Financial Inclusion In Sub-Saharan Africa : A Multidimensional Index

By

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ABSTRACT

Financial inclusion has emerged as a crucial enabler for sustainable development, with significant implications for poverty reduction, economic growth, and gender equality. Despite the growing recognition of its importance, measuring financial inclusion remains a complex challenge, particularly in the context of Sub-Saharan Africa, where countries face unique challenges and opportunities. This thesis aims to contribute to the literature by developing a comprehensive, multidimensional financial inclusion index specifically tailored to the Sub-Saharan African context.

Building upon previous methodologies, the index incorporates an expanded set of both demand-side and supply-side indicators across key dimensions of financial inclusion.

The insights generated by this research have important policy implications, providing a valuable tool for policymakers to diagnose bottlenecks, prioritize reforms, and track progress over time. By contributing to the evidence base on financial inclusion measurement and its implications, this thesis aims to support the development of more efficient, equitable, and inclusive financial systems across Sub-Saharan Africa.

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I. Introduction

Sub-Saharan Africa has experienced significant economic growth in recent decades, with real GDP per capita increasing by an impressive 169% between 2000 and 2022. However, despite this overall positive trend, the growth has been far from uniform across the region, with many countries and segments of the population still grappling with persistent poverty, deep-rooted inequality, and limited access to essential services (The World Bank Group, 2024). A critical factor perpetuating this exclusion and constraining the ability of individuals and enterprises to fully participate in the economy is the lack of access to financial services (FINCA, 2020).

Financial inclusion has become a subject of considerable interest among policymakers, researchers, and other stakeholders (Demirgüç-Kunt & Klapper, 2013). At the macro level, financial inclusion can enhance the efficiency of resource allocation, stimulate productive investments, and improve the transmission of monetary policy (Sharma, 2016).

For individuals and households, it enables smooth consumption, risk management, and investment in human and physical capital, empowering the underserved to escape poverty traps and build resilience against shocks. For businesses, especially SMEs, access to finance is crucial for innovation, growth, and employment generation (Demirgüç-Kunt & Klapper, 2013).

Despite growing recognition of its importance, the measurement of financial inclusion remains a complex challenge. Early studies primarily relied on constructing indices using supply-side, country-level data on financial infrastructure, such as the number of bank branches or ATMs per capita (Sarma, 2008) (Chakravarty & Pal, 2010). While providing a useful starting point, such indicators offer a limited, one-dimensional view that fails to capture the actual usage or distribution of services by different segments of the population and across geographic areas. They may also overestimate the true extent of inclusion due to issues like dormant accounts or multiple accounts held by the same individual (Cámara &

Tuesta, 2014). More recent works have incorporated demand-side indicators, barriers faced by the unbanked, and distributional aspects across population segments to understand the real utilization of financial products (Cámara & Tuesta, 2014)(Park & Mercado, 2015). However, most of these studies have focused on a global or regional perspective, with only a few African countries included in their analyses.

This thesis aims to contribute to the growing body of research on measuring financial inclusion by developing an enhanced multidimensional index specifically tailored to the unique context of Sub-Saharan Africa. Building upon previous methodologies the index will incorporate an expanded set of both demand and supply-side indicators across the key dimensions of availability, access, usage, and barriers. Notably, it will also capture the role of innovative technologies like mobile money, which has seen rapid adoption in many African countries (Demirgüç-Kunt & Klapper, 2013). It will cover a larger sample of Sub-Saharan African countries and multiple years to enable tracking of progress over time.

By providing a rigorous, data-driven measure of financial inclusion that is specific to the Sub-Saharan African context, this research aims to equip policymakers, regulators, and financial service providers with actionable insights to diagnose bottlenecks, design targeted interventions, set measurable goals, and monitor progress over time. The index can help identify which dimensions of financial inclusion are lagging in each country, informing the prioritization of policy reforms and investments. Ultimately, by contributing to the evidence base on financial inclusion measurement and its implications, this research hopes to support the development of more efficient, equitable, and inclusive financial systems across Sub-Saharan Africa. The goal is to enable all individuals and businesses, regardless of their income level, gender, or location, to access and use the financial tools they need to save, invest, manage risks, and achieve their aspirations. In doing so, greater financial inclusion can serve as a key driver for reducing poverty, fostering shared prosperity, and unlocking the immense untapped potential of the African continent.

II. Defining Financial Inclusion

Financial inclusion has emerged as a crucial topic on the global agenda for sustainable long-term economic growth. It can be generally understood as an "economic state where individuals and firms are not denied access to financial services based on motivations other than efficiency criteria" (Amidžić, Massara, & Mialou, 2014). In that sense, the World Bank's 2014 Global Financial Development Report provides a framework for understanding financial inclusion by outlining two categories of financial exclusion: voluntary (self-imposed) and involuntary (enforced) exclusion (The World Bank Group, 2014).

Voluntary financial exclusion pertains to groups or businesses that abstain from financial services, possibly due to an absence of viable projects, or cultural and religious based justifications. Since this form of exclusion typically does not stem from a market failure, there is limited scope for interventions although improvements can be made by increasing financial literacy or encouraging specialized financial institutions that respond to the cultural and religious requirement (The World Bank Group, 2014). Involuntary exclusion, on the other hand, can be further divided into two subsets. The first includes individuals or firms excluded due to insufficient income or excessive lending risk profiles, which do not necessarily indicate market failures (Amidžić, Massara, & Mialou, 2014). The second subset includes individuals and firms who are excluded from financial services due to government failures or market imperfections such as discrimination, lack of information, or inadequate regulatory frameworks (Amidžić, Massara, & Mialou, 2014). Hence, to foster an inclusive financial system, the main objective should be to minimize the population and firms falling in the latter subset of involuntary exclusion. Consequently, a theoretical definition of financial inclusion should inherently be linked to the reduction of financial exclusion that results from inefficiencies in markets or governmental oversight (Amidžić, Massara, & Mialou, 2014).

III. Prior Literature

Various methodologies have been proposed to quantify and compare the level of financial inclusion across countries. This section reviews the prior literature, focusing on the different methodologies employed and the dimensions considered.

One of the earliest attempts to measure financial inclusion was made by Beck, Demirguc-Kunt, and Martinez Peria, who introduced a multidimensional approach to designing new banking outreach indicators. They considered two dimensions: access and usage of financial services. This study highlighted the importance of considering both the physical availability of financial infrastructure and the actual uptake of financial services in assessing financial inclusion (Beck, Demirguc-Kunt, & Martinez Peria, 2007).

Building upon this work, (Sarma, 2008) proposed an index using a similar approach to the UNDP's Human Development Index. It was constructed using three dimensions: penetration (number of bank accounts per 1,000 adults), availability (number of bank branches and ATMs per 1,000 sq. km), and usage (volume of credit and deposits as a proportion of GDP). Each dimension was normalized and assigned equal weights to compute the final index score. This methodology has been widely used and adapted in subsequent studies (Chakravarty & Pal, 2010).

The launch of the Global Findex database in 2011 marked a particularly significant milestone, providing the first publicly available, individual-level, globally comparable data on financial behaviors (Demirgüç-Kunt & Klapper, 2013). It enabled researchers to construct more sophisticated and comprehensive indices by incorporating a wider range of supply-side and demand-side indicators that allows for the analysis of distributional aspects of financial inclusion. Leveraging this new data source, Camara and Tuesta (2014) proposed a novel index using a two-stage Principal Component Analysis (PCA) methodology for 82 countries on 2011 data. Their index captured usage and access dimensions while accounting for self-reported barriers causing involuntary exclusion like cost, distance, lack of necessary documentation,

and lack of trust in financial services. Other researchers have since applied and extended this methodology to different contexts. For example, Park and Mercado (2015) constructed an index for 37 developing Asian economies, considering dimensions such as outreach (geographic and demographic penetration), usage (deposit and lending penetration), and quality (disclosure requirements, dispute resolution, and cost of usage). Amidžić et al. (2014) used factor analysis to develop a financial inclusion indicator for 143 countries, incorporating variables related to outreach (ATMs, bank branches), usage (deposits, loans), and quality (net interest margin, lending-deposits spread).

Methodologically, the literature can be broadly categorized into non-parametric and parametric approaches to constructing financial inclusion indices. Non-parametric methods assign weights to different dimensions and indicators based on the researcher's judgment or expert opinion (Sarma, 2008). A major drawback of this approach is the sensitivity of the resulting index to the subjective choice of weights, which can significantly alter the rankings and comparisons across countries (Cámara & Tuesta, 2014). In contrast, parametric methods seek to derive the weights endogenously from the statistical properties of the data, using techniques like principal component analysis (PCA) or factor analysis. These approaches assume an underlying latent structure that explains the covariation among a set of correlated indicators. By letting the data determine the relative importance of each dimension, parametric methods aim to provide a more objective and data-driven assessment of financial inclusion (Park & Mercado, 2015) (Nguyen, 2020).

