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A Study On Multidimensional Financial Inclusion Index (FII) And Its Policy Implications

Jai Prakash Pandey[1] Dr. Mahesh Kumar Sarva [2] Dr. Nitin Gupta [3]

[1] Research scholar from the reputed Lovely Professional University with publications in Walnut and IGI Global. getjpg@gmail.com
[2] Renowned Professor at Lovely Professional University, Punjab. mahesh.18850@lpu.co.in
[3] Renowned Professor at Lovely Professional University, Punjab. nitin.20368@lpu.co.in

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Abstract

The purpose of the study is to explore the level of financial inclusion in eastern Uttar Pradesh using two stage principal component approach (2S-PCA). PCA addresses issues of over fitting and under fitting observed in earlier studies. To fulfill the study primary data has been collected from the 15 districts of eastern Uttar Pradesh. For this purpose structured questionnaire has been framed. The study identified principal factors for banking penetration and estimated financial inclusion index (FII) based on respective weights of these factors obtained by second stage PCA. The results concluded that financial inclusion index of Varanasi is highest among these districts which is 64.72, followed by Gorakhpur (63.54), whereas the Jaunpur (42.86) and Faizabad (42.28) districts attained lowest values. The study established that districts with higher relative urban population performed better in FII ranking against districts having higher rural population. The financial inclusion improved in these districts, but digital literacy and espousal remains a challenge. The study suggested that use of secure information technology and digital platform can efficiently connect and include remote population into main frame. The study also suggests policy measures to promote financial inclusion. This research mainly contributes to existing literature by suggesting the policymakers in formulating suitable policies and directions to promote Financial Inclusion. It will augment the financial institutions and economy for better performance. It will empower traders, merchants and investors to take investment decisions due to smooth financial transaction system backed by multiple delivery channels.

Key Words: Financial Inclusion Index (FII), Multidimensional, Principal Component Analysis (PCA), two stage PCA (2S-PCA).

GEL Classifications: G18, G21, O53

Introduction

Financial Inclusion is equal opportunity to avail banking products and services in accessible, affordable and usable manner to all the willing people at all places. It can be schematically presented according to figure- 1. Banks are entrusted with promoting financial inclusion. Since banks are commercial organization, so their presence have been mostly concentrated around urban areas. The policy makers of India are aware of these issues and challenges. The government realized the importance of financial inclusion way back in 1950s and took several initiatives to increase level of financial inclusions (RBI, 2021). The government launched Pradhan Mantri Jan Dhan Yojana (PMJDY) on 28th August, 2014 for providing banking facilities. Another scheme for providing easy access to credit Pradhan Mantri MUDRA Yojana (PMMY) scheme was launched 8th April, 2015 to promote micro finance

and self-employment. In-order to provide social security for all, the government also announced Atal Pension Yojana (APY), Pradhan Mantri Suraksha Bima Yojana (PMSBY) and Pradhan Mantri Jivan Jyoti Bima Yojana (PMJJBY) schemes on 09th May, 2015. Aadhaar Enabled Payment system (AEPS) based transactions was introduced for the convenient transactions of small denominations. It has capacity to facilitate both intra and interbank transactions. RuPay card network was established for providing cost effective and conduit environment for digital transactions through debit and credit cards. These initiatives brought the rural and deprived people irrespective of gender, cast and creed on formal banking platform. Recent developments incudes formation of Financial Inclusion Advisory Committee (FIAC) and National Strategy for Financial Inclusion (NSFI), in 2017.

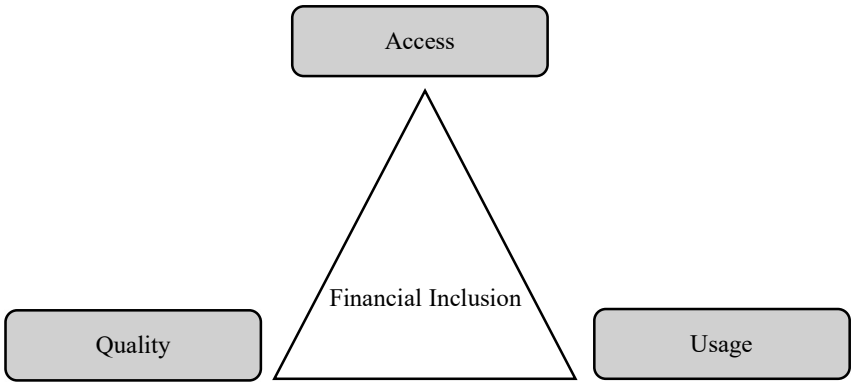


Figure-1: Financial Inclusion triangle:
Source: Author representation

Micro, Small & Medium Enterprises (MSME) plays very important role in the economic development. Several initiatives were taken to boost financing to MSME sector. Micro Units Development & Refinance Agency Ltd. (MUDRA) was proposed and launched in 2015 for refinancing to the financing institutions as a credit guarantor. MUDRA scheme, Standup India, Nari shakti (Women Empowerment), Ayushman Bharat schemes are to name a few. MUDRA scheme has specific advantage to help out the beneficiaries without mortgage of collateral properties. These schemes encouraged Micro, Small & Medium Enterprises (MSME) to produce multidimensional economic growth. Moreover, Immediate Payment Service (IMPS), Unified Payments Interface (UPI), Quick Response (QR) code based digital payment solutions were implemented to facilitate convenient and cost effective transactions. The stage wise merger of large public sector banks further empowered them to take large exposures in infrastructural and industrial financing (Rehman & Dhiman, 2022). Banks plays very important role in socio- economic developments. After realization of importance of banks in social progress, role of banks widened to make its presence and contributions significant in urban as well as remote locations. India is a developing nation, and deepening banking penetration have been a trust area of government and central agencies of India. India is spread across wide geography with 28 states. Uttar Pradesh is one of the state having 75 districts.Uttar Pradesh is the most populous state and second largest state in area in the country. Uttar Pradesh is recognized as a major milk-producing state in India. Uttar Pradesh has famous tourist destination like Taj Mahal, listed as one of the Seven Wonders of the World, located in Agra (Akula et al., 2024). Uttar Pradesh has mixed economy. According to census 2011 total population of Uttar Pradesh province was 19.98 Crores which is expected to cross 24.10 Crores by 2021. Eastern Uttar Pradesh possess significant rural population of about 1.32 Crores. The Lucknow is capital of Uttar Pradesh. Total number of districts in the Eastern Uttar Pradesh is 15. Uttar Pradesh at a glance is presented in table 1.

