

DEVELOPING AN INDEX OF FINANCIAL INCLUSION

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The academic literature has adequately discussed the close relationship between financial development and economic growth (Levine 1997). However, there has not been much discussion on whether financial development implies financial inclusion. It has been observed that even ‘well-developed’ financial systems have not succeeded to be ‘all-inclusive’ and certain segments of the population remain outside the formal financial systems. The importance of an inclusive financial system is widely recognized in the policy circle in recent years and financial inclusion is seen as a policy priority in many countries (*Kempson et. al., 2004*). An inclusive financial system facilitates efficient allocation of productive resources and thus can potentially reduce the cost of capital. In addition, access to appropriate financial services can significantly improve the day-to-day management of finances. An inclusive financial system can help reducing the growth of informal sources of credit (such as moneylenders) which are often found to be exploitative. Thus, an all inclusive financial system enhances efficiency and welfare by providing avenues for secure and safe saving practices and by facilitating a whole range of efficient financial services.

Financial inclusion is the ease of access, availability and usage of the formal financial system by all members of the economy. The growing literature on financial inclusion has provided plenty of evidences of the merits of an inclusive financial system. While the importance of financial inclusion is widely recognized, the literature lacks a comprehensive measure that can be used to estimate the extent of financial inclusion across economies at a regional level. This paper is an attempt to fill this gap, and thus, an original contribution to the literature. In this paper, an attempt is made to fill this gap by proposing an index of financial inclusion. A robust and comprehensive measure of financial inclusion is important in order to take stock of the current

state of affairs with respect to financial inclusion in an economy and to monitor the progress of the policy initiatives undertaken to promote financial inclusion. A robust and comprehensive measure of financial inclusion will also be of importance to the research community to investigate interesting hypothesis relating to financial inclusion that have been raised in the academic literature.

Mandira Sharma (2008) made an attempt to develop *Index of Financial Inclusion (IFI)* across different countries of the world. Following her approach, an attempt is made in this paper to develop an *Index of Financial Inclusion (IFI)* for Punjab state following a multidimensional approach. The proposed *Index of Financial Inclusion (IFI)* captures information on several dimensions of an inclusive financial system. The IFI developed here can be used to compare levels of financial inclusion across economies at a particular time point. It can also be used to monitor the progress of policy initiatives for financial inclusion over a period of time. And, most important, such an index can be of interest to the research community in order to investigate empirical questions on relationship between development and financial inclusion. The IFI developed here incorporates information on various dimensions of an inclusive financial system and it is easy to compute.

INDICATORS:

Several indicators have been used to assess the extent of financial inclusion. The most commonly used indicator has been the number of bank accounts (per 1000 adult persons). Some other indicators are number of bank branches (per million people), number of ATMs (per million people), amount of bank credit and amount of bank deposit. Such indicators, while used individually, provide only partial information on the inclusiveness of the financial system of an economy. Using individual indicators can lead to misleading understanding of the extent of financial inclusion in an economy and fails to adequately capture the extent of financial inclusion. Thus, a comprehensive measure, such as the index proposed in this study, is required. A comprehensive measure of financial inclusion should be able to incorporate information on several aspects (dimensions) of financial inclusion, preferably in one single number. Such a measure can be used to compare the levels of financial inclusion across economies and across states/provinces within countries at a particular time point. It can be used to monitor the progress of policy initiatives for financial inclusion in a country over a period of time. Further, such a

measure can be of useful to address questions of academic interest that have been put forward in the growing literature on financial inclusion. Some of the questions raised by the academic community are whether high economic development leads to an all-inclusive financial system and whether financial inclusion low is associated with high income inequality (*Kempson et al, 2004*). In order to investigate such questions empirically, a robust and comprehensive measure of financial inclusion is required. A good measure of financial inclusion, that serves these purposes, should be constructed based on the following criteria:

1. It should incorporate information on as many aspects (dimensions) of financial inclusion as possible.
2. It should be easy and simple to compute.
3. It should be comparable across countries.

In this study, the proposed *Index of Financial Inclusion* (IFI), satisfies all the above criteria. The proposed IFI takes values between 0 and 1, zero indicating lowest financial inclusion (complete financial exclusion) and 1 indicating complete financial inclusion. Such an index, in our view, will be most useful for policy makers and academic researchers.

METHODOLOGY

As an inclusive financial system should be judged from several dimensions, we follow a multidimensional approach while constructing the *Index of Financial Inclusion* (IFI). Our approach is similar to that used by UNDP for computation of some well known development indexes such as the HDI, the HPI, and the GDI and so on. As in the case of these indices, our proposed IFI is computed by first calculating a dimension index for each dimension of financial inclusion. The dimension index for the *i*-th dimension, d_i , is computed by the following formula.

$$d_i = \frac{A_i - m_i}{M_i - m_i} \quad (1)$$

Where, A_i = Actual value of dimension *i*
 m_i = minimum value of dimension *i*
 M_i = maximum value of dimension *i*

Formula (1) ensures that $0 \leq d_i \leq 1$. Higher the value of d_i , implies higher district's achievement in dimension i . If n dimensions of financial inclusion are considered, then, a district i will be represented by a point $D_i = (d_1, d_2, d_3, \dots, d_n)$ on n -dimensional Cartesian space. (For details see Technical Note in UNDP's Human Development).

