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Transformation of Financial Inclusion in Pakistan: A Comprehensive Index Study (2008-2022)

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Abstract

Purpose: This study aims to develop a Financial Inclusion Index (FI Index) for Pakistan from 2008 to 2022, utilizing a three-stage Principal Component Analysis (PCA) technique. It evaluates the progress in both traditional and digital financial inclusion.

Design and Methodology: The FI index was constructed using supply-side indicators (e.g., bank branches, ATMs, mobile subscriptions) and demand-side variables (e.g., account ownership, savings behavior, and mobile payments). Sub-indices for traditional and digital financial inclusion were combined to form a comprehensive index.

Findings: The results indicate significant improvements in financial inclusion in Pakistan, particularly in digital services, though challenges remain in integrating underserved populations.

Implications: The developed FI index provides valuable insights for policymakers to design strategies that promote inclusive financial systems, contributing to sustainable economic growth.

Keywords: Financial Inclusion (FI), Financial Inclusion Index (FI Index), Principal Component Analysis (PCA), Composite FI Index, Traditional Index, Digital Index.

1. Introduction

Financial exclusion has been detected as key barrier to advancement around globe. It prompts authorities prioritize banking facilities to realize financial inclusion (FI) (Demirguc Kunt et al., 2015). The view of FI developed at the end of 20th century. It focuses goal providing financial facilities with ease to every person of economy. It grabbed reputation in 2010 (Kabakova & Plaksenkov, 2018). FI gathered significant consideration in current period as one of seventeen Sustainable Development Goals. It also puts emphasis on other goals. Those include economic development, poverty reduction, equality and education (Kithinji, 2017; Ozili, 2020). Thus, it helps realize improved and more workable economy. FI aids individuals, particularly those with low economic endowments, in funding education, starting

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businesses, and managing risks, thus playing a pivotal role in poverty alleviation and economic stability (Chaudhry et al., 2020; Chaudhry et al., 2023; Zulfiqar et al., 2023).

The span of FI has mainly been referred to via usage and access to conventional financial facilities. It will employ cumulative supply-side information (Sarma, 2008, 2012; Van et al., 2021). Although studies incorporate demand-side statistics concentrating on specific usage statistics and obstacles (Avom et al., 2021). Recent research highlights the importance of exact FI measurement as a key driver for increased awareness and policy action (Sarma, 2016; Tram et al., 2023). A contribution to literature includes an anew composed indicator of FI in Pakistan over period 2008–2022. This metric accounts for traditional and digital dimensions of FI: availability and usage. The choice of these magnitudes is encouraged by data convenience and current advancement in literature. These magnitudes are considered to have significant impact on FI and are highly correlated (Ahamed & Malick, 2019). According to Verma & Giri (2024), FI is essential for mitigating income inequality, promoting inclusive economic growth, and strengthening financial stability.

There are crucial attributes of figuring out FI in a multi-dimensional approach. Initially, aggregating indicators into an individual index eases sum up the complicated landscape of FI and trace its development. A reliable FI measure enables the investigation of its relationship with other variables, aiding in poverty reduction and economic growth (Jejeniwa et al., 2024; Liu & Guo, 2023). Secondly, a reliable gauge of FI lets to investigate its link with other variables. Thirdly, data by attribute aids well realize challenges for FI. It will be suitable instrument for proposing and assessing development strategies. Furthermore, attribute-based data helps show FI challenges, serving as a valuable tool for proposing and assessing development strategies (Nguyen, 2020; Oanh, 2023). Accurate assessment is crucial for evaluating stakeholder initiatives and guiding future actions (Nguyen, 2020; Kousar et al., 2023; Huang et al., 2023).

Despite the growing body of research on financial inclusion, the measurement of its multidimensional nature is still underexplored, particularly in the context of emerging economies like Pakistan. Existing studies primarily focus on either traditional financial services or digital inclusion, without offering a comprehensive approach that incorporates both dimensions simultaneously. This gap in literature limits the understanding of how both traditional and digital financial services interact to influence overall financial inclusion. This study makes a significant contribution to the existing literature on financial inclusion (FI) by developing a comprehensive Composite Financial Inclusion (CFI) index for Pakistan, which spans from 2008 to 2022. By incorporating a multi-dimensional approach, this research provides a more complete picture of financial inclusion in Pakistan, addressing gaps in earlier studies that often focused on either supply-side or demand-side indicators in isolation. Moreover, the study contributes to the methodological development of financial inclusion indices by applying Principal Component Analysis (PCA) to construct the CFI index, ensuring that the resulting measure is both robust and dependable. The findings of this study are particularly valuable for policymakers and stakeholders looking to design strategies for improving financial access in Pakistan, an increasingly digital economy.

The remainder of this paper is structured as follows: Section 2 reviews the relevant literature on financial inclusion and its measurement; Section 3 outlines the methodology used to construct the Composite Financial Inclusion (CFI) index; Section 4 presents the results and

analysis; Section 5 discusses the implications of the findings for policy and future research; and Section 6 concludes the paper with recommendations for promoting financial inclusion in Pakistan.

2. Literature Review

2.1 Financial Growth Theories

Theories of financial growth explore how financial development, and creative environments influence economic growth. It follows either a demand-following or supply-leading approach. They suggest that economic inactivity often results from income disparities and restricted access to financial services. Thus, ensuring secure, convenient, affordable access to financial resources is crucial for accelerating economic growth and income equality. This promotes equal opportunities, both social and economic integration. It strengthens financial development and provides elasticity anti economic shockwaves (Aduda & Kalunda, 2012). The idea that finance promotes growth was initially introduced by Bagehot (1873). He argued that a robust financial sector eases economic expansion. Similarly, Schumpeter (1911) contended that banks play a key role in fostering economic progress. They offer adequate financing to innovative entrepreneurs. Other scholars, including Goldsmith (1969), McKinnon (1973), Levine & Zervos (1996), and Ndebbio (2004), also highlight the same. They argue that well-functioning financial systems and affordable services contribute positively to economic growth.

2.2 Theories of Financial Intermediation

It refers to process through which financial institutions bridge the gap between surplus and deficit units by connecting savers with borrowers. These theories address a critical question: why do investors prefer not to lend directly to borrowers, but rely on financial intermediaries instead (Ndebbio, 2004). Diamond (1984) highlights the role of banks in minimizing risks through effective monitoring of loans and investments. Dropping financial intermediaries can lead to market friction. It hinders economic growth by increasing income inequality and trapping individuals in poverty (Aduda & Kalunda, 2012). One key issue associated with financial intermediation is information asymmetry. It occurs when one party has more information than the other. This can give rise to challenges such as moral hazard and adverse choice (DemirgüçKunt et al., 2013). Expanding financial opportunities for marginalized groups promotes entrepreneurship. It enhances resource allocation, and drives economic growth (DemirgüçKunt & Levine, 2007). Increased competition among financial institutions drives demand for financial products. It encourages more savings and investments, which ultimately promotes economic expansion. Furthermore, Sharma (2016) emphasizes the positive link involving financial accessibility and national economic progression.

3. Empirical Review

Emerging research highlights multiple dimensions for promoting financial inclusion. It includes financial knowledge, technological modernization, financial stability, and advancements in fintech. The above elements identified as critical success factors for enhancing financial inclusion (Kapadia, 2019; Ozili, 2018; Beck et al., 2014). The critical role

of financial institutions in improving individual welfare through financial services is emphasized by the findings of World Bank (2014), which reveal that around 2.5 billion people worldwide do not have access to formal financial accounts. This gap presents a significant opportunity to improve their economic well-being through better financial services. Nonetheless, access to these services is often hindered by several factors, including excessive costs, the distance of financial institutions from individuals, and regulatory barriers such as collateral requirements that many cannot meet (Ozili, 2023). Literature suggests that FI provides an enabling environment for enhancing social benefits for individuals by providing a means of living. Thus, the countries reaping such benefits excel in economic growth, employment, and equality (Helmy, 2024; Miranda-Lescano et al., 2023).