Table 1: Uttar Pradesh at a Glance	
Area	2,40,928 sq km
Rural Area	2,33,366 sq km
Urban Area	7,562 sq km
Population*	19.98 Crore.

Projected Population (2021)#	24.10 Crore.
Rural Population	15.53 Crore (77.73 %)
Density	829 per sq km
Capital	Lucknow
Literacy Rate	65.46%
Districts	75
Tehsils	350

Sources:* up.gov.in census 2011; # census2011.co.in

Uttar Pradesh economy continue to remain a symbol of economic prosperity and a role model of economic development for the Indian states since the ushering in of the green revolution. The gloomy performance of Uttar Pradesh economy throughout the period of economic reforms relegated the state's economy from a leading to a laggard one. Uttar Pradesh is now ranked at number 24th among the Indian states in terms of per capita income. The rural economy of Uttar Pradesh witnessed agricultural modernization, reduction of incidence of rural poverty and food surpluses that had provided the direly needed food security to the national economy. This remarkable economic success has been essentially attributed to the role played by the state in terms of laying down of conducive institutional and physical infrastructural arrangements (Chadha, 1986). Prayagraj district with 49.36 Lakhs is the most populated district of Uttar Pradesh followed by Azamgarh having 39.39 Lakhs. According to Uttar Pradesh government, Uttar Pradesh is geographically segregated in 6743 wards stretched across 50,362 square km.

This study is structured in six parts. First part begins with introduction. The second part presents review of literature followed by research gap and objectives. Part three presents data collection, research methodology and analysis. Part four belongs to the results and discussion, while fifth part validates the research methodology with robustness checks. Finally, the sixth part presents conclusion and limitations of the study.

Review of Literature

Tanwar et al. (2016) explored the attributes of socio-economic progress in eastern UP during 1995 to 2011. This study captured three dimensions of development viz. agriculture, social and infrastructure attributed to the development of eastern UP. The study employed Composite Index using principle component analysis and concluded that there exist wide level of inequality in socio-economic dynamics across the eastern UP. To bridge the gap readjustments in the resources and priorities are required in the state.

Yadav et al. (2020) assessed district level financial inclusion across 27 states of India during the period 2014-2018. This study examined the financial inclusion index (FII) pre and post PMJDY. The methodology employed for developing FII was in in line with Sarma (2012). This study adopted three dimensional approach in computing FI index. This study captured the impact of PMJDY scheme. The study observed that districts located in southern and western states performed better than rest of India, while

Yadav et al. (2021) developed multidimensional financial inclusion index (FII) for 27 states of India and level of FII over 2004-2017. The FII was based on ATM & branch penetration using UNDP method. The study concluded that there has been marginal improvement in the level of financial inclusion across the states. It was also observed that the states with higher FII have higher HDI as well. Moreover, increased dormant accounts, illiteracy and lower HDI could be attributed to failure of PMJDY schemes. Hence structural reforms are required for better outcomes.

Buteau et al. (2021) depicted financial inclusion policy overview on regulatory aspects and usage of digital financial solutions. The study employed secondary data obtained from TRAI, DFS, RBI and other sources and comparative analysis was conducted. This study described the digital environment, readiness and potential. India's overall rate of adoption of digital tools is right next to Indonesia, which is growing fastest in the world. When compared in absolute users, China has largest digital user base followed by India. This study also indicated that though digital financial services are essential but mere usage is not sufficient. Since it has been observed that

though they access digital platforms, but still they rely on cash remittance modes for major transactions. This gap may be minimized by customized solutions. The digital usage increased many fold during Covid-19 pandemic.

Arora and Kumar (2022) examined financial inclusion level in Haryana using multi-dimensional index from 2010 to 2020. The study concluded that level of financial inclusion was not uniform throughout the state. The Gurugram district demonstrated highest level, while Mewat indicated alarming situation. The gap in the level of financial inclusion exhibited very wide inter district disparity across Haryana. The study emphasized that setting up of digital and financial literacy centers in rural and remote locations can be very favorable. Moreover the easy credit policies will flourish the true essence of financial inclusion and money management in inaccessible areas.

Deshmukh and Dongre (2022) investigated effect of Pradhan Mantri Jan Dhan Yojna (PMJDY) scheme and Business correspondent model on financial inclusion in India. This empirical analysis employed two stage paired t-test. The study established that PMJDY scheme dramatically increased the number of new accounts opened across the country. There has been surge in number of banking transactions. The amount of money in new accounts increased by 63 percent compared to last four years. The benefits of Rupay cards were realized by recipients. There has been significant improvement in the number of customers visiting business correspondent's standpoints.

Rani (2022) examined the present status of financial inclusion in India and various initiatives undertaken by central bank and government of India. The study reiterated observations of Deshmukh and Dongre (2022) regarding constructive effect of PMJDY Scheme. It has significant effect on augmenting financial inclusion penetration into marginalized communities, and deprived population of both men and women across rural and urban places. The people of remote places are unaware of various products and services offered by banks and hence the product should be cost effective and known to the end users staying at distant places. The financial inclusion has potential for inclusive growth through reduced poverty and inequality.