In the n -dimensional space, the point $O = (0,0,0,\dots,0)$ represents the point indicating the worst situation while the point $I = (1,1,1,\dots,1)$ represents the highest achievement in all dimensions. The *Index of Financial Inclusion*, IFI_i for the i th district, then, is measured by the normalized inverse Euclidean distance of the point D_i from the ideal point $I = (1,1,1,\dots,1)$. The exact formula is:

$$IFI_i = 1 - \frac{\sqrt{(1-d_1)^2 + (1-d_2)^2 + \dots + (1-d_n)^2}}{\sqrt{n}} \quad (2)$$

In formula (2), the numerator of the second component is the Euclidean distance of D_i from the ideal point I , normalizing it by n and subtracting by 1 gives the inverse normalized distance. The normalization is done in order to make the value lie between 0 and 1 and the inverse distance is considered so that higher value of the IFI corresponds to higher financial inclusion.

THE PRESENT INDEX

In the Index of Financial Inclusion presented here, we have taken into account three basic dimensions of an inclusive financial system: ***Banking Penetration*** (BP), ***Availability of the Banking Services*** (BS) and ***Usage of the Banking System*** (BU). These dimensions are largely motivated by two factors -- data availability for different districts of state and recent development in the literature. Apart from these three dimensions, one can think of many other dimensions of an inclusive financial system. For example, “*Affordability*” and “*Timeliness*” can be very important aspects of an inclusive financial system, as pointed out by the Rangarajan Committee ***Report on Financial Inclusion in India*** (Rangarajan Committee, 2008). However, data for measuring such dimensions, such as “transaction cost” and “time taken” for a bank transaction, was not readily available at this micro level. Therefore, these dimensions have not

been incorporated in the present index. Had such data are available, one can construct more detailed region specific index using proposed methodology.

Banking Penetration (dimension 1): An inclusive financial system should have as many users as possible, that is, an inclusive financial system should penetrate widely amongst its users. The size of the “banked” population, i.e. number of people having a bank account is a measure of the banking penetration of the system. Thus, if every person in an economy has a bank account, then the value of this measure would be 1. In the absence of the data on “banked” population, we use number of bank accounts as a proportion of the total population as an indicator of this dimension. It is estimated as number of total deposit accounts per lakhs of total population. There may be persons having more than one bank accounts co-existing with others who may have none. Therefore, number of accounts per capita, is likely to actually provide an overestimation of the proportion of the “banked” population.

Availability of Banking Services (dimension 2): The services of an inclusive financial system should be easily available to its users. Availability of services can be indicated by the number of bank outlets (per 1000 population) and/or by the number of ATM per 1000 people, or the number of bank employees per customer. In the absence of comparable data on the number of ATMs and number of bank staff, we use the number of bank branches per 1000 population to measure the availability dimension. It is estimated as number of bank offices per lakhs of total population.

Usage of the Banking System (dimension 3): This dimension is motivated by the notion of “under banked” or “marginally banked” people, as observed by *Kempson et al (2004)*. They have observed that “in some apparently very highly-banked countries, a number of people with bank account are nonetheless making very little use of the services on offer... ” These people are termed “under-banked” or “marginally banked”. Thus, merely having a bank account is not enough for an inclusive financial system; it is also imperative that the banking services are adequately utilized. In incorporating the usage dimension in our index, we consider two basic services of the banking system – credit and deposit. Accordingly, the volume of credit and deposit as proportion of the district’s GDP has been used to measure this dimension. Thus, considering the above three dimensions – penetration, availability and usage – we can represent a district i by a point (p_i, a_i, u_i) in the three dimensional Cartesian space, such that $0 \leq p_i, a_i, u_i \leq 1$,

where p_i , a_i and u_i denote the dimension indexes for district i computed using formula (1). In the three dimensional Cartesian space, the point $(0, 0, 0)$ will indicate the worst situation (complete financial exclusion) and the point $(1, 1, 1)$ will indicate the best or ideal situation (complete financial inclusion).

The IFI for the district i is measured by the normalized inverse Euclidean distance of the point (p_i, a_i, u_i) from the ideal point $(1, 1, 1)$. Algebraically,

$$IFI = 1 - \sqrt{\frac{(1-p_i)^2 + (1-a_i)^2 + (1-u_i)^2}{3}} \quad (3)$$

Consequences of Financial Exclusion

Consequences of financial exclusion will vary depending on the nature and extent of services denied. It may lead to increased travel requirements, higher incidence of crime, general decline in investment, difficulties in gaining access to credit or getting credit from informal sources at exorbitant rates, and increased unemployment, etc. The small business may suffer due to loss of access to middle class and higher-income consumers, higher cash handling costs, delays in remittances of money. According to certain researches, financial exclusion can lead to social exclusion.