While some studies have considered African countries as part of broader cross-country analyses (Sarma, 2008), few have developed indices tailored specifically to the regional context of Sub-Saharan Africa. Avom, Bangake and Ndoya make a notable contribution in this regard, constructing a multidimensional index for 37 African countries using data from 2011 to 2017. Their index incorporates a range of indicators across the dimensions of penetration, availability, usage, and barriers to inclusion, with a particular focus on mobile money services alongside traditional banking. Their findings reaffirm large intra-regional variations in inclusion levels and underscore the transformative role of mobile money in advancing access and usage in the region (Avom, Bangake, & Ndoya, 2021). **Table 1** classifies

previous work on the development of a financial inclusion index based on the measurement methodologies employed.

Table 1. Classification of previous literature

Methodology	Authors	Dimensions	Measures
Factor Analysis	Amidžić et al. (2014)	Outreach	◊ ATMs per 1,000 km2 ◊ Branches of other depository corporations per 1,000 km2
		Usage	◊ Residents household depositors with ODCs per 1,000 adults ◊ Residents household borrowers with ODCs per 1,000 adults
Two-Stage PCA	Avom et al. (2021)	Penetration	◊ ATMs per 100,000 people ◊ Commercial banks per 100,000 people ◊ Commercial banks and ATMs per 1000 km2
		Availability	◊ Proportion of adults with an account in a formal institution ◊ Ownership of a bank card ◊ Proportion of adults with a mobile account
		Usage	◊ Saving in a formal institution ◊ Withdrawals and loans from a formal financial institution ◊ Use of digital payments ◊ Life and non-life insurance policies
		Barriers	◊ Distance ◊ Cost ◊ Documentation ◊ Trust ◊ Lack of funding
Multidimensional approach of designing new banking outreach indicators through two dimensions of access and use of financial services	Beck et al. (2007)	Banking Sector outreach	◊ Bank branches per 1,000 km2 ◊ Bank branches per 100,000 people ◊ ATMs per 1,000 km2 ◊ ATMs per 100,000 people
		Access	◊ Loans per 1,000 people ◊ Average size of loans to GDP per capita (loan-income ratio) ◊ Deposits per 1,000 people ◊ Average size of deposits to GDP per capita (deposit–income ratio)
		Usage	◊ Share of households with bank accounts ◊ Predicted share of households with bank accounts ◊ Small firm share with bank loans ◊ Predicted Small firm share
Two-Stage PCA	Camara & Tuesta (2014)	Access	◊ Account ◊ Loan ◊ Savings

Methodology	Authors	Dimensions	Measures
		Usage	◊ ATMs and commercial bank branches per 100,000 adults ◊ ATMs and commercial bank branches per 1000 km2
		Barriers	◊ Distance ◊ High Cost ◊ Documentation ◊ Lack of Trust
Two-Stage PCA	Nguyen (2020)	Access	◊ Deposit accounts per 1,000 adults ◊ Mobile money accounts
		Availability	◊ Branches per 100,000 adults ◊ ATMs per 100,000 adults ◊ Mobile money agent outlets per 100,000 adults
		Usage	◊ Outstanding deposits (% GDP) ◊ Outstanding loans (% GDP) ◊ Mobile money transactions value (% GDP)
Similar to UNDP's Human Development Index	Park & Mercado (2015)	Availability	◊ ATM per 100,000 adults ◊ Commercial banks branches per 100,000 adults
		Usage	◊ Borrowers from commercial banks per 1,000 adults ◊ Depositors with commercial banks per 1,000 adults ◊ Domestic credit to GDP ratio
Similar to UNDP's Human Development Index	Sarma (2008)	Penetration	◊ Bank accounts per 1,000 adults
		Availability	◊ Bank branches per 1,000 km2. ◊ ATMs per 1,000 km2
		Usage	◊ Outstanding deposits as a % of GDP ◊ Outstanding loans as a % of GDP

IV. Dimensions and Variables Selection

The selection of variables and dimensions is a critical step in the construction of the index. The variables included should capture the key aspects of financial inclusion, be relevant to the specific context of Sub-Saharan Africa and have sufficient data availability and quality across countries and time periods. In this study, the variables used to construct the index are organized into four key dimensions: availability, access, usage, and barriers, as we approach financial inclusion as the optimal combination of its dimensions, subject to data availability. These dimensions are based on a thorough review of the literature on financial inclusion measurement and a careful consideration of the specific features and challenges of the Sub-Saharan African financial landscape.

The availability dimension captures the physical presence and geographical reach of financial service providers. This dimension is crucial for assessing the supply-side aspects of financial inclusion, as the absence of financial infrastructure can severely limit the ability of individuals and businesses to access formal financial services. The indicators included in this dimension provide a comprehensive picture of the density and distribution of financial access points across countries, considering both the demographic and geographic dimensions of availability.

The access dimension focuses on the actual uptake of basic financial products by individuals and businesses. While the availability of financial infrastructure is a necessary condition for financial inclusion, it is not sufficient if people do not have access to their products and services. The variables included in this dimension capture the penetration of different types of financial accounts and payment instruments.

The usage dimension assesses the depth and intensity of engagement with the financial system. While access to financial products is an important step towards financial inclusion, the goal is to ensure that people actively use these products and services to meet their financial needs and improve their economic well-being. The variables included in this

dimension capture the volume and frequency of financial transactions, as well as the extent to which individuals and businesses rely on financial services for their savings, borrowing, and payment needs.

The barriers dimension incorporates demand-side indicators on the reasons for financial exclusion, as reported by individuals in the Global Findex surveys. Despite the increasing availability and accessibility of formal financial services in many Sub-Saharan African countries, significant barriers to financial inclusion persist, particularly among vulnerable and underserved populations. These barriers can be related to factors such as the cost and affordability of financial services, the lack of necessary documentation or collateral, the distance to financial access points, or the lack of trust in formal financial institutions.

The four dimensions of availability, access, usage, and barriers provide a conceptually sound and empirically grounded framework for organizing key indicators, capturing both the supply-side and demand-side aspects. **Table 2** shows the variables included in the study.

Table 2. Study Variables Definitions

Dimension	Acronym	Definitions
Availability	ATMs_adults	Number of ATMs per 100,000 adults
	ATMs_km2	Number of ATMs per 1,000 km2
	bankbr_adults	Number of commercial bank branches per 100,000 adults
	bankbr_km2	Number of commercial bank branches per 1,000 km2
	reg_mb_adults	Number of registered mobile money agent outlets per 100,000 adults
	reg_mb_km2	Number of registered mobile money agent outlets per 1,000 km2
Access	own_credit_cards	Owns a credit card (% age 15+)
	own_debit_cards	Owns a debit card (% age 15+)
	accts	Owns a financial institution account (% age 15+)
	mb_accts	Number of registered mobile money accounts per 100,000 adults

Dimension	Acronym	Definitions
Usage	ost_loans	Outstanding loans from commercial banks (% of GDP)
	ost_deposits	Outstanding deposits with commercial banks (% of GDP)
	depositors	Number of depositors with commercial banks per 1,000 adults
	borrowers	Borrowed from a formal financial institution (% age 15+)
	mb_transac	Number of mobile money transactions per 1,000 adults
Barriers	distance	No account because financial institutions are too far away (% age 15+)
	cost	No account because financial services are too expensive (% age 15+)
	documentation	No account because of a lack of necessary documentation (% age 15+)
	distrust	No account because of lack of trust in financial institutions (% age 15+)

V. Methodology

1. Data sources

This study relies on a comprehensive set of data sources to construct the index. The primary data sources include:

The World Bank's Global Findex database: This database provides individual-level data on financial behaviors, attitudes, and usage patterns based on nationally representative surveys conducted in over 140 countries. It captures information on account ownership, savings, credit, payments, and other key dimensions of financial inclusion.

The International Monetary Fund's Financial Access Survey (FAS): This survey offers a rich set of supply-side indicators on access to and use of financial services, covering a wide range of financial institutions including banks, microfinance institutions, and mobile money providers.

2. Data Imputation Strategies and Limitations

Constructing a comprehensive index inevitably involves dealing with missing or incomplete data. Data availability and quality pose significant challenges in the region, as many countries lack the necessary infrastructure and resources to collect and maintain comprehensive financial statistics. Moreover, the rapid evolution of the financial landscape, particularly with the emergence of digital financial services, can lead to gaps and inconsistencies in the data. To address these issues and ensure the robustness and comparability of the financial inclusion index, a systematic approach to data cleaning was employed in this study.

The first step in the data cleaning process was to identify countries with missing data for an entire dimension (usage, access, availability, barriers) and exclude them from the analysis. This decision was made to avoid the introduction of significant biases or distortions that could arise from imputing entire dimensions based on limited or unreliable information.

