cred. Cards	Value of Cred. Cards
No. of Banks live on UPI	1.000	.995	.995	.803	.811	.181	.475	-.080
Vol. of UPI	.995	1.000	.999	.808	.807	.182	.494	-.068
Value of UPI	.995	.999	1.000	.810	.806	.183	.496	-.072
POS	.803	.808	.810	1.000	.645	.082	.495	-.096
Credit Cards	.811	.807	.806	.645	1.000	.668	.451	-.132
ATM	.181	.182	.183	.082	.668	1.000	.166	-.185
Vol. of Cred. Cards	.475	.494	.496	.495	.451	.166	1.000	.128
Value of Cred. Cards	-.080	-.068	-.072	-.096	-.132	-.185	.128	1.000

Source: Author's own calculation using SPSS

Table 2: KMO and Bartlett's test

Test	Values
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.784**
Bartlett's Test of Sphericity	0.000**

** *significant at 5% level of significance*

Source: Author's own calculation using SPSS

We derive the rotated component matrix, as shown in table 4. The rotated component matrix gives us the weights of the particular variable. For each variable, we will choose that value of the rotated component matrix as weight (shown as W_z in the equation) whichever is higher among the two components.

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Table 3: Rotated Component Matrix

Variable	Component 1	Component 2
No. of Banks Live on UPI	.965	.121
Volume of UPI transactions	.971	.111
Value of UPI transactions	.971	.113
POS machines	.873	.017
Credit Cards	.783	.552
ATM	.141	.861
Vol. of Credit Cards	.635	-.073
Value of Credit Cards	.049	-.630

Source: Author's own calculation using SPSS

The weights derived from the rotated component matrix are then assigned to the earlier-mentioned equation to calculate DFII.

The derived results of the Digital Financial Inclusion Index can be seen in the figure 3. It is evident from the graph that the scope of digital financial inclusion is increasing continuously. UPI was launched in April 2016 in India and since then the digital financial services have seen a revolution in the country, and it is still growing at a rapid pace.

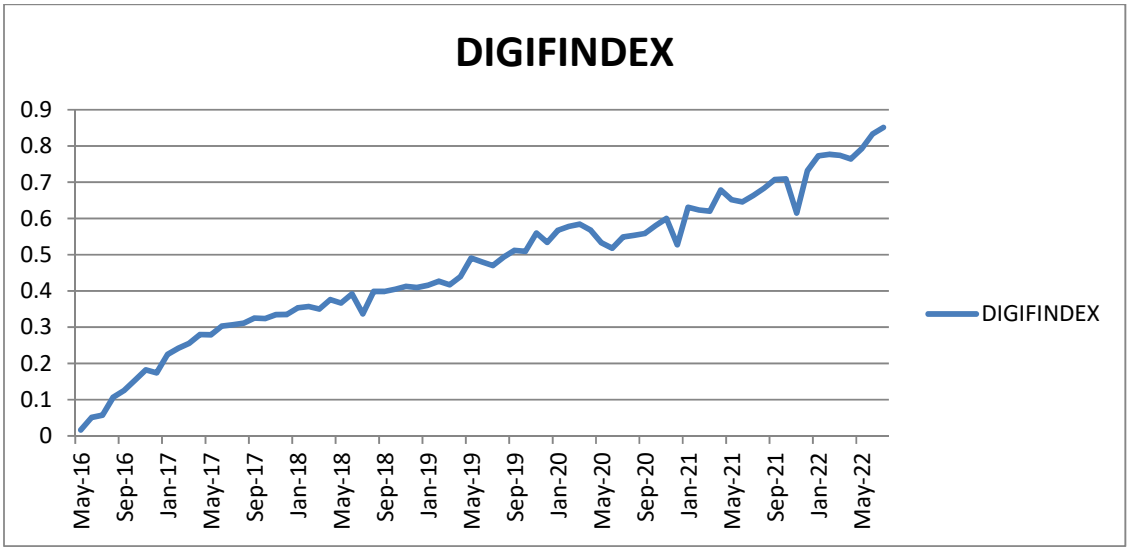

Figure 3: Digital Financial Inclusion Index

Source: Author's own

Digital financial inclusion in India has been blooming at a never-before-seen rate. Technological innovations are playing an increasingly important role in shaping the country's growth towards a more financially inclusive society. Increased use of smartphones and the internet have mostly contributed to this change to digitalisation and are essential in closing the wealth gap, especially in rural and semi-urban areas. When the demonetisation was announced by the union government on November 8, 2016, and the economy was left with only a very small amount of cash for transactions, at that time digital transactions came as a saviour, and it was during that time when the digital financial services experienced the first boom in the country. Also, during the COVID pandemic, digital financial services helped the cause of common people by catering for their demand for day-to-day transactions.

Beyond only providing access to financial services, the idea of digital financial inclusion also takes into account the use of digital tools to improve the cost-effectiveness, efficiency, and security of financial transactions. Initiatives from the Indian government, such as the Jan Dhan-Aadhaar-Mobile (JAM) trinity, have been essential in this respect. Through streamlining subsidies, lowering leakage, and facilitating direct benefit transfers, the JAM framework has increased efficiency and transparency.

In India, digital financial services are growing at a rapid pace and are experiencing exponential growth, but still, a large chunk of the Indian population is not using these services. Lack of financial literacy, low rate of internet penetration and fear of online fraud are some of the main reasons for this. The government's role in simplifying this transition becomes more and more important as the scope of digital financial inclusion expands in India. All sections of Indian society can gain equally from digital financial inclusion if the government prioritizes infrastructure, education, regulatory frameworks, innovation, and inclusive policies.

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