Results and Discussions:

Using data on all three dimensions (*penetration, availability and usage*) for all the 20 districts of Punjab as well as for rural area of the state for the year 2008-2009, IFI values have been computed. Initially all the districts were classified/grouped into three equal categories, that is, up to 0.333; more than 0.33 and up to 0.66 and more than 0.66. However there was none district that falls in HFI group in respect of rural Punjab. Therefore, depending on the value of IFI, all the twenty districts are categorized into categories, viz.:

1. $0.66 < IFI \leq 1.00$ – *Very High Financial Inclusion (VHFI)*
2. $0.50 \leq IFI < 0.66$ – *High Financial Inclusion (HFI)*
3. $0.30 \leq IFI < 0.50$ – *Medium Financial Inclusion (MFI)*
4. $0 \leq IFI < 0.30$ – *Low Financial Inclusion (LFI)*

Index of Financial Inclusion for Punjab

The estimated values of 3-dimensional *Index of Financial Inclusion* (3d-IFI) across all the twenty districts of Punjab are presented in Table 1 and depicted in Fig.1 respectively. All the three dimensions of *Index of Financial Inclusion* (IFI) are depicted in Fig 2. The average 3d-IFI of Punjab was estimated at 0.354 indicating a low level of Financial Inclusion in Punjab. However there was wide variation across different districts of Punjab, the estimated value of Coefficient of Variation being 133.30 per cent. There are only three districts, namely, Jalandhar; Sahibzada Ajit Singh (SAS) Nagar and Kapurthala having IFI values above 0.66 levels whereas *Manchester of Punjab* - Ludhiana (0.638) is very near to high level group of 3d-IFI. Both Jalandhar and Kapurthala districts fall under *Doaba* region, popularly known as ***Forex Spinner of Punjab***. Majority of persons (almost one person from each urban household) from this region has gone abroad and hence have higher NRI accounts. Moreover SAS Nagar, popularly known as ***Electronic hub of Punjab*** and adjoining Chandigarh Union Territory and a part of tri-city ranked second (with 0.750) across different districts of Punjab where majority of the population are working class in the proximity of state capital.

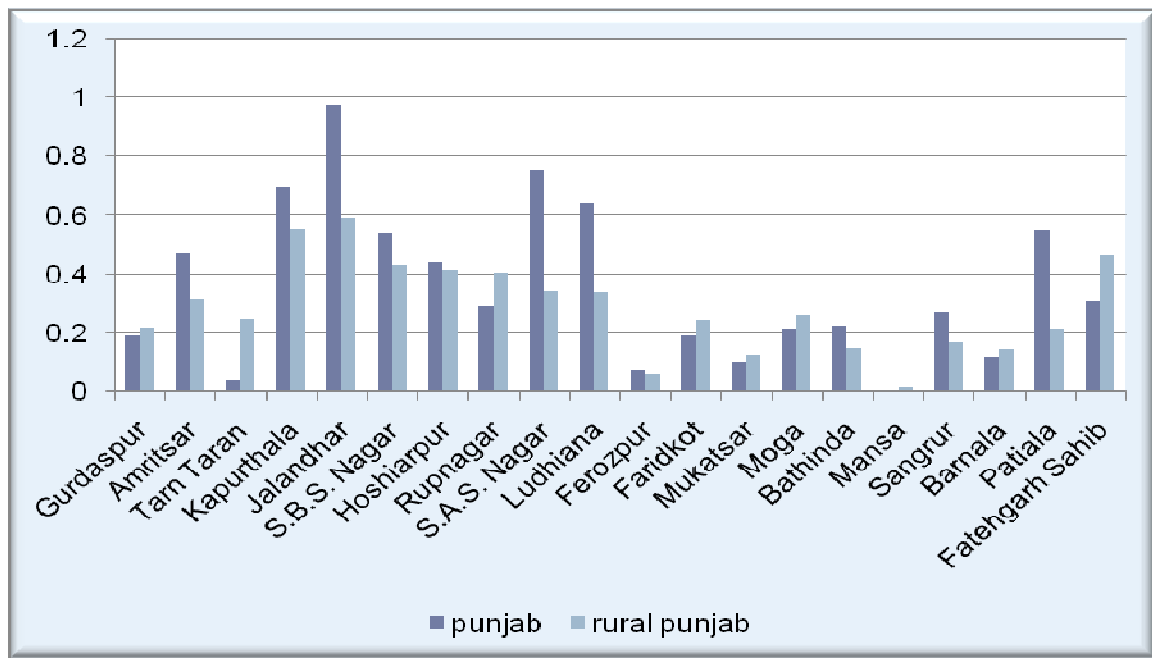
In a group of 20 districts for which 3-dimensional IFI has been estimated using data on three dimensions of financial inclusion, higher level of financial inclusion was estimated in as many as six districts, namely, Jalandhar (0.971), SAS Nagar (0.750), Kapurthala (0.692), Ludhiana (0.638); Patiala (0.550) and SBS Nagar (0.540). On the other hand Mansa was at the lowest ladder of the scale with 0.006 followed by Tarn Taran at 0.040 and Ferozpur at 0.075. Majority of the districts (eleven) are in the low financial index group of having 3-d IFI (up to 0.3 levels). These districts are Gurdaspur, Tarn Taran, Ferozpur, Mukatsar, Moga, Bathinda, Mansa, Sangrur, Barnala, Rupnagar and Faridkot. Majority of these districts are newly created with the view that small administrative units will help more development works. Apparently the creations of small districts have had no improvement in the development process rather these districts served as a *White Elephant* to the state exchequers. There are only three districts,

namely, Amritsar, Hoshiarpur and Fatehgarh Sahib that form the group of medium IFI districts group with 3d-IFI values between $0.3 \leq \text{IFI} < 0.5$

Table 1: Index of Financial Inclusion for Different Districts of Punjab based upon Three Dimensions of Financial Inclusion: 2009.