Gautam et al. (2022) examined the role of financial literacy on the development of rural India. The study analyzed panel data obtained from secondary sources for the period from 2018 to 2020 across 29 states. It concluded that financial literacy is an important factor which influences financial inclusion and government should focus on increasing financial literacy for increasing financial inclusion. It is vital for socio-economic development. Financial inclusion can alleviate poverty and augment economic growth provided appropriate investments improves banking infrastructure and banking facilitates.

Kumar et al. (2022) explored the role of block chain technology in financial inclusion and economic growth. The analysis is based on questionnaire surveys conducted using purposive sampling. The study concluded that 60 percent of the Indians agreed that payments using block chain technology are fast and safe due its peer-to-peer node network connection and authentication mechanism. The block chain technology was found to be capable of safeguarding financial details and making secure payments. The consumers were found to be comfortable in employing block chain technology for making secure transactions.

Dikshit et al. (2022) investigated the role of digital banking in the comparative study of rural transformation of Andhra Pradesh and Uttar Pradesh. The two districts: Anantapur of Andhra Pradesh and Prayagraj of Uttar Pradesh were selected for sampling because of low level of banking penetration in these districts of the states. It was observed that the villages of Anantpur Districts scored better in digital banking penetration when compared with the villages of Prayagraj district of Uttar Pradesh. The study also concluded that digital banking played an important role in in disseminating financial services to the deprived and vulnerable. It makes the banking services cost effective and accessible through Sahaj Seva Kendra, smart phones and plastic money securely linked with the digital payment systems. The service deliveries based on electronic platforms had significant contributions in the economic growth. The information communication technology with digital literacy can transform banking services delivery mechanisms in lower strata of society and remote rural regions.

Research Gap and Objectives:

The prevailing literature indicates substantial level of study exist on financial inclusion but very limited study is

available with focus on eastern Uttar Pradesh. Despite being the most populated state of the country, it is still overlooked specially these 15 districts of eastern Uttar Pradesh. Therefore, it became necessary to systematically investigate the financial inclusion in eastern Uttar Pradesh based on banking penetration approach. This study is an empirical analysis to measure level of financial inclusion in selected districts based on primary data. The multi-dimensional approach provides better comparison between the selected districts. This study also included insurance and digital dimension for correct estimation. The digital dimension comprises of internet banking, mobile banking, mobile wallets etc.

Research Methodology

Data Sources: The present study is based on primary as well as secondary data. The primary data is collected by conducting extensive survey spread across 15 districts of eastern Uttar Pradesh. The survey involves extensive questionnaires for obtaining responses of the respondents. The data set are collected and compiled based on the responses of sample population. The secondary Data sources will be collected from various authentic sites or government organizations such as reports from Reserve Bank of India (RBI), Indian statistical organization, Economic survey of Uttar Pradesh (various issues), state level bankers committee (SLBC), ADB etc. The sampling size of 115 individuals will be collected in phased manner so that conclusive study of the Eastern Uttar Pradesh state can be undertaken in concise manner. To collect primary data of 115 samples belonging to various categories will be selected. These categories include students, professionals, skilled and unskilled. In order to obtain the data both private and public sector banks will be selected.

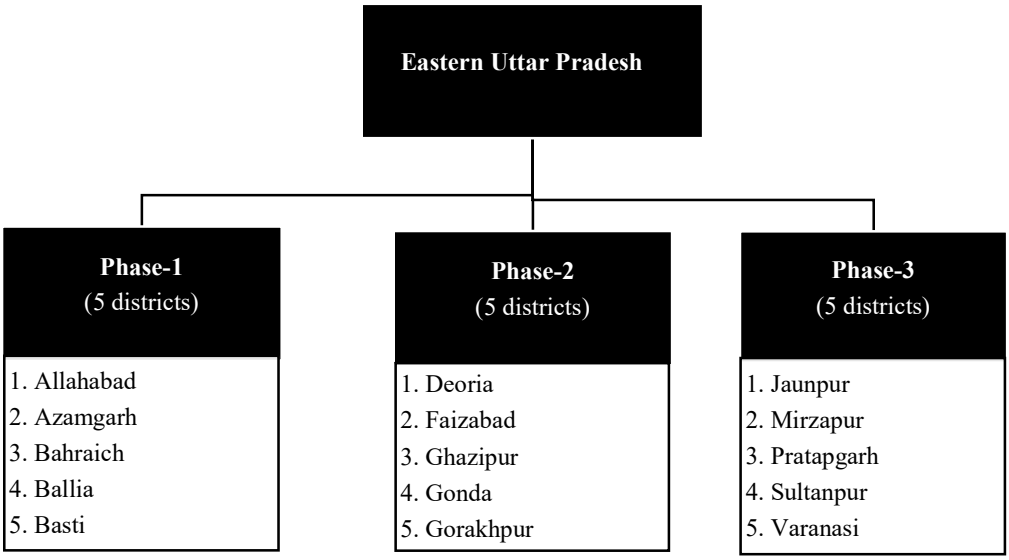
Sampling: The sample design will include Probabilistic sampling technique. Uttar Pradesh is a popular state of glorious India. Eastern Uttar Pradesh was selected as the study area to explore the various measures taken by the banking sector to stimulate financial inclusion in the region. Uttar Pradesh is classified into eastern, western, central and southern Uttar Pradesh. The main districts under eastern Uttar Pradesh include Pryagraj formerly known as Allahabad, Azamgarh, Bahraich, Ballia, Basti, Deoria, Faizabad, Ghazipur, Gonda, Gorakhpur, Jaunpur, Mirzapur, Pratapgarh, Sultanpur, and Varanasi. The district wise demography is presented in table 2. The samples are collected in three phases due to wide geographical area of Eastern Uttar Pradesh. District wise details of respective phases are illustrated inn figure- 2.