While this approach may result in a smaller sample of countries, it ensures that the index is constructed using a consistent and complete set of indicators across all dimensions, enhancing its integrity and comparability.

For countries with partial missing data, two complementary strategies were used to impute the missing values. The first strategy involved leveraging historic data, when available, to estimate the values for the relevant year using regression techniques. This approach is based on the assumption that financial inclusion indicators exhibit some degree of temporal stability and that historical patterns can provide useful information for predicting missing values. By regressing the available data points, it is possible to generate plausible estimates for the missing observations. This strategy has the advantage of utilizing country-specific information and accounting for temporal trends in the data.

In cases where historical data were not available or insufficient for reliable regression estimates, an alternative approach was employed using the Perplexity API. Perplexity is an artificial intelligence tool that can extract and synthesize information from a wide range of online sources, including news articles, reports, and databases. By querying Perplexity with specific keywords and criteria related to the missing financial inclusion indicators, it is possible to obtain estimates from reputable sources that can be used to fill the data gaps. This approach leverages the vast amount of information available online and the power of natural language processing to generate plausible values for the missing data points.

While these imputation strategies have some limitations and potential drawbacks, they were deemed preferable to the alternative of excluding all countries with any missing data. Imputation techniques, when applied judiciously and transparently, can help to maximize the coverage and representativeness of the financial inclusion index while minimizing the impact of data gaps on the overall results. This study aims to strike a balance between data completeness and accuracy, enabling the construction of an index that covers as many Sub-Saharan African countries as possible.

It is important to acknowledge the limitations and potential risks associated with these imputation approaches. Regression estimates based on historical data may not fully capture recent changes or disruptions in the financial landscape, such as the impact of economic shocks. Moreover, the accuracy of these estimates depends on the quality and consistency of the available data points, which may vary across countries and indicators. Similarly, the use of an AI tool like Perplexity introduces some uncertainty regarding the provenance and reliability of the imputed values. While Perplexity is designed to extract information from reputable sources, there is always a risk of incorporating inaccurate or outdated data, particularly in the context of rapidly evolving financial systems.

3. Normalization of Variables

In the development of a robust financial inclusion index, normalizing the dataset is a fundamental preprocessing step that ensures all variables – regardless of their original unit or scale – can be compared on an equal footing. This standardization negates any disproportionate influence that the scale of the original data might exert on the analysis, allowing for a more accurate comparison across countries and indicators.

For this study, we employ Z-score normalization, an established statistical method that rescales data points in terms of their relation to the mean and standard deviation of their corresponding indicators. The formula for Z-score normalization is given by:

$$x\_scaled_{i,j} = \frac{x_{i,j} - \mu_j}{\sigma_j}$$

where i indexes countries, j indexes indicators such that $x_{i,j}$ denotes the original value of indicator j for country i. μ_j and σj respectively represent the mean and the standard deviation of indicator j across all countries.

Through Z-score normalization, each indicator is centered around its mean, with the standard deviation providing a measure of dispersion. This allows for the transformation of the raw data into a standardized scale where the values express the distance of a country's performance in terms of standard deviations from the average. This scaling is particularly

advantageous for its straightforward interpretability: the normalized values signal each country's position and performance relative to the normative pattern of the dataset, providing clear insights into areas where a country excels or lags.

This Z-score normalization technique diverges from the min-max scaling approach adopted in earlier works by researchers such as Camara and Tuesta (2014) and Nguyen (2020). The rationale for selecting a Z-score normalization lies in its strong resistance to the influence of outliers, which can skew results and distort the understanding of financial inclusion landscape. Furthermore, Z-score normalization preserves the original distribution of the indicators, allowing for the detection of anomalies and the maintenance of statistical properties, which is often not the case with min-max normalization. In contrast to min-max scaling, which constrains values within a fixed [0, 1] interval – indicating absolute financial exclusion and inclusion at the boundaries – the standard deviation-based normalization adopted here allows for a dynamic range. This approach eschews artificial ceilings and floors, instead opting for a responsive scaling method that adjusts to variability within the data. This is especially beneficial when comparing countries on indicators that inherently possess different measurement units or scales.

4. Approach

This study employs a two-stage Principal Component Analysis (PCA) approach to develop a comprehensive, multidimensional index of financial inclusion. PCA allows for the endogenous determination of weights for various dimensions and indicators based on their contribution to the overall variance in the data. This data-driven approach addresses the common criticism of arbitrary weight assignment in composite indices and provides a statistically robust method for aggregating multiple variables into a single measure (Amidžić, Massara, & Mialou, 2014) (Cámara & Tuesta, 2014).

The first stage PCA concentrates on the individual dimensions of financial inclusion: availability, access, usage, and barriers. For each dimension, a set of principal components is created to capture the most relevant information contained in the underlying indicators.

This stage enables a thorough examination of the factors influencing financial inclusion within each dimension, identifying the most important drivers and their relative contributions to the overall variance.

By performing separate PCAs for each dimension, the unique characteristics of each aspect of financial inclusion are captured, and the resulting sub-indices provide meaningful representations of the specific dimensions they measure. This approach allows for a more nuanced understanding of the complex nature of financial inclusion.

The second stage involves applying a PCA to the sub-indices created in the first stage, synthesizing the information contained in the separate dimensions into a single, comprehensive measure. Using the first principal components (PC1) of the first stage as inputs for the second stage ensures that the most relevant information from each dimension is incorporated into the final index while reducing the dimensionality of the data and mitigating potential issues of multicollinearity among variables.

The two-stage PCA approach offers several advantages over alternative methods for constructing composite indices. First, by conducting separate PCAs for each dimension, the most important factors influencing financial inclusion within each domain can be identified, providing valuable insights for policymakers and researchers. Second, the use of PCA ensures that the weights assigned to each dimension and indicator are determined objectively, based on their statistical properties and their contribution to the overall variance in the data.

Moreover, the two-stage PCA methodology results in a composite index that is a robust, multidimensional reflection of financial inclusion, suitable for application across various country contexts. The index provides a comprehensive measure of financial inclusion that captures the complex interplay between the different dimensions and indicators while being easily interpretable and comparable across countries and over time. This makes the index a valuable tool for policymakers, researchers, and other stakeholders seeking to assess the state of financial inclusion in different countries, identify areas for improvement, and track progress over time.

5. Equations and Tests

Financial inclusion (FI) is conceptualized as a latent variable linearly defined by:

$$FII_i = w_1 * Y^{year}_{availability,i} + w_2 * Y^{year}_{access,i} + w_3 * Y^{year}_{usage,i} + w_4 * Y^{year}_{barriers,i} + \in_i$$

FII_i represents the composite Financial Inclusion Index (FII) for country i; w_1, w_2, w_3 and w_4 denote the relative weights assigned to each dimension of financial inclusion; year is the year for the analysis; and ϵ_i is the error term.

To capture the evolution of financial inclusion over time and the impact of mobile money and barriers criteria, four specific tests are conducted:

Test 1 (2011 baseline)

This test provides a snapshot of financial inclusion in Sub-Saharan Africa in 2011, using indicators for the availability, access, and usage dimensions. Test 1 yields a baseline financial inclusion index for each country in the sample, allowing for a comparative assessment of the state of financial inclusion in the region at the beginning of the decade.

The dimensions are defined as follows:

$$Y^{2011}_{availability,i} = \alpha_1 * ATMs\_adult_i + \alpha_2 * ATMs\_km2_i + \alpha_3 * bankbr\_adults_i + \alpha_4 * bankbr\_km2_i + \varepsilon_i$$

$$Y^{2011}_{access,i} = \beta_1 * own\_credit\_cards_i + \beta_2 * own\_debit\_cards_i + \beta_3 * accts\_ + \varepsilon_i$$

$$Y^{2011}_{usage,i} = \theta_1 * ost\_loans_i + \theta_2 * ost\_deposits_i + \theta_3 * borrowers_i + \theta_4 * depositors_i + \varepsilon_i$$

Test 2 (2021 update)

This test updates the analysis to the year 2021, using the same set of indicators and dimensions as Test 1, but with more recent data. The purpose of this test is to assess the progress and evolution of financial inclusion in Sub-Saharan Africa over the past decade, by comparing the results of the 2021 index with those of the 2011 baseline. By applying the same

methodology and variables as in Test 1, Test 2 ensures a consistent and comparable measurement of financial inclusion across time, allowing for an evaluation of the effectiveness of policies and interventions implemented during the period.