<i>District</i>	<i>Penetration Dimension</i>		<i>Availability Dimension</i>		<i>Usage Dimension</i>		<i>Index of Financial Inclusion</i>	
	<i>Value</i>	<i>Rank</i>	<i>Value</i>	<i>Rank</i>	<i>Value</i>	<i>Rank</i>	<i>Value</i>	<i>Rank</i>
<i>Gurdaspur</i>	0.30	11	0.10	15	0.195	11	0.192	14
<i>Amritsar</i>	0.54	7	0.40	7	0.478	6	0.467	7
<i>Tarn Taran</i>	0.05	19	0.04	18	0.035	19	0.040	19
<i>Kapurthala</i>	0.75	2	0.77	2	0.597	5	0.692	3
<i>Jalandhar</i>	1.00	1	1.00	1	0.955	2	0.971	1
<i>S.B.S. Nagar</i>	0.68	3	0.74	4	0.329	8	0.540	6
<i>Hoshiarpur</i>	0.57	6	0.37	8	0.405	7	0.439	8
<i>Rupnagar</i>	0.42	9	0.31	9	0.178	12	0.292	10
<i>S.A.S. Nagar</i>	0.64	4	0.76	3	1.000	1	0.750	2
<i>Ludhiana</i>	0.60	5	0.53	5	0.894	3	0.638	4
<i>Ferozpur</i>	0.13	18	0.00	20	0.106	16	0.075	18
<i>Faridkot</i>	0.23	13	0.21	13	0.132	14	0.189	15
<i>Mukatsar</i>	0.14	16	0.09	16	0.087	18	0.103	17
<i>Moga</i>	0.29	12	0.22	12	0.140	13	0.214	13
<i>Bathinda</i>	0.22	14	0.23	11	0.234	10	0.226	12
<i>Mansa</i>	0.00	20	0.02	19	0.000	20	0.006	20
<i>Sangrur</i>	0.19	15	0.06	17	0.123	15	0.271	11
<i>Barnala</i>	0.14	17	0.12	14	0.100	17	0.120	16
<i>Patiala</i>	0.52	8	0.45	6	0.733	4	0.550	5
<i>Fatehgarh Sahib</i>	0.33	10	0.31	10	0.293	9	0.310	9
<i>Average for Punjab</i>	0.387	-	0.337	-	0.351	-	0.354	-
<i>Coefficient of Variance (%)</i>	68.66	-	86.51	-	109.86	-	133.30	-

Fig 4.1: Financial Inclusion across Different Districts of Punjab and Rural Punjab.



INDEX OF FINANCIAL INCLUSION FOR RURAL PUNJAB

Similar estimates were also made for rural areas across different districts of Punjab (defined as Rural Punjab in the present study) taking into account all the three dimensions of Financial Inclusion. The resulting estimates are reported in Table 2 and depicted in Fig. 1. All the three dimensions of Index of Financial Inclusion are depicted in Fig.3. Average 3-d IFI for rural Punjab was estimated at 0.286 with a coefficient variation of 54.95 per cent. This implies that there are lesser variations across different districts of rural Punjab as compared to Punjab as a whole. Higher consistency in the 3d-IFI across different districts of rural Punjab may be attributed to adoption of rural welfare schemes through formal banking system, especially thanks to Mahatma Gandhi NERGA scheme, old age pensions etc on a large scale.

Table 2: Index of Financial Inclusion for Different Districts of Rural Punjab based upon Three Dimensions of Financial Inclusion: 2009.

<i>District</i>	<i>Penetration dimension</i>		<i>Availability dimension</i>		<i>Usage dimension</i>		<i>Index of Financial Inclusion</i>	
	<i>Value</i>	<i>Rank</i>	<i>Value</i>	<i>Rank</i>	<i>Value</i>	<i>Rank</i>	<i>Value</i>	<i>Rank</i>
<i>Gurdaspur</i>	0.46	8	0.22	13	0.038	15	0.220	13
<i>Amritsar</i>	0.49	6	0.45	7	0.072	13	0.311	9
<i>Tarn Taran</i>	0.30	13	0.41	8	0.078	12	0.25	11
<i>Kapurthala</i>	0.68	3	1.00	1	0.295	4	0.553	2
<i>Jalandhar</i>	1.00	1	0.93	2	0.293	5	0.590	1
<i>S.B.S. Nagar</i>	0.50	5	0.63	3	0.237	6	0.432	4
<i>Hoshiarpur</i>	0.69	2	0.57	4	0.138	8	0.416	5
<i>Rupnagar</i>	0.55	4	0.51	5	0.215	7	0.406	6
<i>S.A.S. Nagar</i>	0.37	9	0.25	15	0.417	3	0.342	7
<i>Ludhiana</i>	0.48	7	0.46	6	0.134	9	0.339	8
<i>Ferozpur</i>	0.10	18	0.09	18	0.00	20	0.062	19
<i>Faridkot</i>	0.22	15	0.03	19	0.61	2	0.247	12
<i>Mukatsar</i>	0.15	17	0.21	17	0.026	17	0.125	18
<i>Moga</i>	0.35	11	0.36	9	0.099	11	0.260	10
<i>Bathinda</i>	0.21	16	0.22	16	0.031	16	0.149	16
<i>Mansa</i>	0.04	19	0.00	20	0.015	19	0.018	20
<i>Sangrur</i>	0.24	14	0.27	14	0.02	18	0.169	15
<i>Barnala</i>	0.00	20	0.34	10	0.122	10	0.143	17
<i>Patiala</i>	0.33	12	0.31	12	0.044	14	0.217	14
<i>Fatehgarh Sahib</i>	0.36	10	0.33	11	1.00	1	0.465	3
<i>Average for Punjab</i>	0.3761	-	0.3795	-	0.1942	-	0.2858	-
<i>Coefficient of Variance (%)</i>	64.40	-	68.48	-	126.42	-	54.95	-

However the lesser value of 3d-IFI for rural Punjab as compared to Punjab is a matter of great concern. The need of the hour is that: various banking facilities and services should be introduced/ provided/ adopted in the rural areas of Punjab on war footing. More importantly, more jobs opportunities assuring regular and assured income flow are created for rural population, failing which all banking facilities are going to collapse.