Several researchers explore role of financial modernization and hi-tech progress for enhancing financial inclusion. It emphasizes that current financial systems often struggle to promote inclusion effectively (Al-Mudimigh & Ansari, 2020; Chinoda & Kwenda, 2019). Financial modernization refers to hi-tech advancements, increases in new financial instruments, and upgraded methods for delivering financial facilities. Ouma (2017) found modernization, for instance mobile phones have eased financial inclusion by enabling savings and other financial transactions. Mobile technology and technological advancements significantly contributed to financial inclusion across 49 selected countries (Chinoda & Kwenda, 2019). Populations having high total of internet consumers and FinTech enterprises experienced higher levels in financial inclusion, specifically unbanked individuals (Anshari, 2020). Technological advancements have been particularly transformative in Africa. Smartphone lending, women's empowerment, foreign banks, and microfinance institutions have promoted financial inclusion (Bravo et al., 2018; Leon & Zin, 2019). Agent banking, and postal services integration are key drivers of financial inclusion (Yi et al., 2018). Proximity between banks to customers, and access points significantly enhance financial inclusion (Sherraden, 2013; Banka, 2014). Most researchers and policymakers work on financial inclusion associated with key development entities or study centers. It reveals potential conflicts of interest. These institutions often support research projects promoting financial inclusion. Outcomes of research often aligned with institutional goals. Review results suggest much of research originates from scholars affiliated with these well-established institutions (Mishra et al. 2024).

In recent years, policymakers have intensified efforts to promote financial inclusion. It includes the formulation of consistent financial standards and policies globally (Andriospoulos et al., 2019). The even regulations have enhanced supervision and oversight of financial inclusion initiatives across economies. However, more research is needed to understand how these policies and regulatory frameworks can be improved. I help in achieving higher levels of financial inclusion worldwide (Beck, 2017). It has been accepted globally that FI plays a significant role in economic development policies in many countries, thus receiving much attention from scholars and policymakers. This focus underlines its great significance for the formation of economic policy. As noted earlier, substantial empirical literature concerning FI is available (for instance, (Ambarkhane et al., 2020; Mialou et al., 2017; Nuzzo & Piermattei, 2019; Sarma, 2016; Tram et al., 2023), which discusses possible ways of its measurement as well as the methods for its improvement. While studies have developed composite indices for

measuring FI. There is no consensus on the most effective approach. A summary of prior studies focusing on developing FI indices is presented in Table 1 as below.

Table 1. ***Earlier work on developing FI indices.***

Methodology	Researcher(s)	Dimension	Variables
Principal Component Analysis	Jungo et al. (2022)	Access	Commercial banks per 1000 km^2, Commercial banks per 100,000 adults, ATMsper1000 km^2, ATMs per 100,000 adults
		Usage	Depositors in commercial banks per 100,000 adults, Deposit accounts in commercial banks per 100,000 adults, Borrowers in commercial banks per 100,000 adults, Demand deposits in commercial banks as a percentage of GDP
Principal Component Analysis	Khera et al. (2021)	Access	Traditional: ATMsper100,000 adults, Commercial banks per 100,000 adults Digital: Mobile subscription per 100 people, % of population who have access to the internet
		Usage	Traditional: % of adults with a financial institution account, % of adults who save at a financial institution % of adults with debit cards, % of adults who receive wages through a financial institution account, % of adults who use a financial institution account for utility Digital: % of adults who have a mobile account, % of adults who use internet to pay, % of adults who use mobile phones to receive salary or wages, % of adults who use mobile phones to make utility payments
	Nguyen (2020)	Availability	Branches, ATMs, Mobile money agents

Principal Component Analysis		Access	Deposit accounts, Mobile money accounts
		Usage	Deposits, Loans, Mobile money transactions
Principal Component Analysis	Avom et al. (2021)	Availability	Proportion of adults with an account in a formal institution, Ownership of a bank card, Proportion of adults with a mobile account
		Access	ATMs per 100,000 people, Commercial banks per 100,000 people, Number of commercial banks and ATMs per 1000 km^2
		Usage	Saving in a formal institution, Withdrawals and loans from a formal financial institution, Use of digital payments, Life and non-life insurance policies
Three panel cointegration Method	Huang and Zhang (2019)	Availability	Number of bank employees and bank branches per 10,000 members of the population
		Access	Number of bank employees and bank branches per 10,000 km^2
		Usage	Deposits and credit per capita compared to GDP per capita
Sarma's method (Sarma 2008)	Park and Mercado (2015, 2018)	Availability	ATMs per 100,000 adults, Commercial bank branches per 100,000 adults
		Usage	Commercial Bank Borrowers per 1000 adults, Commercial bank depositors per 1000 adults, Household credit/ GDP ratio
Principal Component Analysis	Camara and Tuesta (2014)	Access	ATMs and commercial bank branches per 100,000 adults, ATMs and commercial bank branches per 1000 km^2
		Usage	Accounts, Loans, Savings
		Barriers	Distance, Affordability, Documentation, Lack of trust
Combining approaches of Sarma (2008) and Park and Mercado (2015)	Van et al. (2021)	Availability	Number of commercial bank branches and ATMs per 100,000 adults
		Usage	Ratio of bank credit of the private sector to GDP

Multi-dimensional approach	Sarma (2008, 2012, 2015, 2016)	Availability	Number of bank branches and ATMs per 100,000 adults
		Access	Number of bank deposit accounts per 1000 adults
		Usage	Volume of credit and deposits to adults as a proportion of GDP

2.3 Measurement of Financial Inclusion

To accurately examine connection amongst financial inclusion and other factors, it is essential to have a suitable measurement of financial inclusion. However, there is no universally accepted method for quantifying financial inclusion across economies. Literature presents two broad methods for assessing financial inclusion: (1) individualistic statistics, and (2) the construction of composite financial inclusion index (commonly referred as FI index). Beck et al. (2007) are pioneers in quantifying a country's access to financial services by developing indicators of banking access. Their model assessed three major financial services: deposits, lending, and payments. These were analyzed employing two aspects: accessibility, and usage, of financial facilities. Global datasets further enhance the analysis of financial inclusion by tracking indicators. It covers the number of bank branches, ATMs, deposit accounts, and outstanding deposits or loans. Building on these datasets, studies have developed a composite FI index to measure financial inclusion. One popular approach to constructing such an index is inspired by the Human Development Index (HDI). It is clear in research by Park & Mercado (2018), Kaur & Abrol (2018), and Prastowo & Putriani (2019). Sarma (2008, 2012, 2015, 2016) introduced an innovative method for calculating financial inclusion. It develops subindices for individual dimensions instead of relying on weighted averages, as had been the norm in earlier studies. The final FI index was computed as standardized inverse of the Euclidean gap from reference work standard view. Studies, including those by Wang & Guan (2017), Sethi & Sethy (2019); and Huang & Zhang (2020), later adopted Sarma's method for building their FI indices.

Despite offering a more robust measure of financial inclusion compared to individual indicators, this approach has faced criticism. It relies on arbitrary weights figured out by the researcher's judgment. To address these concerns, later studies proposed parametric methods. It assigns endogenous weights based on statistical models. Mialou et al. (2017) and Camara & Tuesta (2018) tackled limitations in earlier methods by using data-driven approaches. It employed Factor Analysis (FA) and Principal Component Analysis (PCA). Mialou et al. (2017) developed FI index that encompassed multiple dimensions. It includes outreach (both geographical and demographic), use (deposits and loans), and value (disclosure, query resolution mechanisms, and use costs). The use of FA reduces the number of variables considered. Camara & Tuesta (2018) used a two-stage PCA technique for constructing their FI index. As of a methodological standpoint, PCA approach chosen over FA. It does not require assumptions about raw data (Camara & Tuesta, 2018). Consequently, later research, such as those by Ahamed & Malick (2019), Yorulmaz (2018); Shaban et al., (2020); and Gharbi & Kammoun (2023), employed PCA techniques to develop comprehensive FI indices. With the rapid growth in mobile phone usage, particularly in developing countries, mobile phone penetration now serves as a proxy for mobile banking adoption. It has gained acceptance as a

part of financial inclusion capacity (Chauvet & Jacolin, 2017). Additionally, mobile money accounts have appeared as a key financial transaction platform for man households in developing economies (Mehrotra & Nadhanael, 2016). However, due to data constraints, mobile money indicators are not yet consistently incorporated into FI indices.