The dimensions are defined as follows:

$$Y^{2021}_{availability,i} = \alpha_1 * ATMs\_adult_i + \alpha_2 * ATMs\_km2_i + \alpha_3 * bankbr\_adults_i + \alpha_4 * bankbr\_km2_i + \varepsilon_i$$

$$Y^{2021}_{access,i} = \beta_1 * own\_credit\_cards_i + \beta_2 * own\_debit\_cards_i + \beta_3 * accts_i + \varepsilon_i$$

$$Y^{2021}_{usage,i} = \theta_1 * ost\_loans_i + \theta_2 * ost\_deposits_i + \theta_3 * borrowers_i + \theta_4 * depositors_i + \varepsilon_i$$

Test 3 (2021, with mobile money)

This test builds upon Test 2 by introducing additional indicators related to mobile money. The inclusion of these indicators in the availability, access and usage dimensions reflects the transformative role this innovation has played in extending financial services to underserved populations in Sub-Saharan Africa. Mobile money services have experienced rapid growth and adoption in the region, leveraging the widespread use of mobile phones to provide accessible, affordable, and convenient financial services to millions of people who were previously excluded from the formal financial system (Demirgüç-Kunt et al., 2018). With these indicators, Test 3 provides a more comprehensive and up-to-date assessment of financial inclusion in the region and captures the transformative impact of mobile money.

The dimensions are defined as follows:

$$Y^{2021}_{availability,i} = \alpha_1 * ATMs\_adult_i + \alpha_2 * ATMs\_km2_i + \alpha_3 * bankbr\_adults_i + \alpha_4 * bankbr\_km2_i + \alpha_5 * reg\_mb\_adults_i + \alpha_5 * reg\_mb\_km2_i + \varepsilon_i$$

$$Y^{2021}_{access,i} = \beta_1 * own\_credit\_cards_i + \beta_2 * own\_debit\_cards_i + \beta_3 * accts_i + \beta_4 * mb\_accts_i + \varepsilon_i$$

$$Y^{2021}_{usage,i} = \theta_1 * ost\_loans_i + \theta_2 * ost\_deposits_i + \theta_3 * borrowers_i + \theta_4 * depositors_i + \theta_5 * mb\_transac_i + \varepsilon_i$$

Test 4 (2021, with mobile money and barriers indicators)

This test further extends the analysis by adding the barriers dimension. Test 4 provides a more nuanced and policy-relevant assessment of the challenges to financial inclusion in Sub-Saharan Africa, highlighting the persistent obstacles that prevent many individuals from accessing and using formal financial services, even as the availability and accessibility of these services have improved over time.

The dimensions are defined as follows:

$$Y^{2021}_{availability,i} = \alpha_1 * ATMs\_adult_i + \alpha_2 * ATMs\_km2_i + \alpha_3 * bankbr\_adults_i + \alpha_4 * bankbr\_km2_i + \alpha_5 * reg\_mb\_adults_i + \alpha_5 * reg\_mb\_km2_i + \varepsilon_i$$

$$Y^{2021}_{access,i} = \beta_1 * own\_credit\_cards_i + \beta_2 * own\_debit\_cards_i + \beta_3 * accts_i + \beta_4 * mb\_accts_i + \varepsilon_i$$

$$Y^{2021}_{usage,i} = \theta_1 * ost\_loans_i + \theta_2 * ost\_deposits_i + \theta_3 * borrowers_i + \theta_4 * depositors_i + \theta_5 * mb\_transac_i + \varepsilon_i$$

$$Y^{2021}_{barriers,i} = \gamma_1 * distance_i + \gamma_2 * cost_i + \gamma_3 * documentation_i + \gamma_4 * distrust_i + \varepsilon_i$$

The results of these four tests are compared and analyzed to provide a dynamic and comprehensive understanding of the state and evolution of financial inclusion in Sub-Saharan Africa. The comparison of Tests 1 and 2 sheds light on the overall progress made in the region over the past decade, while the comparison of Tests 2 and 3 highlights the specific contribution of mobile money to this progress. The inclusion of the barriers dimension in Test 4 adds a further layer of depth to the analysis, providing insights into the remaining challenges and policy priorities for promoting greater financial inclusion in the region.

VI. Results and Insights

1. Baseline – FII in Sub-Saharan Africa (2011)

The first test (Test 1) establishes a baseline assessment of financial inclusion in Sub-Saharan Africa for the year 2011, focusing on the dimensions of availability, access, and usage :

$$Y^{2011}_{availability,i} = \alpha_1 * ATMs\_adult_i + \alpha_2 * ATMs\_km2_i + \alpha_3 * bankbr\_adults_i + \alpha_4 * bankbr\_km2_i + \varepsilon_i$$

$$Y^{2011}_{access,i} = \beta_1 * own\_credit\_cards_i + \beta_2 * own\_debit\_cards_i + \beta_3 * accts\_ + \varepsilon_i$$

$$Y^{2011}_{usage,i} = \theta_1 * ost\_loans_i + \theta_2 * ost\_deposits_i + \theta_3 * borrowers_i + \theta_4 * depositors_i + \varepsilon_i$$

1.1. 2011 First-stage PCA Results

Availability Dimension

The availability dimension in 2011 is primarily characterized by the first principal component (PC1), which explains a substantial 82.68% of the variance. This suggests that a single underlying factor, likely related to the physical presence of financial infrastructure, plays a dominant role in capturing the variability within the availability of financial services. The second component (PC2) accounts for a notable 14.79% of the variance, indicating that it captures a secondary aspect of availability. The remaining components, PC3 and PC4, have minimal contributions of 2.43% and 0.10%, respectively.

The eigenvalues for the availability dimension further support the importance of PC1. The eigenvalue for PC1 is 3.3071, significantly higher than the eigenvalues for the other components. PC2 has an eigenvalue of 0.5914, while PC3 and PC4 have much lower eigenvalues of 0.0974 and 0.0041, respectively. The large difference between the eigenvalue of PC1 and the other components indicates that it captures the most relevant information in the data.

Access Dimension

In the access dimension, PC1 proves to be the most influential, explaining 88.30% of the variance. This suggests that access to financial services in Sub-Saharan Africa in 2011 was largely determined by a single underlying factor. The subsequent components, PC2 and PC3, account for 9.63% and 2.07% of the variance, respectively, indicating that they capture fewer dominant aspects of access.

The eigenvalues for the access dimension confirm the significance of PC1, with a value of 2.6489. PC2 has an eigenvalue of 0.2890, while PC3 has a lower eigenvalue of 0.0621. The notable difference between the eigenvalues of PC1 and the other components highlights its dominant role in explaining the variability in the access dimension.

Usage Dimension

The usage dimension exhibits a more distributed variance among the components compared to the availability and access dimensions. PC1, while still the most significant, explains 72.64% of the variance, indicating a less dominant role compared to the other dimensions. The remaining components, PC2, PC3, and PC4, have higher contributions, with values of 16.39%, 9.31%, and 1.67%, respectively. This distribution suggests a more complex set of relationships and variability within the usage data, reflecting the presence of multiple influential factors on how financial services are utilized.

The eigenvalues for the usage dimension show a more gradual decrease from PC1 to PC4. PC1 has an eigenvalue of 2.9055, followed by PC2 with 0.6554, PC3 with 0.3724, and PC4 with 0.0667.

Table 3. 2011 Principal Component estimates for sub-indices

Components	Eigenvalue	Difference	Proportion	Cumulative
		Availability		
Comp 1	3.3071	2.7157	0.8268	0.8268
Comp 2	0.5914	0.4941	0.1479	0.9746
Comp 3	0.0974	0.0933	0.0243	0.9990
Comp 4	0.0041	.	0.0010	1.0000

Components	Eigenvalue	Difference	Proportion	Cumulative
		Access		
Comp 1	2.6489	2.3599	0.8830	0.8830
Comp 2	0.2890	0.2269	0.0963	0.9793
Comp 3	0.0621	.	0.0207	1.0000
		Usage		
Comp 1	2.9055	2.2500	0.7264	0.7264
Comp 2	0.6554	0.2830	0.1639	0.8902
Comp 3	0.3724	0.3057	0.0931	0.9833
Comp 4	0.0667	.	0.0167	1.0000

1.2. 2011 Second-Stage PCA Results

The second stage of the PCA yields the weights for each dimension in the overall Financial Inclusion Index. The weights assigned to the availability, access, and usage dimensions are 0.6261, 0.5344, and 0.5678, respectively. These weights indicate the relative importance of each dimension in the composite index.

The relatively balanced weights suggest that all three dimensions play a significant role in determining the overall level of financial inclusion in a country. The availability dimension, with the highest weight, emphasizes the importance of physical infrastructure and the presence of financial service providers. The usage dimension, with the second-highest weight, highlights the significance of the actual utilization of financial services by individuals and businesses. The access dimension, with the lowest weight, underscores the relevance of the accessibility and affordability of financial services.

1.3. 2011 Country Rankings

Mauritius emerges as the country with the highest level of financial inclusion, far outpacing the second-ranked country, South Africa. Mauritius' strong performance can be attributed to its consistently high rankings across all three dimensions: availability (1st), access (1st), and usage (1st). This suggests that Mauritius has a well-developed financial infrastructure, highly accessible financial services, and widespread usage of formal financial products. South Africa, despite being ranked second overall, has a significantly lower FII score than Mauritius.