Jalandhar (with 3d-IFI = 0.590) again topped across different district of rural Punjab followed by Kapurthala (0.553) and falls in the high 3d-IFI group, the reason being quite obvious. There are as many as 11 districts, namely, Gurdaspur, Tarn Taran, Ferozpur, Faridkot, Mukatsar, Moga, Bathinda, Mansa, Sangrur, Barnala and Patiala that lie in the low IFI group (up to 0.3 level). Mansa (0.018) remained at the bottom of the ladder followed by Ferozpur with 0.062. There are seven districts, namely, Amritsar, S.B.S. Nagar, Hoshiarpur, Rupnagar, S.A.S. Nagar, Ludhiana and Fatehgarh Sahib that lie in middle IFI group ($0.30 \leq \text{IFI} < 0.50$).

COMPLEMENTARY BETWEEN DIFFERENT DIMENSIONS:

It was hypothesized that those districts which had lower 3-dimensional Index of Financial Inclusion were also having all the three dimensions at a lower rank and those where 3d-IFI was higher all the three dimensions had higher ranks. This implies that different dimensions move in complimentary fashions. Different dimensions of Financial Inclusions are depicted in Fig. 2 for Punjab and Fig. 3 for rural Punjab. It is interesting to note that all the three dimensions of financial inclusion moved in unison for Punjab as well as for rural Punjab. For example in higher IFI group all the three dimensions of Financial Inclusion topped across different districts of Punjab. Likewise all the three dimension of Financial Inclusion remained at the bottom of the ladder across different districts of Punjab in low 3d-IFI group.

To confirm this, Coefficient of Complementary was estimated by rank correlation between all possible pairs of ranks of different dimensions of Financial Inclusions. There were three dimensions and hence three possible pairs. The resulting estimates of Coefficient of Complimentary are reported in Table 3. All these estimated values are highly significant for both Punjab as well as for rural Punjab. These estimates confirmed our view that all the three dimensions moved in a complimentary fashions. This showed that in order to bring improvements in the Financial Inclusions viz. various dimensions, all the three dimensions in the lowest IFI group have to be tackled; for those in the middle group, the lagged dimensions have to

be identified and given the priority and again for those already in the top gear, all the dimensions have to be further improved.

Table 3: Coefficient of Complimentary between Different Dimensions

District	Punjab	Rural Punjab
Gurdaspur	0.971	0.941
Amritsar	0.998	0.935
Tarn Taran	0.998	0.968
Kapurthala	0.986	0.989
Jalandhar	0.998	0.980
S.B.S. Nagar	0.968	0.989
Hoshiarpur	0.995	0.958
Rupnagar	0.986	0.989
S.A.S. Nagar	0.989	0.838
Ludhiana	0.998	0.989
Ferozpur	0.981	0.994
Faridkot	0.998	0.644
Mukatsar	0.993	1.00
Moga	0.998	0.994
Bathinda	0.980	1.00
Mansa	0.998	0.998
Sangrur	0.993	0.976
Barnala	0.984	0.850
Patiala	0.981	0.994
Fatehgarh Sahib	0.998	0.863

COMPARISON OF INDEX OF FINANCIAL INCLUSION:

A study into the comparison of pattern of Financial Inclusion between Punjab as well as for rural Punjab has to be necessarily preceded by an examination of occurrence of any change. Further; we can distinguish two types of changes, via, (i) *shifts*, and (ii) *deviations*.

When two or more patterns are compared on arranging them on an increasing or decreasing order and if they do not exhibit similarity between them, *shift* is said to occur. On other hand, when difference occurs on account of changes within the pattern of different dimensions of Financial Inclusion, then these are taken as *deviations*. There is not much variation or shift in the pattern of

financial inclusion between Punjab as well as rural Punjab. However, some deviations do occur as the customers respond to changes in banking facilities and services and other influencing variables.

However some significant changes have been noticed in some of the districts of rural Punjab as compared to Punjab. Importantly, Fatehgarh Sahib has improved its position from ninth to third; Rupnagar from tenth to six while Tarn Taran has improved its position from nineteen to eleventh. Slight improvement in the relative position of Moga; Mukatsar and SBS Nagar has also been noticed.

On the other hand, Ludhiana has deteriorated/slipped its fourth position to eighth position; Patiala from fifth to fourteen while S.A.S Nagar slipped to seventh position from second best. Likewise relative position of Bathinda and Sangrur, though at the lower end, has further deteriorated in rural Punjab as compared to Punjab. All the districts fall in the Central Punjab region. To test whether there is a shift in the pattern of financial inclusion across different districts of Punjab with that of rural Punjab; Kendall's rank correlation coefficient ($\Gamma = \tau$) was estimated at 0.767, which is highly significant. Apparently, there are no shifts in the pattern of financial inclusion across different districts in Punjab as compared to rural Punjab. Alternatively, a coefficient of concordance was also estimated to be 0.8103 which was again highly significant. Hence it can be definitely concluded that there has been no shift in the pattern of 3-dimensional Index of Financial Inclusions (IFI) across different districts of Punjab as compared to rural Punjab.