4. Methodology

FI is multi-dimensional degree of an economy's financial segment inclusiveness. Today, there's no universally accepted approach for assessing FI. Institutions, including the World Bank, central banks, and Gallup World Poll, have made efforts to do so. An evaluation of literature shows two main approaches to deciding FI:

Non-parametric approach distribute rank to markers by considering percentages externally built on researcher belief. This method is sensitive to subjective weight assignments. Minor changes in percentages will significantly change the results. A common example is Sarma's approach (2008, 2012).

Parametric approach are established on the principle and underlying construct explains deviation in associated markers. It allows the significance of markers (percentages) to be calculated internally by co-variation among markers on each attribute. Two common parametric methods are Principal Component Analysis (PCA) and Common Factor Analysis (CFA).

Additionally, universal databases like Financial Access Survey (FAS) and Global Findex Survey (Findex) assess FI using various financial access indicators. These indicators are number of bank branches, ATMs, deposits, outstanding deposits, credits. These records enable construction for composite index "FI Index". Its computers are FI. Studies adopted this method to assess FI levels (Jungo et al., 2022).For the purpose of this study, FI index will be constructed by considering demand, supply, and infrastructure and drag factors. Based on work of Khera et al. (2021), three-stage Principal Component Analysis (PCA) method will be utilized. This approach aims including multiple dimensions for FI across each stage: in initial stage, consideration will be given to both provision ("access"), utilization ("usage") elements for FI; the later stages will research FI offered by conventional financial institutions ("traditional"), those vested for technology ("digital"); finally, third stage will involve the development of a comprehensive index that holds all these constituent parts. The proportions for the fundamental indicators through PCA will be influenced in direction of indicators that show high correlation with each other. By approximating the sub-indices separately in distinct stages, this bias can be addressed. The method is parallel to the procedure adopted in prevailing research on traditional FI (Camara & Tuesta, 2017). This index captures various dimensions for FI, including access, usage, and technology empowerment. We included it to understand how broader FI initiatives impact bank profitability and stability, considering the significance of inclusive financial systems in promoting economic development. A detail of variables used in research models is presented in Table 2 as below.

Table 2. ***Detail of variables used in PCA analysis***

Variables	Notation	Measure	Variables	Notation	Measure
Traditional FI index			**Digital FI index**		
Access			**Access**		
Number of ATMs	A1	Number of ATMs, per 100,000 adults	Mobile subscription, per 100 people	C1	%age of people, with mobile subscription
Number of bank branches	A2	Number of commercial bank branches, per 100,000 adults	% of population, who have access to internet	C2	%age of population, who have access to internet
			Usage		
Usage					
% of adults, with a financial institution account	U1	%age of adults, with a financial institution account	% of adults, who have a mobile account	S1	%age of adults, who have a mobile account
% of adults, who save at a financial institution	U2	%age of adults, who save at a financial institution	% of adults, who use internet to pay	S2	%age of adults, who use internet to pay
% of adults, with debit cards	U3	%age of adults, with debit cards	% of adults, who use mobile phone to receive salary or wages	S3	%age of adults, who use mobile phone to receive salary or wages
% of adults, who received wages through	U4	%age of adults, who	% of adults, who use mobile phone	S4	%age of adults, who use mobile phone to make utility payments

a financial institution account		received wages through a financial institution account	to make utility payments
% of adults, who use a financial institution account for utility	U5	%age of adults, who use a financial institution account for utility	

3.1 First-stage PCA:

At this phase, sub-indices for 'access' and 'usage' categories constructed traditional (FI_T^a, FI_T^u) and digital (FI_D^a, FI_D^u) FI.

$$(FI_T^a)_{it} = \sigma_1(A_1)_{it} + \sigma_2(A_2)_{it} + d_{it} \quad (1)$$

$$(FI_T^u)_{it} = \omega_1(U_1)_{it} + \omega_2(U_2)_{it} + \omega_3(U_3)_{it} + \omega_4(U_4)_{it} + \omega_5(U_5)_{it} + d_{it} \quad (2)$$

$$(FI_D^a)_{it} = \rho_1(C_1)_{it} + \rho_2(C_2)_{it} + d_{it} \quad (3)$$

$$(FI_D^u)_{it} = f_1(S_1)_{it} + f_2(S_2)_{it} + f_3(S_3)_{it} + f_4(S_4)_{it} + d_{it} \quad (4)$$

3.2 Second-stage PCA:

In second stage PCA, access and usage sub-indices resulted above, converted into FI index for traditional and digital inclusion.

$$(FI_T)_{it} = \beta_1(FI_T^a)_{it} + \beta_2(FI_T^u)_{it} + d_{it} \quad (5)$$

$$(FI_D)_{it} = \beta_1(FI_D^a)_{it} + \beta_2(FI_D^u)_{it} + d_{it} \quad (6)$$

3.3 Third-stage PCA:

Lastly, composite FI index (CFI_{it}) calculated using PCA for above indices.

$$CFI_{it} = \beta_1(FI_T)_{it} + \beta_2(FI_D)_{it} + d_{it} \quad (7)$$

The data used to construct the indices extracted from IMF Financial Access Survey (IMF FAS) andWorld Bank Financial Inclusion Database (WB Findex) for Pakistan from 2008 to 2022.

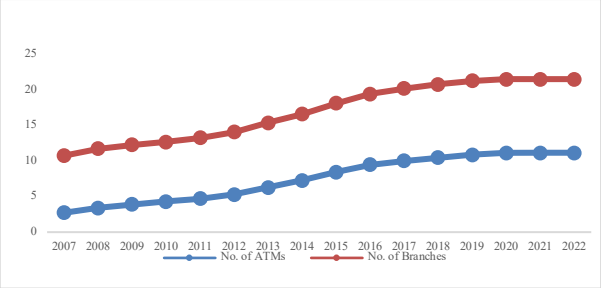
3.4 Dimensions of Financial Inclusion:

Although substantial developments over time, a significant gap of financial inclusion persists, particularly in services provided by financial institutions for various underserved populations in Pakistan during 2008 to 2022.

The number of ATMs per 100,000 adults has significantly increased over recent years, showing greater access to financial institutions

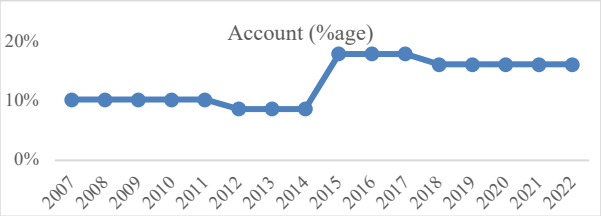
Figure 1: Number of ATMs and branches per 100,000 adults

(Figure 1). Similarly, the number of bank branches per 100,000 adults has shown a similar trend.



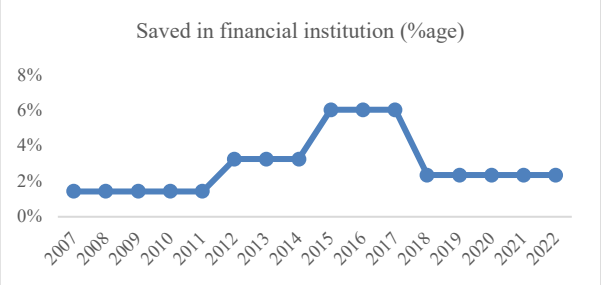
The share of adults with a financial institution account shows an increase in the usage of financial services. The proportion of adults holding such accounts shown significant development since 2014-15 (Figure 2).