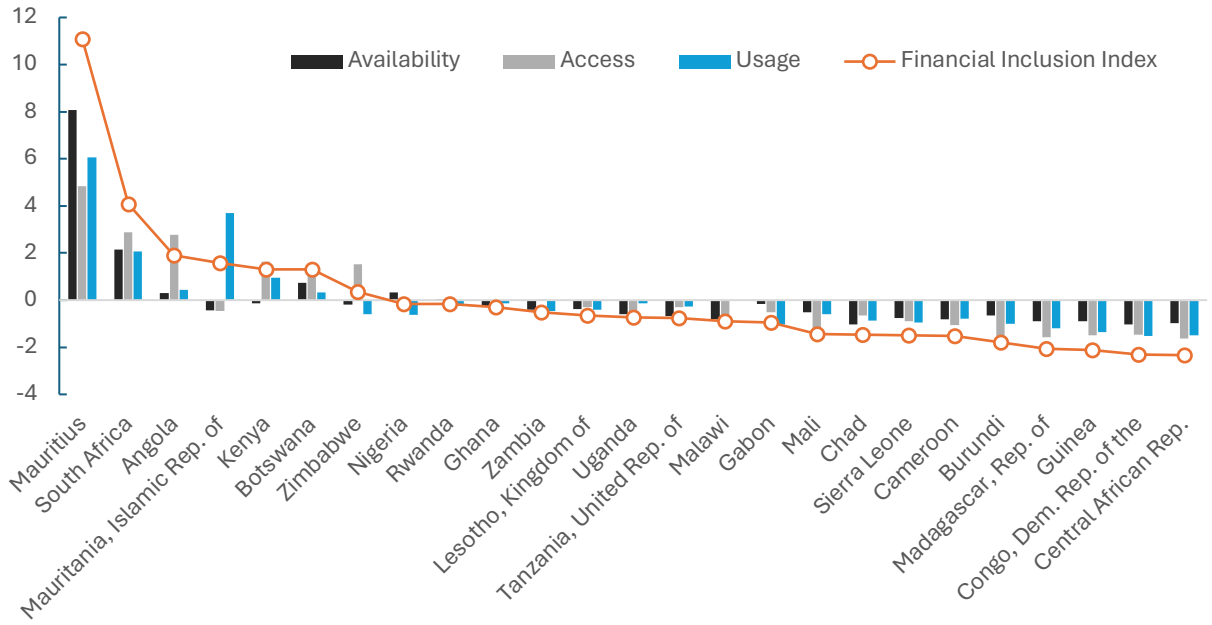
This indicates that while South Africa performs well relative to other countries in the region, there is still substantial room for improvement in its financial inclusion landscape.

At the lower end of the spectrum, the Central African Republic and the Democratic Republic of the Congo have the lowest FII scores. These countries consistently rank among the bottom across all dimensions, highlighting the significant challenges their financial services face. Factors such as political instability, weak institutional frameworks, and limited financial infrastructure may contribute to their poor performance.

Table 4. 2011 Estimation of the FII and Rankings

Country	FII	Ranks	Availability	Ranks	Access	Ranks	Usage	Ranks
Mauritius	11.09	**1**	8.08	**1**	4.84	**1**	6.07	**1**
South Africa	4.07	**2**	2.15	**2**	2.88	**2**	2.08	**3**
Angola	1.91	**3**	0.29	**5**	2.77	**3**	0.44	**5**
Mauritania, Islamic Rep. of	1.58	**4**	-0.43	**13**	-0.46	**13**	3.70	**2**
Kenya	1.32	**5**	-0.14	**7**	1.62	**4**	0.94	**4**
Botswana	1.30	**6**	0.73	**3**	1.23	**6**	0.33	**6**
Zimbabwe	0.36	**7**	-0.18	**9**	1.51	**5**	-0.59	**15**
Nigeria	-0.15	**8**	0.32	**4**	0.01	**7**	-0.62	**16**
Rwanda	-0.16	**9**	0.04	**6**	-0.19	**10**	-0.15	**10**
Ghana	-0.30	**10**	-0.26	**10**	-0.11	**9**	-0.14	**9**
Zambia	-0.51	**11**	-0.41	**12**	0.00	**8**	-0.46	**13**
Lesotho, Kingdom of	-0.64	**12**	-0.39	**11**	-0.31	**12**	-0.41	**12**
Uganda	-0.74	**13**	-0.60	**15**	-0.54	**15**	-0.13	**8**
Tanzania, United Rep. of	-0.75	**14**	-0.69	**17**	-0.30	**11**	-0.28	**11**
Malawi	-0.90	**15**	-0.80	**19**	-0.74	**17**	0.00	**7**
Gabon	-0.95	**16**	-0.15	**8**	-0.51	**14**	-1.02	**21**
Mali	-1.43	**17**	-0.52	**14**	-1.44	**20**	-0.58	**14**
Chad	-1.48	**18**	-1.02	**24**	-0.64	**16**	-0.87	**18**
Sierra Leone	-1.50	**19**	-0.76	**18**	-0.91	**18**	-0.95	**19**
Cameroon	-1.53	**20**	-0.82	**20**	-1.05	**19**	-0.79	**17**
Burundi	-1.79	**21**	-0.66	**16**	-1.52	**23**	-1.00	**20**
Madagascar, Rep. of	-2.07	**22**	-0.88	**21**	-1.57	**24**	-1.19	**22**
Guinea	-2.11	**23**	-0.89	**22**	-1.48	**22**	-1.34	**23**
Congo, Dem. Rep. of the	-2.29	**24**	-1.03	**23**	-1.46	**21**	-1.53	**25**
Central African Rep.	-2.33	**25**	-0.98	**25**	-1.64	**25**	-1.49	**24**

Figure 1. Graphical Representation of FII and its Dimensions for 2011



2. Evolution of FII in Sub-Saharan Africa from 2011 to 2021

To assess the evolution of the Financial Inclusion Index (FII), we performed Test 2 on the same set of countries included in the 2011 index (Test 1). Test 2 assesses the state of financial inclusion in Sub-Saharan Africa for the year 2021, using the same dimensions and indicators as the 2011 FII:

$$Y^{2021}_{availability,i} = \alpha_1 * ATMs\_adult_i + \alpha_2 * ATMs\_km2_i + \alpha_3 * bankbr\_adults_i + \alpha_4 * bankbr\_km2_i + \varepsilon_i$$

$$Y^{2021}_{access,i} = \beta_1 * own\_credit\_cards_i + \beta_2 * own\_debit\_cards_i + \beta_3 * accts_i + \varepsilon_i$$

$$Y^{2021}_{usage,i} = \theta_1 * ost\_loans_i + \theta_2 * ost\_deposits_i + \theta_3 * borrowers_i + \theta_4 * depositors_i + \varepsilon_i$$

2.1. 2021 First-stage PCA Results

Availability Dimension

The availability dimension in 2021 is primarily characterized by the first principal component (PC1), which explains 71.70% of the variance. The second component (PC2) accounts for 19.92% of the variance, indicating that it captures a secondary aspect of availability that has gained importance since 2011. The remaining components, PC3 and PC4, have minimal contributions of 8.18% and 0.21%, respectively.

The eigenvalues for the availability dimension support the importance of PC1. The eigenvalue for PC1 is 2.8678, significantly higher than the eigenvalues for the other components. PC2 has an eigenvalue of 0.7968, while PC3 and PC4 have much lower eigenvalues of 0.3270 and 0.0084, respectively.

Access Dimension

In the access dimension, PC1 remains the most influential, explaining 85.15% of the variance. The subsequent components, PC2 and PC3, account for 12.83% and 2.02% of the variance.

The eigenvalues for the access dimension confirm the significance of PC1, with a value of 2.5544 compared to PC2 (0.3848) and PC3 (0.0607). The notable difference between the eigenvalues of PC1 and the other components highlights its dominant role in explaining the variability in the access dimension.

Usage Dimension

The usage dimension in 2021 exhibits a more distributed variance among the components compared to the availability and access dimensions, similar to the findings in Test 1. PC1 explains 59.56% of the variance, indicating a less dominant role compared to the other dimensions. The second component, PC2, has gained importance, accounting for 31.71% of the variance. The remaining components, PC3 and PC4, have contributions of 7.29% and 1.44%, respectively.

The eigenvalues for the usage dimension show a more gradual decrease. PC1 has an eigenvalue of 2.3826, followed by PC2 with 1.2682, PC3 with 0.2915, and PC4 with 0.0577.