Table 2: The district wise details of the east Uttar Pradesh

Districts	**Population**	**Rural Population**			**Urban Population**		
	Total	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**
Prayagraj	4936105	3729320	1962425	1766895	1206785	664023	542762
Azamgarh	3939916	3642615	1796544	1846071	297301	153871	143430
Bahraich	2381072	2143074	1149080	993994	237998	126271	111727
Ballia	2761620	2491676	1272108	1219568	269944	141666	128278
Basti	2084814	1968829	1014325	954504	115985	61440	54545
Deoria	2712650	2444345	1215257	1229088	268305	139766	128539
Faizabad	2088928	1807655	925443	882212	281273	152029	129244
Ghazipur	3037582	2804212	1414994	1389218	233370	122147	111223
Gonda	2765586	2571267	1346004	1225263	194319	105097	89222
Gorakhpur	3769456	3030865	1532750	1498115	738591	390447	348144
Jaunpur	3911679	3622268	1790619	1831649	289411	151284	138127
Mirzapur	2116042	1829536	962560	866976	286506	152689	133817
Pratapgarh	2731174	2586619	1287741	1298878	144555	75207	69348
Sultanpur	3214832	3062574	1543351	1519223	152258	80468	71790
Varanasi	3138671	1878100	976055	902045	1260571	673132	587439

Source: census2011.co.in

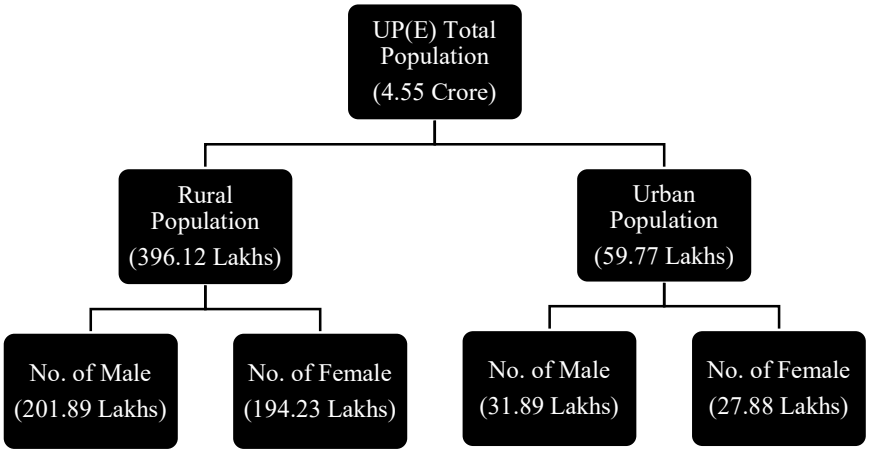
Figure- 2: Segregation of UP East in to three phases for sample collection



Source: census2011.co.in

To be precise Total sample population is 4,55,90,127 (source: anvikshikijournal.com). This includes males 2,33,78,793; Females 2,22,11,334. However the aggregate population of eastern Uttar Pradesh as per census 2011 is presented in figure- 3:

Figure- 3: Segregation of sample population into rural/urban and Male/Female

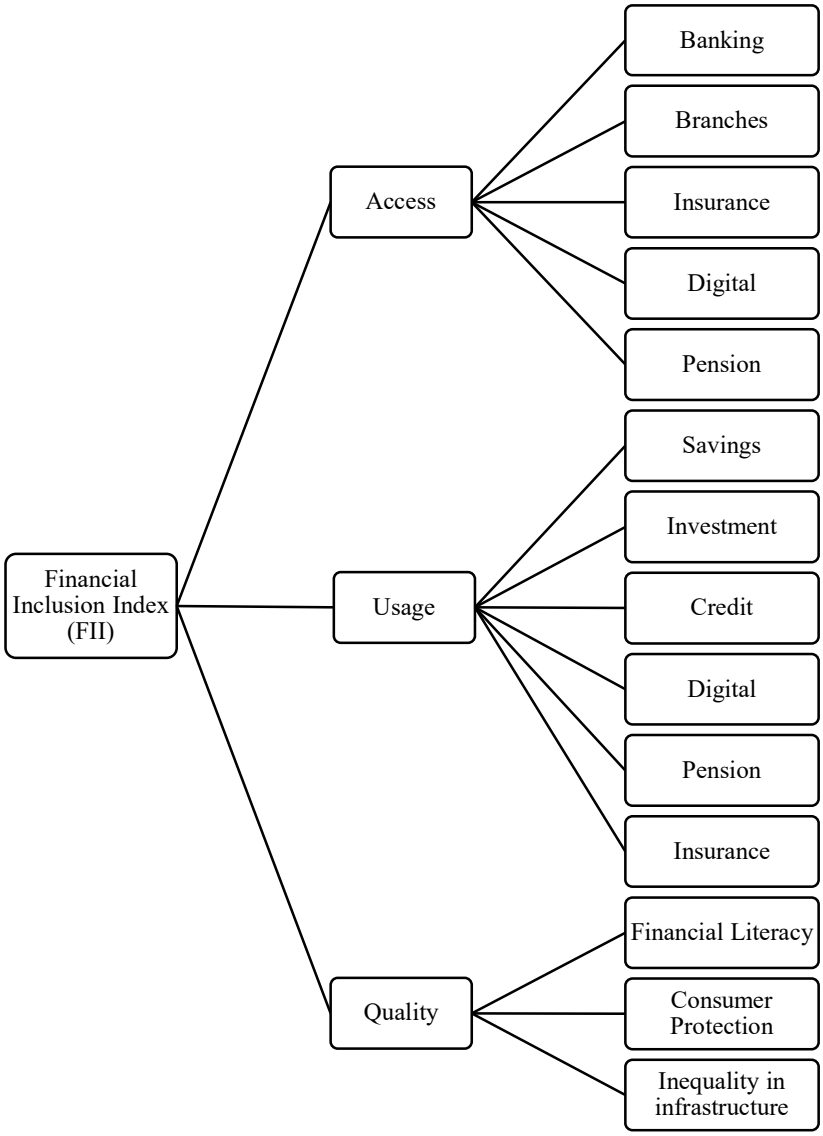


Source: census2011.co.in

A multi-dimensional financial inclusion index for fifteen districts are computed. The structure of sub-indices are represented in figure- 4. The three sub- indices viz. Access, Usage and Quality are further divided into various dimensions and indicators. The sub-index "Access" comprises of five dimension of supply side namely Banking, Branch, Insurance, Pension, and Digital services. The sub-index "Usage" comprises of six dimension of demand side namely savings, deposits & investments, credit, pension, insurance and digital transactions. The sub-index "Quality" comprises of three dimension namely financial literacy, consumer protection and inequality in

infrastructure (RBI, 2021). These dimensions are determined after reducing the financial indicators into sub-indices.

Figure- 4: Multi-dimensional indicators of Financial Inclusion



Source: Reserve Bank of India

Analysis:

Method I: The method proposed by Mandira Sarma (2010) estimated financial inclusion index (FII) based on three dimensions, where each dimension (D_i) had *n* number of variables. Each Dimension was a simple average of all the variables. This method had arbitrary weights 1, 0.5 and 0.5 assigned to the dimensions. It did not justified any clustering in the data set. Moreover, final index was computed using normalized inverse Euclidean distance method between the perceived point and ideal point.

Method II: To address this problem identified in the first method, mean (M_i) and standard deviation was proposed which is normal standardization method. Also FII was calculated based on UNDP, HDI (2010) methodology.

Here, $di = \frac{\text{actual value of Ai – Mean } (Mi)}{\text{Standard deviation}}$, where di can take values from -∞ to +∞. The dimension $D_1 = \Sigma d_{1i}/n$; i = 1,2,3, (5) (Gupte et al., 2012). The Outreach Dimension D1 represents penetration dimension and takes into account variables like Branch Penetration, ATM penetration etc. This Dimension examined the penetration level. It was directly proportional to the IFI i.e. higher the di, better was the D1. Here the, di so obtained was not bounded and it produced negative indexes, which was not acceptable. Moreover, if any of the dimension has zero value, the index was resulting to zero.

Method III: To address negative index in second method, absolute value was proposed as:

$di = \frac{|\text{actual value of Ai – Mean } (Mi)|}{\text{Standard deviation}}$, Here absolute value rectified the negative index, but di could take values from 0 to ∞, and thus it was also not bounded on higher side. Further, the absolute values was not able to differentiate between lower and upper indexes corresponding to same magnitude of di.

Method IV: To address inherent issues present in former techniques, another methodology was proposed. Which is discussed ahead.

$$di = \frac{\text{actual value of Ai – minimum value of Ai}}{\text{Standard deviation}} \quad \ldots(1)$$

Here Minimum value is subtracted rather than mean value from respective factors. This di can take values from 0 to ∞, but it was also not bounded on higher side. Subsequently we adopted normalization technique to address unbounded problem and weighted index was obtained using principal component analysis method (PCA). PCA addresses issues of over fitting and under fitting observed in earlier studies. The components are selected based on Eigen values greater than one.

The two stage principal component analysis (PCA) method has been applied to obtain principal components and weights (Nguyen, 2021). The first stage identifies Functional Principal Components (FPC) as Access, Usage and Quality, while the second stage PCA provides weights of the dimensions according to priority calculated systematically. This addresses problem of unjustified weights applied to the factors for indexing. The PCA assigns weights according to the significance of each factor and addresses issues of all previous methodologies like, uniform weights assigned by Sarma (2010) and arbitrary weights assigned by other authors (Gupte et al., 2012; RBI, 2021). The systematic weight allotted by second stage PCA provides better calculation of Financial Inclusion Index (FII). The three factors of our study are combined in proportion to respective weights to form a single index for each districts.

For a district i, let the factor indices are D_{1i}, D_{2i}, …, D_{ni} with corresponding weights of α_1, α_2, …α_n; such that

$$\sum_{i=1} \alpha_i = 1 \quad \ldots(2)$$

Hence Financial Inclusion Index for a particular district i is computed as;

$$FII_i = [(\alpha_1 D_1 + \alpha_2 D_2 + \ldots\ldots + \alpha_n D_n)] / (\alpha_1 + \alpha_2 + \ldots\ldots + \alpha_n) \quad \ldots(3)$$

The denominator adds upto one as the sum of all weights is unity i.e. $(\alpha_1 + \alpha_2 + \ldots\ldots + \alpha_n) = 1$, Therefore above equation can be summarized as equation (4);

$$FII = \sum_{\substack{i=1 \\ j=1}}^{n} \alpha_i D_j \quad \ldots(4)$$

This equation can be used to compute FII for each districts and then compared for ranking. Based on three sub-indices the Estimated Financial Inclusion Index is a weighted combination of determinants as mentioned in

equation (5):

$$FII = (\alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3) \quad \ldots(5)$$

Where:

FII: Financial Inclusion level, α_i : Weighted Index Coefficients, D_1: Access, D_2: Usage, D_3: Quality,

Assumption made to harmonize the sample data:

i. These determinants of 15 states are formulated based on the primary data set collected through questionnaire.

ii. The weights are used using second stage PCA.

iii. For financial Inclusion (FII) calculation, weighted combination of weighted index is applied for the ranking of each district.