Figure 2: age of individuals with financial institution account



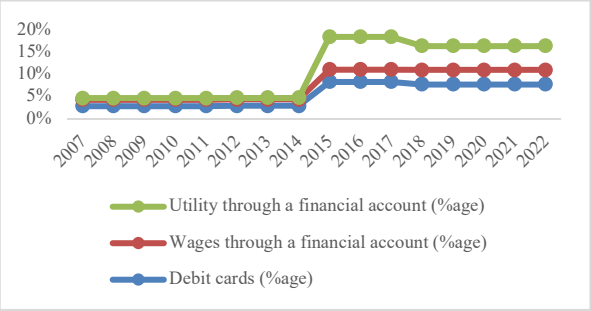
Having an account does not always equate to genuine usage of financial services. The percentage of individuals saving within a financial institution, for example, shows more fluctuating usage patterns (Figure 3).

Figure 3: age of individuals who save in a financial institution.



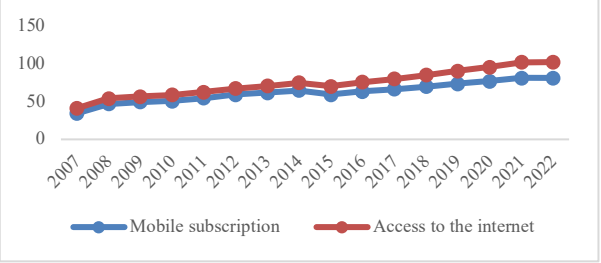
To better understand the actual use of financial services, indicators such as the share of individuals using debit cards, receiving wages via financial institutions, and paying utility bills through financial institutions show varying trends (Figure 4).

Figure 4: age of individuals who used debit cards, receiving wages, and paying utilities through a financial institution.



There has been notable progress in the use of mobile technology for financial transactions. Mobile subscriptions in Pakistan have surged and have become the primary means of accessing the internet (Figure 5).

Figure 5: Mobile subscription, and %age of people with internet access



Additionally, there has been a noticeable increase in the proportion of the population running mobile accounts, using the internet to pay bills, and making purchases using debit cards (Figure 6). A significant rise is also observed in the use of mobile phones to receive wages and pay utilities.

A three-stage principal component analysis (PCA) employed to derive a composite FI index. Financial inclusion is unobserved and is revealed in relation to various variables mentioned earlier. To calculate a quantitative extent of financial inclusion, we adopt there is an inherent latent variable, 'financial inclusion,' behind a set of correlated variables. PCA helps compute input of each variable in supporting variability for dataset.

Figure 6: age of people having mobile accounts, using internet to pay, using mobile to receive wages, and utility.

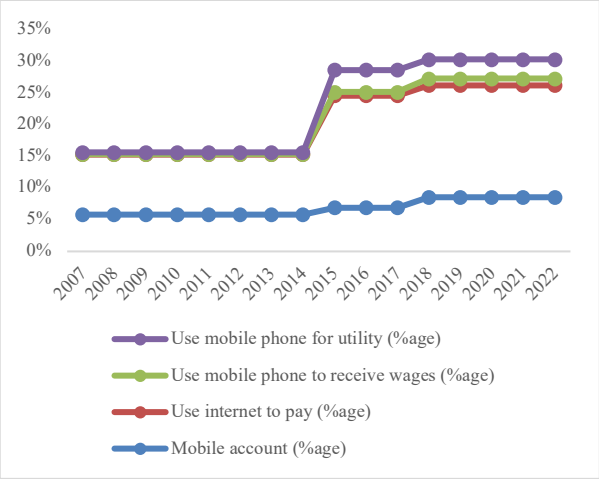


Table 3. ***Summary statistics of the selected variables for the traditional and digital FI index***

	Mean	Median	Standard Deviation	Range	Min	Max
Access (Traditional)						
ATM per 100,000 population	7.526	7.860	3.134	6.353	2.720	11.140
Bank branches per 100,000 population	9.393	9.480	0.894	1.885	8.020	10.410
Usage (Traditional)						
Account at a financial institution (%)	0.133	0.133	0.038	0.060	0.087	0.180
Saving at a financial institution (%)	0.029	0.024	0.017	0.018	0.014	0.061
Debit card (%)	0.054	0.053	0.026	0.049	0.029	0.083
Financial institution account for wages (%)	0.022	0.021	0.009	0.019	0.014	0.033
Financial institution account for utility (%)	0.033	0.029	0.030	0.049	0.004	0.074
Access (Digital)						
Mobile subscription per 100 people	62.457	63.065	13.056	21.114	34.551	81.747
Internet (%)	12.187	10.500	5.063	8.638	6.800	21.037
Usage (Digital)						

Mobile account (%)	0.069	0.063	0.012	0.027	0.058	0.085
Use internet to pay (%)	0.136	0.135	0.042	0.082	0.095	0.177
Mobile for wages (%)	0.005	0.003	0.005	0.010	0.001	0.011
Mobile for utility (%)	0.017	0.017	0.015	0.027	0.003	0.035

Table 4 . ***Correlation matrix: Explanatory variables***

Variables	No. of ATMs	No. of Branches	Account (%)	Saved in fin. Inst.%	Debit cards (%)	Wages through a fin. Acc. (%)	Utility through a fin. acc (%)	Mobile subscription	Access to the internet	Mobile account (%)	Use internet to pay (%)	Use mobile phone to receive wages (%)	Use mobile phone for utility (%)
No. of ATMs	1												
No. of Branches	0.99	1											
Account (%age)	0.82	0.83	1										
Saved in financial institution (%age)	0.42	0.43	0.55	1									
Debit cards (%age)	0.90	0.91	0.98	0.56	1								
Wages through a financial account (%age)	0.93	0.93	0.91	0.32	0.95	1							
Utility through a financial account (%age)	0.85	0.85	0.98	0.66	0.98	0.89	1						
Mobile subscription	0.93	0.92	0.60	0.24	0.72	0.80	0.63	1					

Access to the internet	0.92	0.91	0.73	0.12	0.80	0.91	0.71	0.91	1				
Mobile account (%age)	0.89	0.89	0.78	0.07	0.84	0.96	0.74	0.83	0.95	1			
Use internet to pay (%age)	0.91	0.92	0.97	0.50	0.99	0.97	0.97	0.74	0.84	0.87	1		
Use mobile phone to receive wages (%age)	0.91	0.91	0.82	0.14	0.88	0.97	0.79	0.83	0.94	0.99	0.91	1	
Use mobile phone for utility (%age)	0.89	0.90	0.98	0.58	0.99	0.94	0.99	0.70	0.79	0.82	0.99	0.86	1

3.5 First Stage PCA:

At this phase, sub-indices for 'access' and 'usage' categories constructed for traditional (FI_T^a, FI_T^u) and digital (FI_D^a, FI_D^u) FI. These are based on selected variables as in Table 2. The access component (FI_T^a) of traditional FI is determined employing two indicators: number of cash machines per 100,000 population (A_1) and number of bank branches per 100,000 population (A_2). Usage component (FI_T^u) is determined by the following indicators: percentage of population having financial institution account (U_1), who save at financial institution (U_2), use debit cards (U_3), who receive wages through financial institution account (U_4), and who use financial institution account for utility payments (U_5).

$$(FI_T^a)_{it} = \sigma_1(A_1)_{it} + \sigma_2(A_2)_{it} + d_{it} \quad (1)$$

$$(FI_T^u)_{it} = \omega_1(U_1)_{it} + \omega_2(U_2)_{it} + \omega_3(U_3)_{it} + \omega_4(U_4)_{it} + \omega_5(U_5)_{it} + d_{it} \quad (2)$$