Table 5 – 2021 Principal Component estimates for sub-indices

Components	Eigenvalue	Difference	Proportion	Cumulative
		Availability		
Comp 1	2.8678	2.0710	0.7170	0.7170
Comp 2	0.7968	0.4697	0.1992	0.9162
Comp 3	0.3270	0.3187	0.0818	0.9979
Comp 4	0.0084	.	0.0021	1.000
		Access		
Comp 1	2.5544	2.1696	0.8515	0.8515
Comp 2	0.3848	0.3241	0.1283	0.9798
Comp 3	0.0607	.	0.0202	1.000
		Usage		
Comp 1	2.3826	1.1144	0.5956	0.5956
Comp 2	1.2682	0.9767	0.3171	0.9127
Comp 3	0.2915	0.2338	0.0729	0.9856
Comp 4	0.0577	.	0.0144	1.000

Comparing the results of the first-stage PCA in 2011 and 2021, we observe that the overall structure of the dimensions remains similar, with the availability and access dimensions being largely characterized by a single underlying factor, while the usage dimension exhibits a more distributed variance among the components. However, there are some notable changes in the proportion of variance explained by each component, particularly in the usage dimension, where PC2 has gained importance. This may be attributed to changes in consumer behavior, technological advancements, or policy interventions during this period.

2.2. 2021 Second-Stage PCA Results

The weights assigned in the overall Financial Inclusion Index to the availability, access, and usage dimensions are 0.6217, 0.5821, and 0.5240, respectively.

Compared to 2011, the weights for the availability and usage dimensions have slightly decreased, while the weight for the access dimension has increased. This shift suggests that the access of financial services has gained more importance in determining the overall level of financial inclusion between 2011 and 2021.

2.3. 2021 Country Rankings

Comparing the country rankings and FII scores between 2011 and 2021 reveals the evolution of financial inclusion in Sub-Saharan Africa over the past decade. Mauritius maintains its position as the country with the highest level of financial inclusion. This suggests that while Mauritius remains a leader in financial inclusion, the gap between it and other countries has narrowed over time.

South Africa retains its second rank in both years, with a slight increase in its FII score from 4.07 in 2011 to 4.28 in 2021. This indicates that South Africa has made modest progress in improving financial inclusion during this period. Mauritania has shown improvement, moving up from the 4th rank in 2011 to the 3rd rank in 2021. This progress can be primarily attributed to its strong performance in the usage dimension, where it ranks 1st in 2021 and 2nd in 2011. Another country that has shown notable improvements in its FII scores and rankings is Botswana. Botswana has moved up from the 6th rank in 2011 to the 4th rank in 2021.

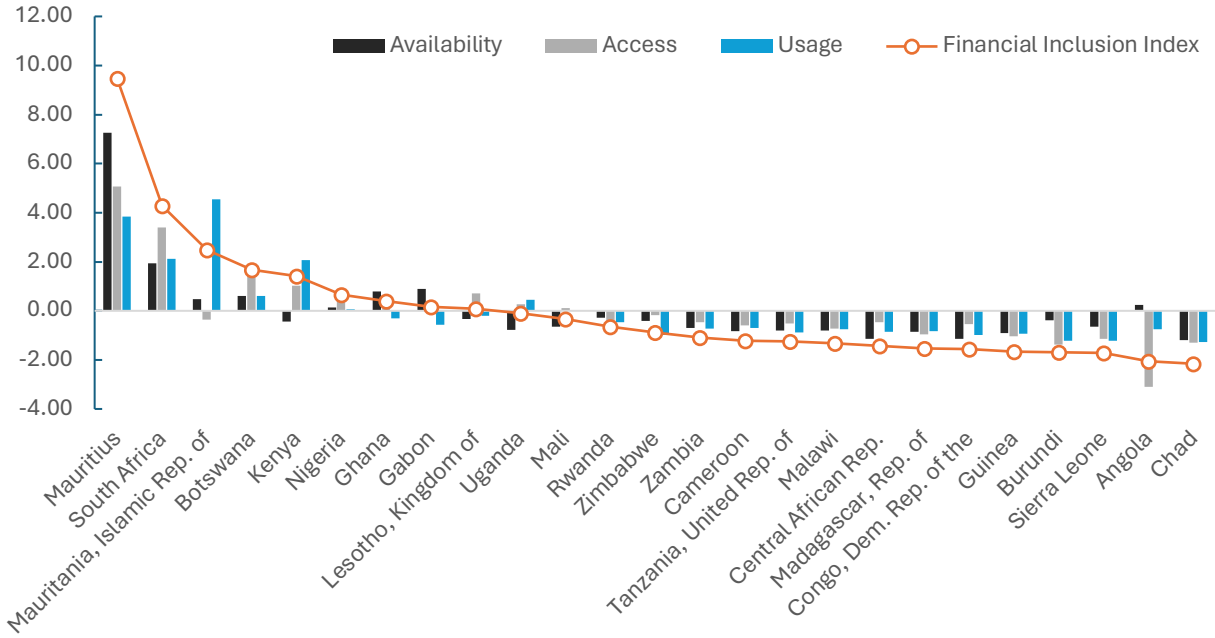
At the lower end of the spectrum, the Central African Republic, the Democratic Republic of the Congo, and Chad consistently rank among the bottom three countries in both years. However, there have been some changes in the rankings of other low-performing countries. For example, Burundi has moved down from the 21st rank in 2011 to the 22nd rank in 2021, while Angola has dropped significantly from the 3rd rank in 2011 to the 24th rank in 2021. This drastic change in Angola's ranking can be attributed to its poor performance in the access dimension, where it ranks last in 2021.

These changes in rankings and scores highlight the uneven progress in financial inclusion across Sub-Saharan Africa. While some countries have made significant strides in improving access to and usage of financial services, others have stagnated or even regressed. The comparison between 2011 and 2021 underscore the need for continued efforts to promote financial inclusion, particularly in countries that have shown limited progress over the past decade.

Table 6. 2021 Estimation of the FII and Rankings

Country	FII	Ranks	Availability	Ranks	Access	Ranks	Usage	Ranks
Mauritius	9.47	**1**	7.26	**1**	5.07	**1**	3.83	**2**
South Africa	4.28	**2**	1.93	**2**	3.41	**2**	2.11	**3**
Mauritania, Islamic Rep. of	2.48	**3**	0.48	**6**	-0.35	**12**	4.56	**1**
Botswana	1.68	**4**	0.61	**5**	1.69	**3**	0.59	**5**
Kenya	1.41	**5**	-0.43	**13**	1.03	**4**	2.07	**4**
Nigeria	0.65	**6**	0.14	**8**	0.90	**5**	0.06	**7**
Ghana	0.39	**7**	0.79	**4**	0.11	**8**	-0.32	**10**
Gabon	0.17	**8**	0.89	**3**	-0.14	**10**	-0.58	**12**
Lesotho, Kingdom of	0.10	**9**	-0.33	**10**	0.70	**6**	-0.21	**9**
Uganda	-0.11	**10**	-0.79	**17**	0.27	**7**	0.44	**6**
Mali	-0.33	**11**	-0.66	**14**	0.10	**9**	0.03	**8**
Rwanda	-0.66	**12**	-0.28	**9**	-0.42	**13**	-0.46	**11**
Zimbabwe	-0.89	**13**	-0.41	**12**	-0.19	**11**	-1.00	**22**
Zambia	-1.08	**14**	-0.70	**16**	-0.45	**14**	-0.72	**14**
Cameroon	-1.22	**15**	-0.82	**20**	-0.58	**18**	-0.70	**13**
Tanzania, United Rep. of	-1.26	**16**	-0.80	**18**	-0.51	**16**	-0.88	**19**
Malawi	-1.32	**17**	-0.81	**19**	-0.71	**19**	-0.76	**16**
Central African Rep.	-1.43	**18**	-1.15	**23**	-0.46	**15**	-0.85	**18**
Madagascar, Rep. of	-1.52	**19**	-0.86	**21**	-0.96	**20**	-0.82	**17**
Congo, Dem. Rep. of the	-1.55	**20**	-1.15	**24**	-0.54	**17**	-0.99	**20**
Guinea	-1.66	**21**	-0.91	**22**	-1.03	**21**	-0.93	**21**
Burundi	-1.69	**22**	-0.38	**11**	-1.38	**24**	-1.23	**24**
Sierra Leone	-1.71	**23**	-0.66	**15**	-1.13	**22**	-1.23	**23**
Angola	-2.06	**24**	0.23	**7**	-3.11	**25**	-0.75	**15**
Chad	-2.16	**25**	-1.19	**25**	-1.30	**23**	-1.27	**25**

Figure 2. Graphical Representation of FII and its Dimensions for 2021



3. Impact of Mobile Money on Financial Inclusion Index

The rapid growth and adoption of mobile money services in the region have transformed the financial landscape, providing accessible, affordable, and convenient financial services to millions of people who were previously excluded from the formal financial system (Demirgüç-Kunt & Klapper, 2013). In this section, we explore the impact of including mobile money indicators in the Financial Inclusion Index (FII).

As information on more countries are available in 2021, we first performed Test 2 again on a larger set of countries, to increase the robustness of our analysis. We than included mobile money indicators for the same countries (Test 3) and compared the results.