5. Result and Discussion:

Table 3: Respondents Profile

Attributes	Particulars (Age in years)	Frequency	Percent
Age (in years)	Up to 21	8	6.96
	21-30	16	13.91
	31-40	32	27.83
	41-50	26	22.61
	51-60	12	10.43
	Above 61	21	18.26
	Total	**115**	**100.0**
Gender	Male	65	56.52
	Female	50	43.48
	Total	**115**	**100.0**
Population Area	Metropolitan	6	5.22
	Urban	41	35.65
	Semi Urban	31	26.96
	Rural	37	32.17
	Total	**115**	**100.0**
Education	Illiterate	17	14.78
	Metric	23	20.00
	Senior Secondary High School	39	33.91
	Graduate	26	22.61
	Post Graduate or higher	10	8.70
	Total	**115**	**100.00**
Occupation	Business	11	9.57
	Agricultural Income	31	26.96
	Rental Income	6	5.22
	Street Vendor	5	4.35
	Daily Wager	5	4.35
	Salaried	35	30.43
	Pensioner	9	7.83

	Housewife	17	14.78
	Student	5	4.35
	Total	**115**	**100.00**

Source: Author's calculation based on field survey

From the Table- 3, it can established that most of the respondents belong to age group between 31 to 50 years, contributing to more than 50 percent of the sample population. About 56 percent of the respondents were male. Among the respondents contacted one third belong to rural, while combining with semi- urban they share more than 50 percent of the sample population. One third of the respondents possess qualification of senior secondary high school level and combined with graduate level qualification, they make up more than half of the sample population. Among the people interviewed, salaried class people were found to have maximum number of bank accounts. It was also observed that several respondents have not availed banking facilities due to their poor economic condition and low earnings. The PMJDY schemes with zero balance was launched to address such issues and it received tremendous response.

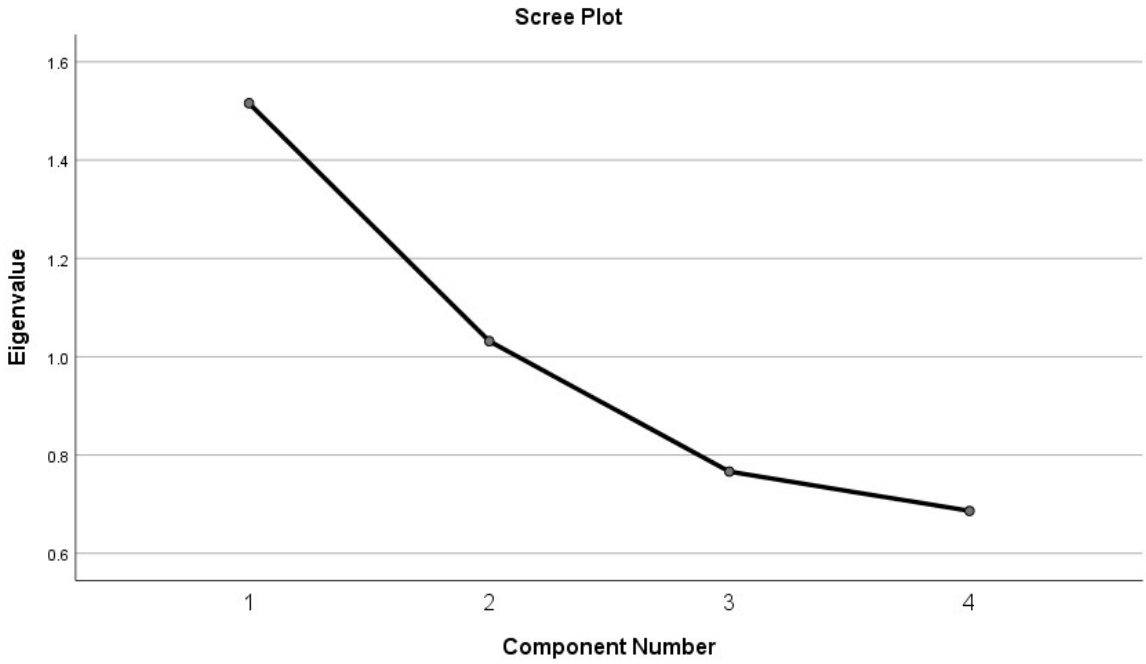
The First Stage PCA: combines indicators of sub- indices viz. "Access", "Usage" and "Quality". Table- 4 represents results of first stage PCA. We have added a third dimension as "Quality" unlike Sahay et al., (2020). Based on the results of first stage PCA, equations for FII for sub-indices are estimated. Principal components which explains higher variations are retained. We have considered only eigenvalues having values greater than 1 for our analysis (Kaiser, 1960).

Table- 4: First Stage PCA results

Variables	Eigen Values	Rotated Sum of Squared Loadings	Variance Explained	Cumulative %
Access (Estimate- y_{access})				
Branch Access	1.516	1.514	37.893	37.893
Digital Access	1.032	1.033	25.793	63.686
Usage (Estimate- y_{usage})				
Deposits	2.371	1.951	29.633	29.633
Credit	1.471	1.747	18.388	48.021
Insurance	1.125	1.268	14.061	62.082
Quality (Estimate- $y_{quality}$)				
Infrastructure	1.837	1.835	45.913	45.913
Consumer Protection	1.016	1.017	25.400	71.313