In this model for Pakistan, *i* denotes country, and *t* represents the years (2008 to 2022) under analysis. The total variation in access and usage indicators divided into two impertinent components: variation explained by explanatory variables and variation due to error, denoted by d_{it}. If the model well stated, then $E_e = 0$ and $E_\mu = 0$, meaning error variance is insignificant related to variance for latent variables, which represent 'access' and 'usage' for traditional payment facilities in Pakistan. For proportions of digital financial inclusion, access component (FI_D^a) computed by two indicators: mobile subscriptions per one hundred persons (C_1) and percentage of the people having internet access (C_2). Usage component ((FI_D^u) is determined by the following indicators: percentage of people having mobile account (S_1), who use the internet for making payments (S_2), who receive wages via mobile phone (S_3), and who adopt mobile phone to pay utility bills (S_4).

$$(FI_D^a)_{it} = \rho_1(C_1)_{it} + \rho_2(C_2)_{it} + d_{it} \quad (3)$$

$$(FI_D^u)_{it} = f_1(S_1)_{it} + f_2(S_2)_{it} + f_3(S_3)_{it} + f_4(S_4)_{it} + d_{it} \quad (4)$$

For above dimension-related sub-index, PCA generates linear amalgamations of underlying variables to produce principal components. These workings ranked so that first principal component represent largest probable variation in explanatory variables. The first principal component, PC_1, describes more than 84 percent of total variation in the explanatory variables (see Table 5). This highlights the significance of the first component in capturing most data's variability. To estimate sub-indices for each year, the underlying explanatory variables (x) and corresponding absolute loadings (L) from the first principal component required. In this process, explanatory variables normalized so that standard deviation stands one and mean comes zero. The absolute loadings, obtained from first principal component, determine the weight each variable contributes to the calculation of the sub-indices (see Table 6).

This standardization ensures that the variables are on the same scale for accurate comparison across years. To determine relative significance of each explanatory variable in sub-indices, the study can get weightings from loadings results of the first principal component. These weightings represent percentage involvement of every variable to sub-indices. By analysing loadings, the study can identify how much each variable influences the overall index. The weightings for each explanatory variable displayed in the results of the first principal component (Figure 7a, b). It will provide insight into their relative impact on the sub-indices.

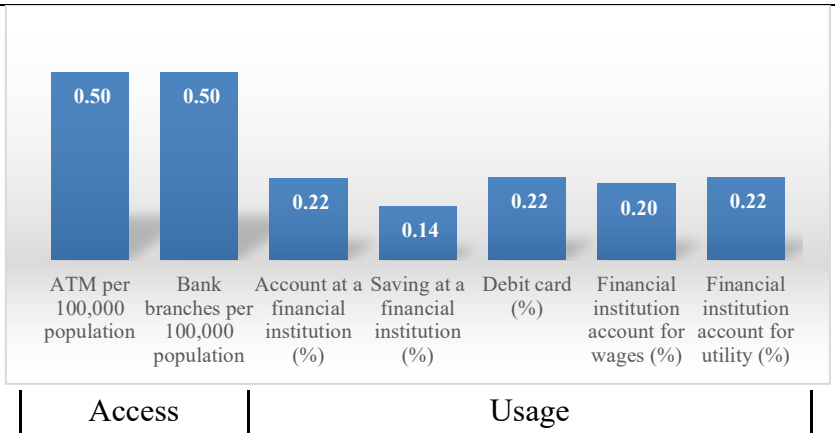
Table 5. ***First-stage PCA: Cumulative variance explained by principal components***.

Access (Traditional)		**Access (Digital)**	
PC_1	0.9988	PC_1	0.9574
PC_2	1.0000	PC_2	1.0000
Usage (Traditional)		**Usage (Digital)**	
PC_1	0.8435	PC_1	0.9344
PC_2	0.9905	PC_2	1.0000
PC_3	1.0000	PC_3	1.0000
PC_4	1.0000	PC_4	1.0000
PC_5	1.0000		

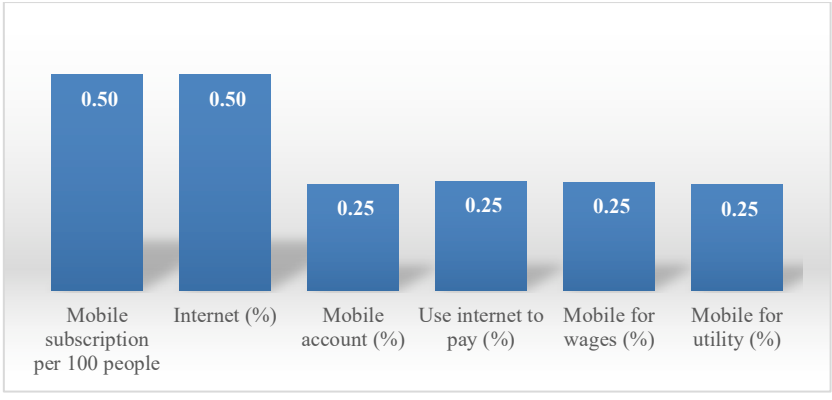
Table 6. ***First-stage PCA: Loadings***

Access (Traditional)						
	Notation	**PC_1**	**PC_2**	**PC_3**	**PC_4**	**PC_5**
ATM per 100,000 population	A_1	0.707	-0.707			
Bank branches per 100,000 population	A_2	0.707	0.707			
Usage (Traditional)						
Account at a financial institution (%)	U_1	0.479	0.105	0.68	-0.45	0.291
Saving at a financial institution (%)	U_2	0.314	-0.890	-0.25	-0.19	0.099
Debit card (%)	U_3	0.484	0.124	-0.13	0.67	0.530
Financial institution account for wages (%)	U_4	0.449	0.424	-0.63	-0.45	-0.10

Financial institution account for utility (%)	U_5	0.486	-0.044	0.212	0.320	-0.78
Access (Digital)						
Mobile subscription per 100 people	C_1	0.707	-0.707			
Internet (%)	C_2	0.707	0.707			
Usage (Digital)						
Mobile account (%)	S_1	0.495	0.561	-0.64	0.175	
Use internet to pay (%)	S_2	0.506	-0.397	0.243	0.726	
Mobile for wages (%)	S_3	0.505	0.424	0.668	-0.34	
Mobile for utility (%)	S_4	0.493	-0.590	-0.29	-0.56	



a) Traditional Financial Inclusion Index Access and Usage variables



b) Digital Financial Inclusion Index Access and Usage variables

Figure 7. First stage principal components analysis weights

3.6 Second-stage PCA:

In second phase PCA, access and usage sub-indices resulted above, converted into FI index for traditional and digital inclusion.

$$(FI_T)_{it} = \beta_1(FI_T^a)_{it} + \beta_2(FI_T^u)_{it} + d_{it} \quad (5)$$

$$(FI_D)_{it} = \beta_1(FI_D^a)_{it} + \beta_2(FI_D^u)_{it} + d_{it} \quad (6)$$

3.7 Third-stage PCA:

Lastly, composite FI index (CFI_{it}) estimated by using PCA on above indices.

$$CFI_{it} = \beta_1(FI_T)_{it} + \beta_2(FI_D)_{it} + d_{it} \quad (7)$$

Table 7. ***Second and Third-stage PCA: Cumulative variance***

Traditional FI Index		Digital FI Index	
PC_1	0.9410	PC_1	0.9389
PC_2	1.0000	PC_2	1.0000
	Composite FI Index		
	PC_1	0.9692	
	PC_2	1.0000	