3.1. 2021 Financial Inclusion Index Pre-Mobile Money Considerations

The new iterance of Test 2 includes 31 countries, and uses the same dimensions and indicators as before :

$$Y^{2021}_{availability,i} = \alpha_1 * ATMs\_adult_i + \alpha_2 * ATMs\_km2_i + \alpha_3 * bankbr\_adults_i + \alpha_4 * bankbr\_km2_i + \varepsilon_i$$

$$Y^{2021}_{access,i} = \beta_1 * own\_credit\_cards_i + \beta_2 * own\_debit\_cards_i + \beta_3 * accts_i + \varepsilon_i$$

$$Y^{2021}_{usage,i} = \theta_1 * ost\_loans_i + \theta_2 * ost\_deposits_i + \theta_3 * borrowers_i + \theta_4 * depositors_i + \varepsilon_i$$

3.1.1. *First-Stage PCA Pre-Mobile Money Considerations*

Availability Dimension

In the availability dimension, the first principal component (PC1) explains 69.46% of the variance, while the second component (PC2) accounts for 23.22%. The remaining

components, PC3 and PC4, have minimal contributions of 7.16% and 0.16%, respectively. The eigenvalues for PC1 and PC2 are 2.7784 and 0.9288.

Access Dimension

For the access dimension, PC1 proves to be the most influential, explaining 85.06% of the variance. The subsequent components, PC2 and PC3, account for 13.07% and 1.87% of the variance, respectively. The eigenvalues for PC1, PC2, and PC3 are 2.5517, 0.3921, and 0.0562, highlighting the dominant role of PC1 in explaining the variability in the access dimension.

Usage Dimension

PC1 explains 58.91% of the variance, while PC2 accounts for 31.40%. The remaining components, PC3 and PC4, have contributions of 7.75% and 1.94%, respectively. The eigenvalues for PC1, PC2, PC3, and PC4 are 2.3562, 1.2561, 0.3100, and 0.0777.

Table 7. 2021 Principal Component estimates for sub-indices (updated sample)

Components	Eigenvalue	Difference	Proportion	Cumulative
		Availability		
Comp 1	2.7784	1.8496	0.6946	0.6946
Comp 2	0.9288	0.6423	0.2322	0.9268
Comp 3	0.2865	0.2802	0.0716	0.9984
Comp 4	0.0063	.	0.0016	1.000
		Access		
Comp 1	2.5517	2.1596	0.8506	0.8506
Comp 2	0.3921	0.3359	0.1307	0.9813
Comp 3	0.0562	.	0.0187	1.000
		Usage		
Comp 1	2.3562	1.1002	0.5891	0.5891
Comp 2	1.2561	0.9461	0.3140	0.9031
Comp 3	0.3100	0.2323	0.0775	0.9806
Comp 4	0.0777	.	0.0194	1.000

3.1.2. Second-Stage PCA Pre-Mobile Money Considerations

The second stage of the PCA for the new set of 31 countries yields the weights for each dimension in the overall Financial Inclusion Index. The weights assigned to the availability, access, and usage dimensions are 0.6163, 0.5813, and 0.5313, respectively.

3.1.3. *Country Rankings Pre-Mobile Money Considerations*

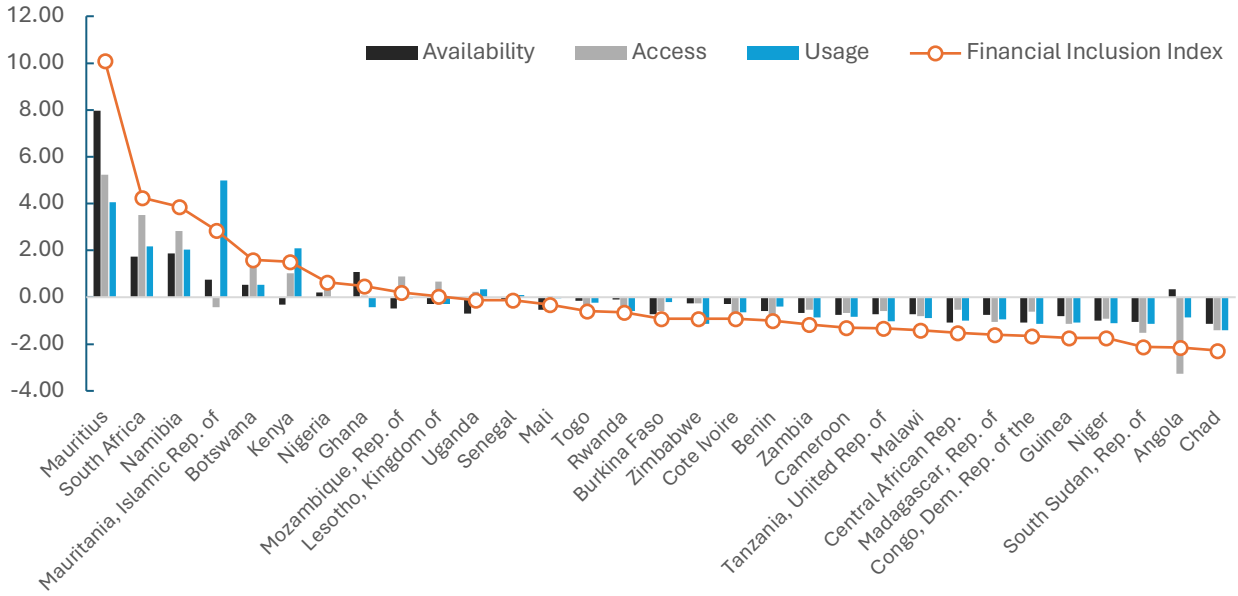
Mauritius, South Africa, and Namibia emerge as the top three countries, with Mauritius maintaining its position as the country with the highest level of financial inclusion. These countries perform well across all three dimensions.

At the lower end of the spectrum, Chad, Angola, and the Republic of South Sudan have the lowest Financial Inclusion Index (FII) scores. These countries consistently rank among the bottom three across all dimensions, highlighting the need for targeted interventions to improve the availability, access, and usage of financial services.

Table 8. 2021 Estimation of the FII and Rankings (updated sample)

Country	FII	Ranks	Availability	Ranks	Access	Ranks	Usage	Ranks
Mauritius	10.10	**1**	7.96	**1**	5.22	**1**	4.06	**2**
South Africa	4.26	**2**	1.74	**3**	3.50	**2**	2.18	**3**
Namibia	3.87	**3**	1.86	**2**	2.83	**3**	2.02	**5**
Mauritania, Islamic Rep. of	2.86	**4**	0.74	**5**	-0.43	**14**	5.00	**1**
Botswana	1.60	**5**	0.52	**6**	1.71	**4**	0.54	**6**
Kenya	1.51	**6**	-0.31	**15**	1.01	**5**	2.10	**4**
Nigeria	0.63	**7**	0.21	**8**	0.88	**7**	-0.01	**9**
Ghana	0.48	**8**	1.09	**4**	0.06	**10**	-0.42	**16**
Mozambique, Rep. of	0.20	**9**	-0.48	**16**	0.90	**6**	-0.04	**10**
Lesotho, Kingdom of	0.05	**10**	-0.30	**13**	0.67	**8**	-0.30	**14**
Uganda	-0.12	**11**	-0.69	**20**	0.22	**9**	0.35	**7**
Senegal	-0.12	**12**	-0.16	**10**	-0.13	**12**	0.09	**8**
Mali	-0.33	**13**	-0.53	**17**	0.04	**11**	-0.05	**11**
Togo	-0.60	**14**	-0.16	**11**	-0.65	**21**	-0.23	**13**
Rwanda	-0.66	**15**	-0.11	**9**	-0.49	**15**	-0.58	**17**
Burkina Faso	-0.90	**16**	-0.73	**21**	-0.60	**19**	-0.20	**12**
Zimbabwe	-0.91	**17**	-0.26	**12**	-0.25	**13**	-1.14	**29**
Cote Ivoire	-0.93	**18**	-0.30	**14**	-0.68	**23**	-0.65	**18**
Benin	-1.00	**19**	-0.58	**18**	-0.74	**24**	-0.39	**15**
Zambia	-1.17	**20**	-0.66	**19**	-0.53	**16**	-0.86	**21**
Cameroon	-1.29	**21**	-0.75	**24**	-0.67	**22**	-0.84	**19**
Tanzania, United Rep. of	-1.34	**22**	-0.74	**22**	-0.59	**18**	-1.02	**25**
Malawi	-1.40	**23**	-0.74	**23**	-0.80	**25**	-0.90	**22**
Central African Rep.	-1.51	**24**	-1.09	**29**	-0.55	**17**	-0.99	**24**
Madagascar, Rep. of	-1.59	**25**	-0.76	**25**	-1.06	**27**	-0.95	**23**
Congo, Dem. Rep. of the	-1.64	**26**	-1.09	**30**	-0.62	**20**	-1.15	**30**
Guinea	-1.74	**27**	-0.81	**26**	-1.13	**28**	-1.09	**26**
Niger	-1.75	**28**	-1.01	**27**	-0.91	**26**	-1.11	**27**
South Sudan, Rep. of	-2.13	**29**	-1.04	**28**	-1.53	**30**	-1.12	**28**
Angola	-2.16	**30**	0.33	**7**	-3.28	**31**	-0.86	**20**
Chad	-2.27	**31**	-1.13	**31**	-1.41	**29**	-1.42	**31**

Figure 3. Graphical Representation of FII and its Dimensions for 2021 (updated sample)



3.2. 2021 Financial Inclusion Index Post-Mobile Money Considerations

Below are the results of the Two-Stage PCA analysis and derived Country Rankings when considering mobile money indicators.