The need of the hour is that more branches of banks should be opened in the ***Rural Areas***. People must be made aware of financial services and new products should be introduced by banks. Banks should design their products according to the requirement of low income group people which will lead to inclusive growth. Moreover bank employees should change their behaviour towards the customers. The banks should provide credit to people at lower rate of interest. Paper work and formalities should be reduced in banks. The Reserve Bank of India should encourage scheduled commercial banks to open their branches in Rural Areas because generally banks prefer to open their branches in urban areas due to profitable business. There is need to change the mindset of the banking community. These efforts will increase the level of Financial Inclusion in Rural Punjab.

Fig 2(a): Penetration, Availability, Usage and Index of Financial Inclusion of Different District of Punjab.

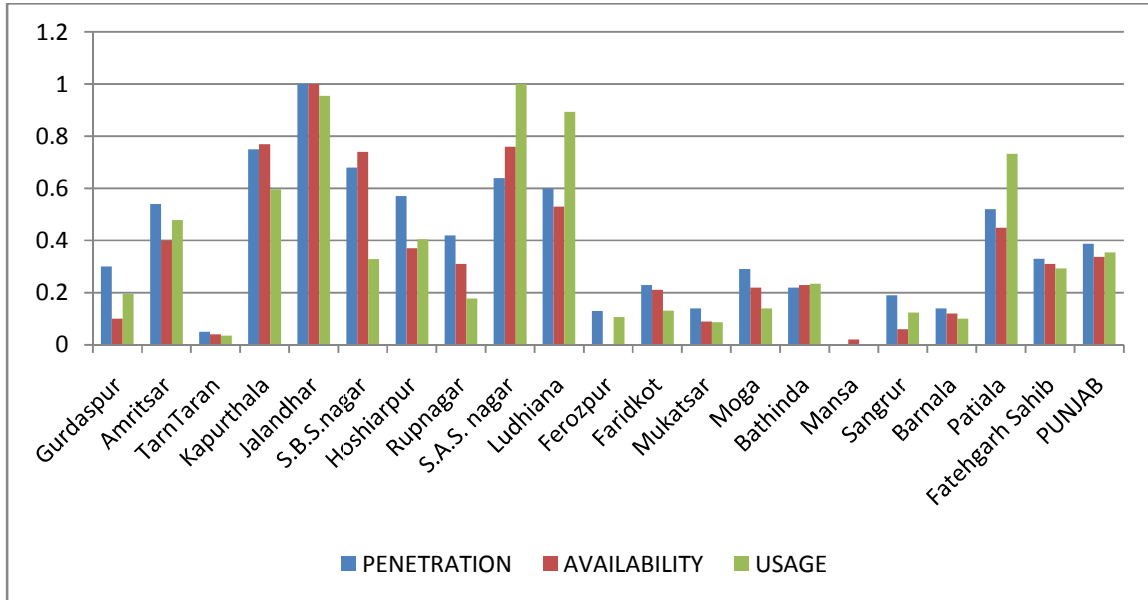


Fig 2(b): Penetration, Availability, Usage and IFI of Different District of Rural Punjab

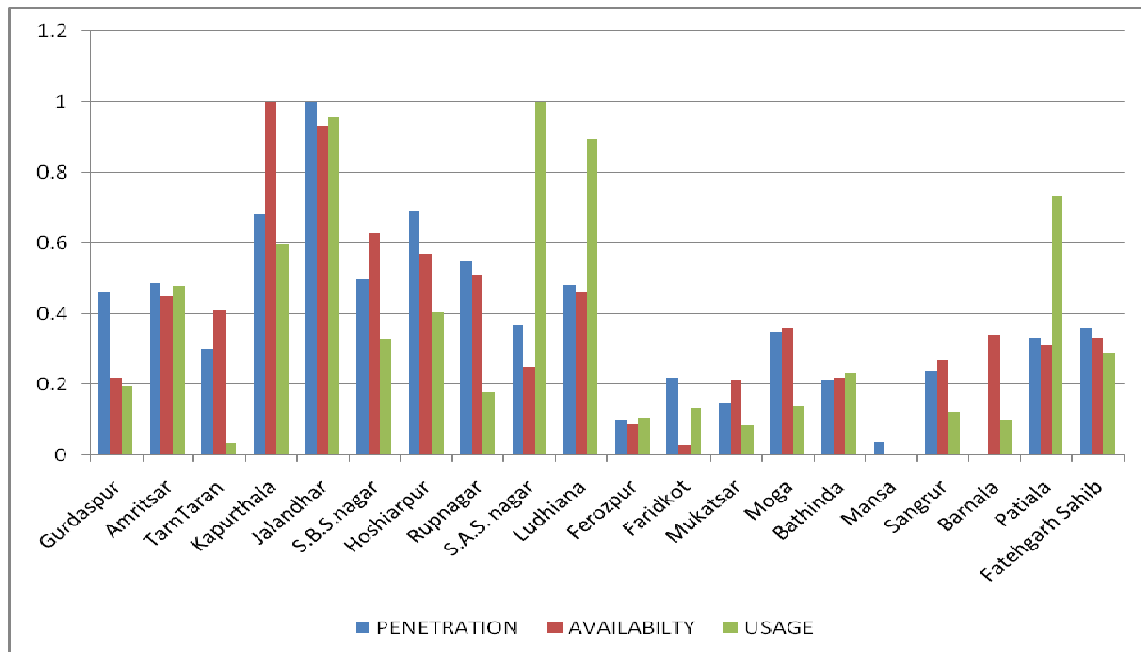


Fig 2(c): Penetration across Different District of Punjab and Rural Punjab.