Table 8. ***Second and Third-stage PCA: Loadings***

Traditional FI Index		Digital FI Index	
PC_1	0.707	PC_1	0.707
PC_2	0.707	PC_2	0.707
	Composite FI Index		
	PC_1	0.707	
	PC_2	0.707	

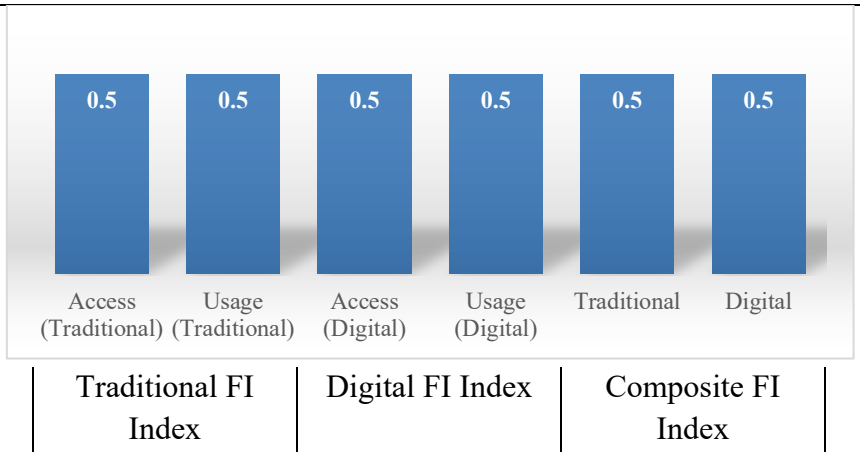


Figure 8. Second- and third-stage principal components analysis: Weights

Table 9. ***Summary Statistics of Financial Inclusion Indices***

No. of years	Category	Mean	Median	Standard Deviation	Min.	Max.
			Traditional FI Index			
15	Access	-0.00	0.144	1.413	-2.17	1.59
15	Usage	-0.00	-0.152	2.054	-2.011	2.623
15	Traditional	-0.00	0.33	2.38	-2.956	2.689
			Digital FI Index			
15	Access	0.00	-0.236	1.384	-2.263	2.28

15	Usage	-0.00	-0.337	1.932	-1.834	2.239
15	Digital	-0.00	-0.406	2.274	-2.897	3.195
			Composite FI Index			
15	Overall	-0.00	-0.0235	3.239	-4.138	3.83

5. Results and Discussion

The financial inclusion landscape in Pakistan has undergone significant shifts from 2008 to 2022. It is clear from the trends in traditional, digital, and composite financial inclusion indices (see Table 10). Table 10 highlights these shifts, illustrating the growing importance of digital financial services. It is alongside the gradual decline in traditional financial inclusion channels. The composite index reflects these changes, capturing overall progress in financial inclusion over the years. The traditional financial inclusion index shows a consistent decline from 2008 to 2014. It writes down diminishing access to or usage of conventional banking services, such as bank branches and ATM networks (Beck et al., 2014; Ozili, 2018). The years following 2015, however, saw a modest recovery. It may reflect efforts by the banking sector. These include addressing infrastructure gaps and expanding physical access points. It is consistent with findings from Sherraden (2013) and Banka (2014). Although the growth is still limited compared to earlier years.

The first decline could be attributed to several factors. It includes high operational costs for banks in supporting physical branches and limited outreach in rural areas. It also covers general shift in consumer behavior toward digital platforms (Onuka et al., 2023). Additionally, economic challenges and regulatory changes during the early 2010s may have contributed to the declining importance of traditional banking channels (Mutuku, 2023). The digital financial inclusion index presents a contrasting trend, rising steadily from 2008 to 2022. This growth highlights the increasing adoption of digital financial services. These are mobile banking, e-wallets, and branchless banking. This trend supports earlier studies by Ouma (2017) and Chinoda & Kwenda (2019), who noted similar patterns in developing economies. A pivotal point can be seen around 2015.

It reflects an accelerated shift toward digital platforms. These results are echoing observations by Anshari (2020) and Leon & Zin (2019) about the transformative impact of digital technologies on financial inclusion. The composite index, which captures the combined effect of both traditional and digital financial inclusion, mirrors the trends seen in digital financial services. The early decline reflects the challenges faced by the banking sector. The later rise writes down that digital inclusion efforts have largely offset the fall in traditional banking services. This finding is in line with global research by Kapadia (2019) and Bravo et al. (2018), emphasizing the critical role of fintech and policy interventions in enhancing financial inclusion. The continued rise in the composite index highlights that Pakistan's financial inclusion agenda is evolving with an increased focus on digital transformation.

Government policies promoting financial inclusion through digital payments, mobile wallets, and branchless banking have played a critical role in boosting the digital financial inclusion index. Initiatives such as Pakistan's National Financial Inclusion Strategy (NFIS) and regulatory frameworks for fintech have created an enabling environment for digital growth. These are similar initiatives seen in other emerging economies (Andriospoulos et al., 2019; Yi et al., 2018). Regulatory frameworks and fintech support have created an enabling environment

for digital growth, consistent with the recommendations of Tram et al. (2023) and Verma & Giri (2024). Although digital inclusion has grown, there is still a need to address infrastructure challenges. It includes improving rural internet access and promoting financial literacy. Additionally, traditional banking services still play a role in serving segments that prefer physical banking access. This aligns with the findings of Chaudhry et al. (2020) and Ozili (2023), who emphasize the importance of infrastructure and education in sustaining financial inclusion. It causes a hybrid approach to financial inclusion.

Table 10. Financial Inclusion Indices

Year	Traditional	Digital	Composite
2008	(2.68)	(2.39)	(3.58)
2009	(2.57)	(2.25)	(3.41)
2010	(2.51)	(2.15)	(3.29)
2011	(2.35)	(2.00)	(3.08)
2012	(2.03)	(1.82)	(2.72)
2013	(1.70)	(1.62)	(2.35)
2014	(1.40)	(1.41)	(1.99)
2015	2.15	0.60	1.94
2016	2.47	0.90	2.38
2017	2.69	1.14	2.71
2018	2.06	2.19	3.00
2019	2.20	2.51	3.33
2020	2.19	2.82	3.54
2021	2.22	3.19	3.82
2022	2.22	3.20	3.83

4.1 Robustness of the CFI:

To confirm the robustness of the Composite Financial Inclusion (CFI) index, a sensitivity analysis was conducted by examining its correlation with key financial inclusion indicators, such as account ownership and savings behavior, using data from the Global Findex Database. The results showed a strong positive correlation between the CFI index and account ownership (Kendall's tau = 0.8047, p-value = 0.0002), as well as with savings behavior (Kendall's tau = 0.7303, p-value = 0.0015). These findings suggest that higher levels of financial inclusion, as measured by the CFI index, are associated with increased access to financial accounts and higher savings rates. This result aligns with Beck et al. (2007), who emphasize the importance of financial access in promoting economic stability and poverty reduction. In addition to traditional indicators, the CFI index also showed significant positive correlations with digital financial inclusion measures, such as mobile payments and digital account ownership. For instance, the correlation between CFI and Acc Digital (Kendall's tau = 0.8891, p-value = 0.0000) further supports the growing body of literature, particularly Ozili (2020) and Chaudhry et al. (2023), which highlights the role of digital financial services in enhancing financial inclusion. The CFI index, which includes both traditional and digital financial services, reflects contemporary trends in the financial sector, where digital platforms are becoming essential components of inclusive financial systems.