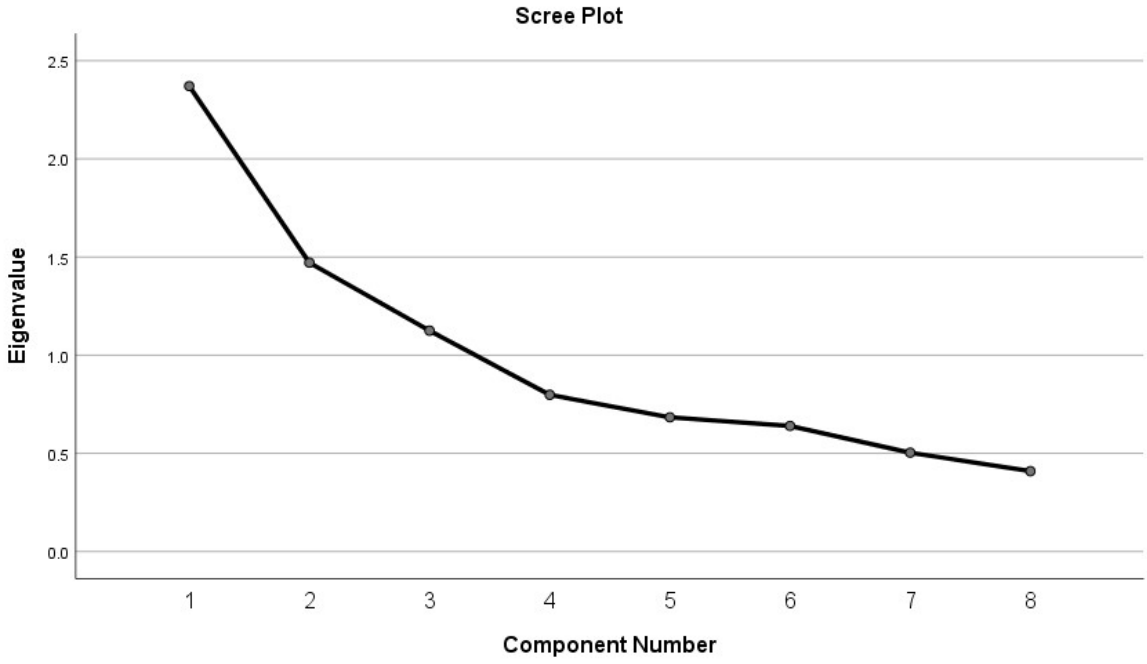
Source: Author calculation

Figure- 5: Scree Plot of Access



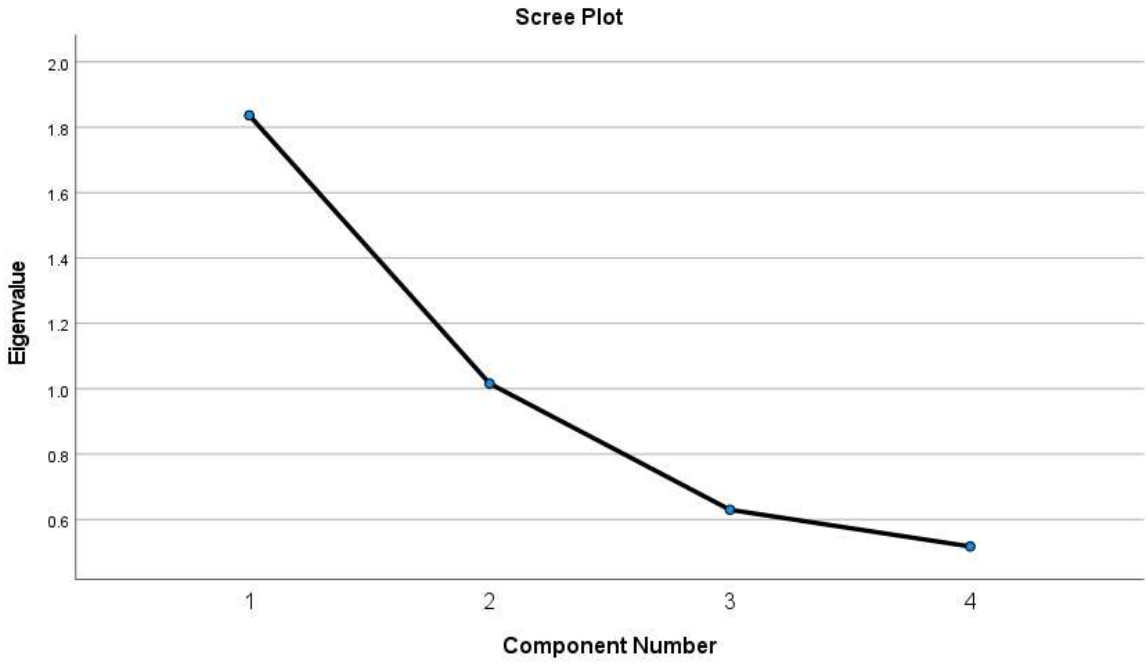
Source: Author calculation

Figure- 6: Scree Plot of Usage



Source: Author calculation

Figure- 7: Scree Plot of Quality



Source: Author calculation

The scree plot indicates how many factors are retained in PCA. Factors with Eigen values more than one are only retained for analysis of the dimensions. The scree plot for Access demonstrates that two factors having eigen value more than one. The scree plot for Usage illustrates that three factors having eigen value more than one while the scree plot for Quality shows that only two factors having eigen value more than one are retained. The eigen values greater than 1 for Access, Usage and Quality are evident on scree plots mentioned in figure- 5, figure-6 and figure-7 respectively. Accordingly, the estimated equations for sub- indices "Access", "Usage" and "Quality" are postulated, which are labelled as equation (6), (7) and (8) respectively.

$$\boldsymbol{y_{\text{access}} = \alpha_{1i}\, Branch\ Access_{1i} + \alpha_{2i}\, Digital\ Access_{2i} + C_{1i}} \quad \ldots (6)$$

$$\boldsymbol{y_{\text{usage}} = \beta_{1i}\, Deposits_{2i} + \beta_{2i}\, Credit_{2i} + \beta_{3i}\, Insurance_{3i} + C_{2i}} \quad \ldots (7)$$

$$\boldsymbol{y_{\text{access}} = \gamma_{1i}\, Infrastructure\ _{1i} + \gamma_{2i}\, Consumer\ Protection_{2i} + C_{3i}} \quad \ldots (8)$$

Where, α_{ji} , β_{ji} and γ_{ji} are coefficients of respective indicators. The C_{ji} , indicates corresponding constants of the equation.