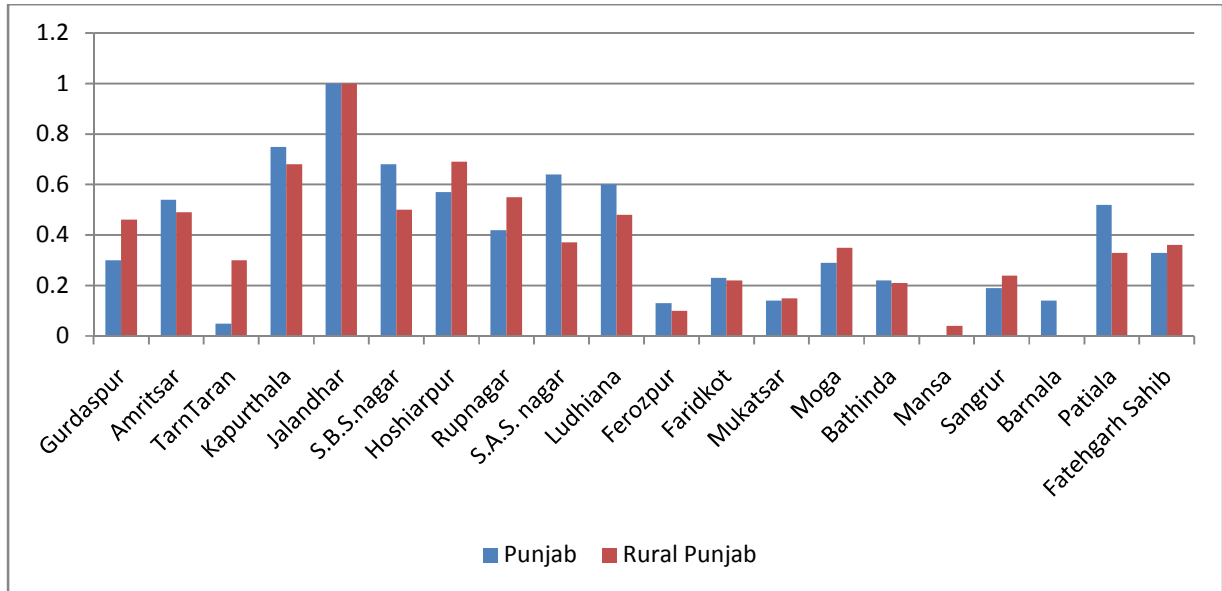


Fig 2(d): Availability Dimensions across Different District of Punjab and Rural Punjab