When comparing these results with earlier studies, Ahamed and Mallick (2019) and Nguyen (2020) emphasize the effectiveness of composite indices in measuring financial inclusion, like the approach used in this study. Their findings suggest that integrating both supply-side and demand-side indicators into a single index offers a comprehensive measure of financial inclusion, which is consistent with the method applied in the development of the CFI index. Furthermore, Chaudhry et al. (2023) argue for the inclusion of indicators that capture both the availability of financial services, such as bank branches, and the usage of services, such as digital payments. This balanced approach is reflected in the CFI index, ensuring a holistic perspective on financial inclusion. The sensitivity analysis confirms the validity and robustness of the CFI index, proving its reliability in capturing financial inclusion trends in Pakistan. The strong correlations with both traditional and digital financial inclusion indicators, along with its consistency with prior research, highlight the CFI index as a robust tool for measuring financial inclusion. These findings provide valuable insights for policymakers looking to promote inclusive financial systems, particularly in an increasingly digital financial landscape.

6. Conclusion

Financial inclusion has appeared as a cornerstone of sustainable development, empowering marginalized populations, improving livelihoods, and driving economic participation, particularly among small and medium enterprises (SMEs). At the macroeconomic level, enhanced financial inclusion contributes to financial system stability, strengthens monetary policy effectiveness, and fosters overall economic growth (Nasir et al., 2020; Demirgüç-Kunt et al., 2018). Despite its critical role, measuring financial inclusion has still been a persistent challenge. Traditional indices are often criticized for relying on arbitrary weighting methods and excluding crucial components like mobile financial services, thereby presenting an incomplete picture of the financial landscape (Allen et al., 2016; Sarma, 2012). This study addresses these challenges by proposing a multidimensional composite financial inclusion (FI) index, developed using a rigorous three-stage Principal Component Analysis (PCA). Unlike traditional indices, this comprehensive approach integrates key dimensions—penetration, availability, and usage—offering a more granular and exact assessment of financial inclusion (Prastowo & Putriani, 2019). By segmenting financial inclusion into sub-indices, policymakers can show specific drivers and challenges, easing targeted interventions and policy reforms. This aligns with the calls for more nuanced and data-driven metrics in earlier research (Park & Mercado, 2015; Chakravarty & Pal, 2013).

The strength of our proposed index lies in its goal, data-driven weighting system. By focusing on highly correlated indicators within each dimension, it minimizes bias and enhances accuracy, capturing the dynamic transition from traditional banking services to digital financial platforms. This shift, particularly noticeable post-2018, underscores the growing significance of digital financial services, such as mobile banking, e-wallets, and branchless banking. This trend is supported by studies highlighting the role of digital innovation in expanding financial access and reducing inequality (Ozili, 2021; Khera et al., 2023). While the qualitative aspects of financial inclusion remain challenging to measure due to data limitations, this study offers a robust framework for analyzing financial access. It equips policymakers, especially in

developing economies, with valuable insights into craft targeted strategies that address both traditional and digital financial ecosystems (Yorulmaz, 2018). This composite index also serves as a powerful tool for assessing the impact of financial inclusion on macroeconomic indicators, contributing to sustainable economic growth and resilience (Beck et al., 2014; Anarfo et al., 2019). Moreover, our findings underscore the importance of continued investment in digital infrastructure, financial literacy, and regulatory frameworks. Despite the notable progress in digital inclusion, challenges are still, particularly in rural areas where internet connectivity and digital literacy are limited. Addressing these gaps is crucial for ensuring that the benefits of financial inclusion are equitably distributed. A hybrid approach that integrates traditional and digital financial services can help bridge these disparities and foster more inclusive economic development.

Future research can build on this framework by incorporating emerging technologies such as blockchain, artificial intelligence, and big data analytics to refine financial inclusion measurements further. Additionally, exploring the impact of fintech innovations on different segments of the population will offer deeper insights into the evolving financial landscape. As global financial systems continue to transform, a more sophisticated understanding of financial inclusion will be essential for developing policies that address the diverse needs of modern economies and support long-term, inclusive growth (Mhlanga, 2020; Leon & Zin, 2019). In conclusion, this study offers a comprehensive and innovative approach to measuring financial inclusion, addressing critical gaps in existing methodologies. By providing a multidimensional perspective, it lays the groundwork for more informed policymaking and strategic interventions. Ensuring inclusive financial growth requires ongoing efforts to adapt to technological advancements and address systemic barriers, ultimately contributing to a more equitable and resilient global economy.

5.1 Limitations

This study has limitations that should be acknowledged. Firstly, it relies on available data from 2008 to 2022, which may not capture all dimensions of financial inclusion, particularly qualitative factors such as user satisfaction and service quality. Additionally, limited data from rural and informal sectors could affect the comprehensiveness of the findings. While the focus on digital financial inclusion is robust, the study does not fully explore the implications of emerging technologies like blockchain and artificial intelligence, which are increasingly shaping financial ecosystems. Furthermore, the Principal Component Analysis (PCA) approach assumes static relationships between variables; however, the dynamic nature of financial inclusion, driven by technological and policy changes, might alter these relationships over time. Lastly, the geographical scope of this research is confined to Pakistan, which may limit the generalizability of the findings to other developing economies with different socio-economic and financial contexts.

5.2 Academic Implications

This study contributes significantly to the academic discourse on financial inclusion by proposing a multidimensional composite index, addressing gaps in existing methodologies, particularly the exclusion of digital services. This framework provides a foundation for future research to refine financial inclusion measurements using advanced statistical techniques. Moreover, applying this framework to other countries could enable comparative analyses,

showing the best global practices and context-specific challenges. Academics are also encouraged to explore the impact of emerging technologies, such as AI and blockchain, on financial inclusion to enrich the understanding of future trends. Additionally, there is a need for future research to incorporate qualitative dimensions, including customer experience, financial literacy, and socio-cultural factors, to offer a more holistic perspective on financial inclusion.

5.3 Policy Implications

The findings offer valuable insights for policymakers aiming to enhance financial inclusion. The multidimensional approach presented in this study allows for the identification of specific areas of weakness—such as access, availability, or usage—enabling the design of targeted interventions. Enhancing digital infrastructure, particularly in rural areas, is crucial for sustaining the observed growth in digital financial inclusion. Investments in internet connectivity, mobile networks, and digital literacy programs are essential to bridge rural-urban disparities. Additionally, regulatory support for fintech innovation is critical. Policymakers should foster an enabling environment that encourages innovation while ensuring robust consumer protection. Public-private partnerships (PPPs) should be promoted to develop tailored financial products for underserved populations, using the strengths of both sectors. Implementing a standardized financial inclusion index, like the one proposed, would provide a reliable tool for checking progress, allowing for regular assessments to track intervention effectiveness. Lastly, promoting financial literacy stays a cornerstone of financial inclusion. Educational programs targeting marginalized groups can ensure broader participation in the financial system, contributing to more inclusive and sustainable economic growth.

References

Aduda, J., & Kalunda, E. (2012). Financial inclusion and financial sector stability with reference to Kenya: A review of literature. *Journal of Applied Finance and Banking, 2*(6), 95.

Ahamed, M. M., & Malick, S. K. (2019). Is financial inclusion good for bank stability? International evidence. *Journal of Economic Behavior and Organization, 157,* 403–427. https://doi.org/10.1016/j.jebo.2018.10.011

Avom, D., Bangaké, C., & Ndoya, H. (2021). Measuring financial inclusion in African countries. *Economics Bulletin, 41,* 848–866.

Banka, H. (2014). M-PESA at the point of sale: Expanding financial inclusion and reducing demand for physical cash. *Journal of Payments Strategy & Systems, 7*(4), 359–369.

Beck, T., Demirgüç-Kunt, A., & Levine, R. (2007). Finance, inequality, and the poor. *Journal of Economic Growth, 12*(1), 27–49. https://doi.org/10.1007/s10887-007-9010-6

Camara, N., & Tuesta, D. (2018). Measuring financial inclusion: A multidimensional index. *IFC Bulletins Chapters, 47,* 1–23.