Table A5- represents KMO and Bartlett's Test reports. The first stage PCA indicates that KMO measure of Access, Usage and Quality are 0.689, 0.657 and 0.648 respectively. It indicates that KMO values are more than 0.5. Hence analysis of the factors satisfactorily explain the study. Individual sub- indices for Access, Usage and Quality are computed using stata. The weights of these sub- indices are computed using second level PCA for Financial Inclusion Index (FII). The results of second level PCA are represented in table- 6.

Table- 5: KMO and Bartlett's Test reports

Variables	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	Bartlett's Test of Sphericity	
		Chi-Square	df

Access	0.689***	21.870	6
Usage	0.657***	139.969	28
Quality	0.648***	55.583	6

Source: Author calculation
*** indicate significance at the 1%, 5% and 10% level, respectively.

Table- 6: Second stage PCA for weights of the Financial Inclusion Index

Variables	Eigen Values	Rotated Sum of Squared Loadings	Variance Explained	Cumulative %
Access (Estimate- y_{access})	1.653	1.002	0.551	0.551
Usage (Estimate- y_{usage})	0.940	1.000	0.313	0.864
Quality (Estimate- $y_{quality}$)	0.407	0.908	0.136	1.000

Source: Author calculation

Table 7: District wise ranking based on FII

Rank	Districts of UPE	FII (%)
1	Varanasi	64.72
2	Gorakhpur	63.54
3	Bahraich	63.19
4	Ballia	63.07
5	Ghazipur	63.07
6	Sultanpur	62.26
7	Mirzapur	60.64
8	Deoria	59.95
9	Pratapgarh	59.27
10	Azamgarh	59.09
11	Basti	58.09
12	Allahabad	57.35
13	Gonda	57.09
14	Jaunpur	42.86
15	Faizabad	42.28

Source: Author calculation

Based on the sub-indices of Accessibility Usability, and Quality weighted Financial Inclusion Index (FII) is computed. According to the responses obtained from respondents of the questionnaire, the fifteen districts of the Uttar Pradesh East under the study can be ranked as represented in table 7. Among the districts studied, Varanasi indicating highest level of financial inclusion followed by Gorakhpur and Bahraich. The gap in of about 1% between the top two performers. The results also established that urban population are included to larger extent in comparison to rural population (Rehman et al., 2024). The districts which has larger rural population lags in financial inclusion index. Mean age of the Account holders is observed 39.59 years, which indicates that still a lot of youngsters are deprived of financial services.

Robustness check:

The primary data obtained through questionnaire has 48 variables with 115 respondents. For the robustness check, we employed validation by Parallel analysis and split the observations into two parts. We bifurcated the primary data into two parts in the ratio 60:40. The research methodology was reapplied on both parts separately and results were matched. When compared with the original analysis, the results of the two parts of the observation were found to be similar. The output of Principal Components Analysis (PCA) and correlation matrix reassures the results. These validations ensure robustness and consistency in the research methodology adopted.

Policy implications:

For developing states like Uttar Pradesh, this study proposes focus on enhanced use of secure information technology for deepening digital financial inclusion. The state in line with central agencies should promote digital literacy which will augment financial inclusion in cost effective and efficient way. The telecom industry possess tremendous potential thorough digital platform to connect and include remote population into the main frame. National Strategy for Financial Education (NSFE) should focus on framing the policies to attract the young population by incorporating financial education in school. The policies of National Strategy for Financial Inclusion (NSFI) should support deepening financial inclusion at various stages by all available appropriate modes. It's time to target the bottom of the pyramid for deepening level of Financial Inclusion with special attention to remote areas.

It is pertinent to mention that suitable infrastructure is must to support the digital financial inclusion policies. Polices should be framed in such a way so that it can address the demand of custom made products suitable for the specific segment of the consumer. The acceptability and usage of the product can be enhanced provided the availability of the digital products in vernacular language. For example "MANI" application introduced by RBI for detection of denomination for visually challenged individuals. It supports thirteen languages including English and Hindi. If the policies can harmonize the languages of digital products, it is ought to increase consumer confidence despite limited digital literacy.

Conclusion: From the results it is concluded that there exist wide gap among the best and lowest performing districts of the state. It was majorly attributed to Access and Usage parameters. The banking access is not only due to presence of physical branches but also augmented by financial literacy and digital banking. Digitization may substitute branches and lead to better penetration and coverage in remote areas. Information Communication Technology (ICT) plays important role in financial inclusion. Digital Banking through ICT, smart phones, wallet money can do wonders in field of deepening financial inclusion (Goyal et al., 2021)(Cheema et al., 2024). India's overall rate of adoption of digital tools is the second fastest in the world (trailing behind Indonesia) and, in absolute terms, the number of digital users in India is second only to **China** (Gupta et al., 2020). In the recent years, there has been increase in the banking amenities. Though increasing branch penetration augments easy access to the natives, but increasing digital penetration has wider prospects. Digital outreach is cost effective and convenient with 24x7 access provided it is supplemented with adequate infrastructure and digital literacy. The respondents were affirmative that it is safe and secure mode of executing banking transactions.

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ANNEXURES:

1. **Selected factors for Sub- indices for multidimensional Analysis**

	cess	**age**	**ality**
	nking	vings	nches per 1,00,000 adults
	nches	rrowings	Ms per 1,00,000 adults
	urance	m Deposits	bile Money agents per 1,00,000 adults

	nsion	urance	nk Mitra/ BC per 1,00,000 adults
	gital	tual Fund	edit cooperatives
	nvenience	nsion	gital wallets
	proachable	mittances	st

2. Component Transformation Matrix using Principal Component Factors:

Component	1	2	3
1. Access	0.945	-0.323	0.049
2. Usage	0.319	0.881	-0.350
3. Quality	0.070	0.347	0.935

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.