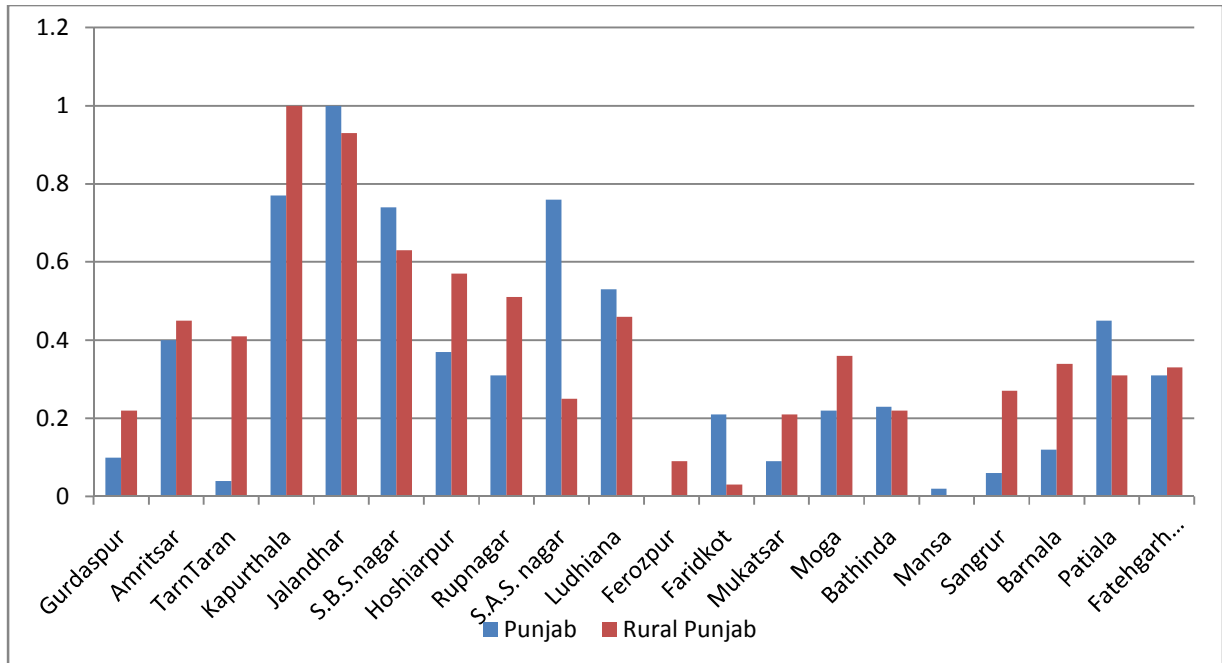
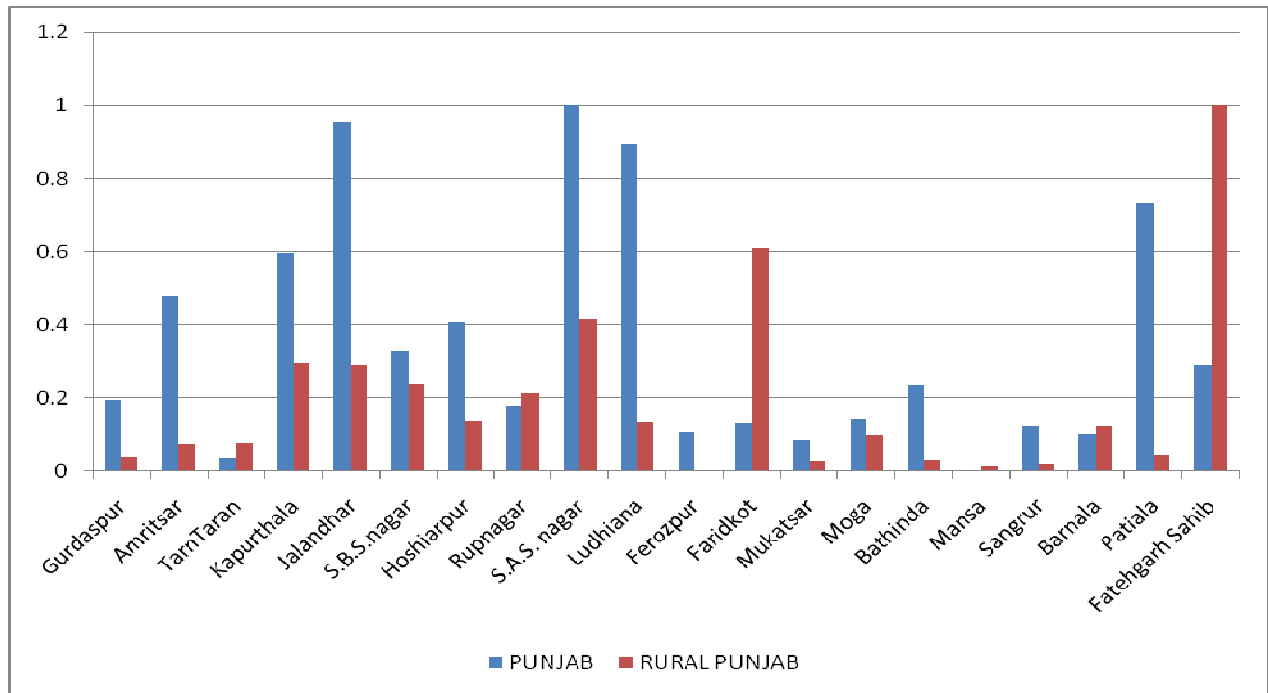


Fig 2(e): Usability Dimensions of Across Different District of Punjab and Rural Punjab.



FOOTNOTES

1. The Coefficient of Kendall's Rank correlation ($\Gamma = \tau$) was computed by using the formula:

$$\Gamma = \frac{S}{1/2 N (N - 1)}$$

Where N is the number of individuals ranked and S is defined as

$$S = \sum_i \sum_j S_{ij}$$

And S_{ij} is the value of a random variable X_{ij} defined as

$$X_{ij} = \begin{cases} 1 & \text{if } R_{xi} < R_{yj} \quad \forall i \ \& \ j \\ -1 & \text{if } R_{xi} > R_{yj} \quad \forall i \ \& \ j \end{cases}$$

The significance was tested by using Z-test. Since in our case N is greater than 10 may be considered as normally distributed with

$$\text{Mean} = \mu_{\Gamma} = 0$$

$$\text{Standard Deviation} = \sigma_{\Gamma} = \frac{2(2N+5)}{9N(N-1)}$$

$$\text{That is } Z = \frac{\Gamma - \mu_{\Gamma}}{\sigma_{\Gamma}}$$

Is approximately normally distributed with Zero mean and unit variance? Thus, the probability associated with the occurrence under H_0 of any value as extreme as an observed T may be determined by computing the value of Z as defined above and there determining the significance of that Z-value. For detail see Kendall (1938, 1948a, 1948b and 1949).

2. The coefficient of concordance was worked out by using the formula:

$$W = \frac{S}{m^2 (n^3 - n)}$$

Where S stands for the sum of squares of the deviations of the total of the ranks assigned to each individuals from $m (n + 1) / 2$.

To test the significance of W, the statistic χ^2 was computed by the formula:

$$\chi^2 = m (n - 1)$$

$$12 S$$

$$W = \frac{12 S}{m n (n + 1)} \quad \chi^2 \sim n-1$$

For detail see Kendall and Smith (1939); and Kendall (1948).

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