Chaudhry, S. M., Ahmed, R., Shafiullah, M., & Huynh, T. L. D. (2020). The impact of carbon emissions on country risk: Evidence from the G7 economies. *Journal of Environmental Management, 265,* Article 110533. https://doi.org/10.1016/j.jenvman.2020.110533

Chaudhry, S. M., Chen, X. H., Ahmed, R., & Nasir, M. A. (2023). Risk modelling of ESG (Environmental, Social, and Governance), healthcare, and financial sectors. *Risk Analysis.* https://doi.org/10.1111/risa.14195

Chauvet, L., & Jacolin, L. (2017). Financial inclusion, bank concentration, and firm performance. *World Development, 97,* 1–13. https://doi.org/10.1016/j.worlddev.2017.03.018

Chinoda, T., & Kwenda, F. (2019). Do mobile phones, economic growth, bank competition, and stability matter for financial inclusion in Africa? *Cogent Economics & Finance.* https://doi.org/10.1080/23322039.2019.1600880

Demirgüç-Kunt, A., Klapper, L., & Singer, D. (2013). Financial inclusion and legal discrimination against women: Evidence from developing countries. *Policy Research Working Paper,* 6416. The World Bank Group.

Demirgüç-Kunt, A., Klapper, L., Singer, D., & Van Oudheusden, P. (2015). *The Global Findex Database 2014: Measuring financial inclusion around the world* (No. 7255). The World Bank.

Helmy, A. (2024). The mutual interdependence between financial inclusion and human development and their effects on economic development: Comparative study between Egypt and The BRICS countries. *Arab Journal of Administration, 44*(2), 227–244. https://doi.org/10.21608/aja.2021.65317.1057

Huang, Y., & Zhang, Y. (2020). Financial inclusion and urban–rural income inequality: Long-run and short-run relationships. *Emerging Markets Finance and Trade, 56*(2), 457–471. https://doi.org/10.1080/1540496X.2019.1623876

Huang, W., Gu, X., Lin, L., Alharthi, M., & Usman, M. (2023). Do financial inclusion and income inequality matter for human capital? Evidence from sub-Saharan economies. *Borsa Istanbul Review, 23*(1), 22–33. https://doi.org/10.1016/j.bir.2022.06.006

Jejeniwa, T. O., Mhlongo, N. Z., & Jejeniwa, T. O. (2024). AI solutions for developmental economics: Opportunities and challenges in financial inclusion and poverty alleviation. *International Journal of Advanced Economics, 6*(4), 108–123.

Jungo, J., Madaleno, M., & Botelho, A. (2022). The effect of financial inclusion and competitiveness on financial stability: Why financial regulation matters in developing countries? *Journal of Risk and Financial Management, 15,* 122. https://doi.org/10.3390/jrfm15030122

Kabakova, O., & Plaksenkov, E. (2018). Analysis of factors affecting financial inclusion: Ecosystem view. *Journal of Business Research, 89,* 198–205. https://doi.org/10.1016/j.jbusres.2018.01.066

Kaur, P., & Abrol, V. (2018). Measuring financial inclusion in Jammu & Kashmir state: An empirical study. *Journal of Business & Management, 20*(1), 37–44.

Khera, P., et al. (2021). Measuring digital financial inclusion in emerging market and developing economies: A new index. *IMF Working Paper, WP/21/90.* https://doi.org/10.5089/9781513584445.001

Kousar, S., Bhutta, A. I., Ullah, M. R., & Shabbir, A. (2023). Impact of economic and green growth on poverty, income inequalities, and environmental degradation: A case of South Asian economies. *Environmental Science and Pollution Research, 30*(12), 35200–35213. https://doi.org/10.1007/s11356-022-21288-5

Liu, L., & Guo, L. (2023). Digital financial inclusion, income inequality, and vulnerability to relative poverty. *Social Indicators Research, 170*(3), 1155–1181. https://doi.org/10.1007/s11205-023-03093-z

Mialou, A., Amidzic, G., & Massara, A. (2017). Assessing countries' financial inclusion standing—a new composite index. *Journal of Banking and Financial Economics, 2*(8), 105–126. https://doi.org/10.7172/2353-6845.jbfe.2017.2.6

Miranda-Lescano, R., Muinelo-Gallo, L., & Roca-Sagalés, O. (2023). Human development and decentralization: The importance of public health expenditure. *Annals of Public and Cooperative Economics.* https://doi.org/10.1111/apce.12373

Nguyen, T. T. H. (2020). Measuring financial inclusion: A composite FI index for developing countries. *Journal of Economics and Development, 23,* 77–99. https://doi.org/10.1108/JOED-02-2020-0016

Oanh, T. T. K. (2023). Relationship between financial inclusion, monetary policy, and financial stability: An analysis in high financial development and low financial development countries. *Heliyon, 9*(6), e16647. https://doi.org/10.1016/j.heliyon.2023.e16647

Ozili, P. K. (2018). Impact of digital finance on financial inclusion and stability. *Borsa Istanbul Review, 18*(4), 329–340. https://doi.org/10.1016/j.bir.2017.11.003

Ozili, P. K. (2020). Contesting digital finance for the poor. *Digital Policy, Regulation and Governance, 22,* 135–151. https://doi.org/10.1108/DPRG-01-2020-0045

Park, C. Y., & Mercado, R. (2018). Financial inclusion, poverty, and income inequality. *The Singapore Economic Review, 63*(1), 185–206. https://doi.org/10.1142/S0217590818500141

Prastowo, P., & Putriani, D. (2019). Income inequality and regional index of financial inclusion for Islamic banks in Indonesia. *Al-Iqtishad: Jurnal Ilmu Ekonomi Syariah, 11*(1), 135–152.

Sarma, M. (2012). Index of financial inclusion—a measure of financial sector inclusiveness (No. 1207). Berlin (GE): Berlin Working Papers on Money, Finance, Trade, and Development.

Sarma, M. (2015). Measuring financial inclusion. *Economics Bulletin, 35*(1), 604–611.

Sarma, M. (2016). Measuring financial inclusion for Asian economies. In *Financial inclusion in Asia* (pp. 3–34). London: Palgrave Macmillan.

Sethi, D., & Sethy, S. K. (2019). Financial inclusion matters for economic growth in India: Some evidence from cointegration analysis. *International Journal of Social Economics, 46*(1), 132–151. https://doi.org/10.1108/IJSE-05-2017-0197

Sharma, D. (2016). Nexus between financial inclusion and economic growth: Evidence from the emerging Indian economy. *Journal of Financial Economic Policy.* https://doi.org/10.1108/JFEP-07-2015-0043

Tram, T. X. H., Lai, T. D., & Nguyen, T. T. H. (2023). Constructing a composite financial inclusion index for developing economies. *The Quarterly Review of Economics and Finance, 87,* 257–265. https://doi.org/10.1016/j.qref.2021.01.003

Van, L. T. H., Vo, A. T., Nguyen, N. T., & Vo, D. H. (2021). Financial inclusion and economic growth: International evidence. *Emerging Markets Finance and Trade, 57,* 239–263. https://doi.org/10.1080/1540496X.2021.1862722

Verma, A., & Giri, A. K. (2024). Does financial inclusion reduce income inequality? Empirical evidence from Asian economies. *International Journal of Emerging Markets, 19*(9), 2428–2445. https://doi.org/10.1108/IJEM-12-2022-0756

Wang, X., & Guan, J. (2017). Financial inclusion: Measurement, spatial effects, and influencing factors. *Applied Economics, 49*(18), 1751–1762. https://doi.org/10.1080/00036846.2017. 1296144

Yorulmaz, R. (2018). An analysis of constructing global financial inclusion indices. *Borsa Istanbul Review, 18*(3), 248–258. https://doi.org/10.1016/j.bir.2018.06.001

Zulfiqar, M., Tahir, S. H., Ullah, M. R., & Ghafoor, S. (2023). Digitalized world and carbon footprints: Does digitalization really matter for sustainable environment? *Environmental Science and Pollution Research International*, 88789–88802. https://doi.org/10.1007/s11356-023-28332-z