3.1.4. *First-Stage PCA Post-Mobile Money Considerations*

Availability Dimension

In the availability dimension, the first principal component (PC1) explains 47.66% of the variance, while the second component (PC2) accounts for 28.30%. The third component (PC3) explains 13.42% of the variance, and the remaining components (PC4, PC5, and PC6) have minimal contributions of 6.33%, 4.25%, and 0.04%, respectively.

The eigenvalues for PC1 and PC2 are 2.8597 and 1.6978, confirming their importance in capturing the variability within the availability dimension.

Access Dimension

For the access dimension, PC1 proves to be the most influential, explaining 63.79% of the variance. The subsequent component, PC2, accounts for 25.36% of the variance, while PC3 and PC4 have minimal contributions of 9.70% and 1.15%, respectively.

The eigenvalues for PC1, PC2, PC3, and PC4 are 2.5518, 1.0143, 0.3881 and 0.0458, highlighting the dominant role of PC1 in explaining the variability in the access dimension.

Usage Dimension

The usage dimension exhibits a more distributed variance among the components. PC1 explains 48.70% of the variance, while PC2 accounts for 26.48%. The remaining components, PC3, PC4, and PC5, have contributions of 17.73%, 5.54%, and 1.55%, respectively.

The eigenvalues for PC1, PC2, PC3, PC4, and PC5 are 2.4352, 1.0143, 0.3881, 0.2768, and 0.0775, indicating the importance of both PC1 and PC2 in capturing the variability in the usage dimension.

Table 9. 2021 Principal Component estimates for sub-indices, post mobile money considerations

Components	Eigenvalue	Difference	Proportion	Cumulative
		Availability		
Comp 1	2.8597	1.1619	0.4766	0.4766
Comp 2	1.6978	0.8923	0.2830	0.7596
Comp 3	0.8055	0.4258	0.1342	0.8938
Comp 4	0.3797	0.1246	0.0633	0.9571
Comp 5	0.2551	0.2527	0.0425	0.9996
Comp 6	0.0024	.	0.0004	1.0000
		Access		
Comp 1	2.5518	1.5374	0.6379	0.6379
Comp 2	1.0143	0.6262	0.2536	0.8915
Comp 3	0.3881	0.3423	0.0970	0.9885
Comp 4	0.0458	.	0.0115	1.0000
		Usage		
Comp 1	2.4352	1.1111	0.4870	0.4870
Comp 2	1.3241	0.4377	0.2648	0.7519
Comp 3	0.8864	0.6095	0.1773	0.9291
Comp 4	0.2768	0.1993	0.0554	0.9845
Comp 5	0.0775	.	0.0155	1.0000

Comparing the results of the first-stage PCA before and after mobile money considerations, we observe that the overall structure of the dimensions remains similar, with the access dimensions being largely characterized by a single underlying factor. However, there are some notable changes in the proportion of variance explained by each component, particularly in the availability and usage dimensions, where the inclusion of mobile money indicators has led to a reduction in the dominance of PC1 and an increased importance of subsequent components. This may be attributed to the additional variability and complexity introduced by mobile money indicators,

In the availability dimension, the proportion of variance explained by PC1 has decreased from 69.46% to 47.66%, while PC2 has gained importance, accounting for 28.30% of the variance after the addition of mobile money indicators. Similarly, in the usage dimension, the proportion of variance explained by PC1 has reduced from 58.91% to 48.70%. The access dimension, although still largely characterized by PC1, has also seen a reduction in the proportion of variance explained by PC1 from 85.06% to 63.79% , with PC2 accounting for 25.36% of the variance when accounting for mobile money considerations.

3.1.5. Second-Stage PCA Post-Mobile Money Considerations

The inclusion of mobile money indicators has led to slight changes in the weights assigned to the availability, access, and usage dimensions. The availability dimension has seen a marginal increase in weight, from 0.6163 to 0.6219, suggesting a slightly enhanced importance of this dimension when accounting for mobile money. Similarly, the usage dimension has increased from 0.5313 to 0.5323. The weight for the access dimension has decreased slightly from 0.5813 to 0.5744.

Despite these changes, the overall ranking of the dimensions' contributions to financial inclusion remains consistent, with availability being the most influential, followed by access and usage. The incorporation of mobile money indicators has led to minor adjustments in the weights, reflecting the evolving landscape of financial services accessibility and usage.

3.1.6. *Country Rankings Post-Mobile Money Considerations*

Comparing the rankings pre and post accounting for mobile money indicators reveals their impact on the assessment of financial inclusion in Sub-Saharan Africa. The overall rankings remain largely consistent, with Mauritius, South Africa, and Namibia maintaining their positions as the top three countries in both tests.

However, there are some notable shifts in the relative positions of other countries. For example, Ghana's ranking drops from the 8th position before mobile money considerations to the 9th position, suggesting that the inclusion of mobile money indicators may have highlighted some challenges in the usage dimension, where the country now ranks 27th compared to 16th when excluding mobile money variables.

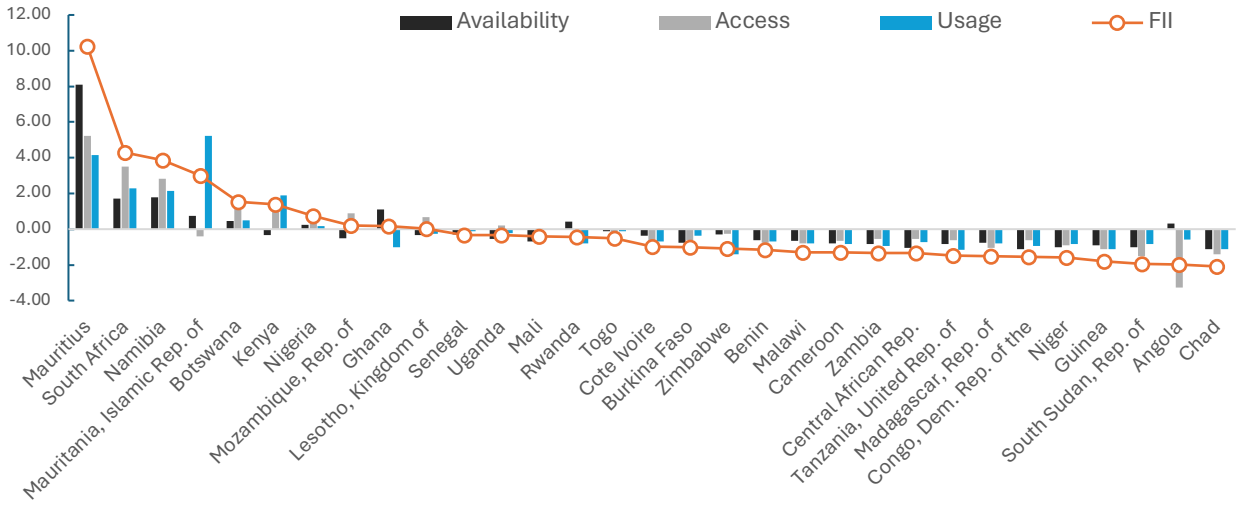
Considering mobile money indicators also sheds light on the persistent challenges faced by some countries, such as Angola and Chad, which continue to rank at the bottom of the index in both tests. This underscores the need for targeted interventions to address the specific barriers to financial inclusion in these countries, even as the potential benefits of mobile money are recognized.

Table 10. 2021 Country Rankings Comparisons Pre and Post Mobile Money Considerations

	Pre-Mobile Money		FII Post-Mobile Money				
Country	FII Score	FII Ranks	FII Score	FII Ranks	Availability Ranks	Access Ranks	Usage Ranks
Mauritius	10.10	**1**	10.25	**1**	**1**	**1**	**2**
South Africa	4.26	**2**	4.29	**2**	**3**	**2**	**3**
Namibia	3.87	**3**	3.87	**3**	**2**	**3**	**4**
Mauritania, Islamic Rep. of	2.86	**4**	2.99	**4**	**5**	**14**	**1**
Botswana	1.60	**5**	1.54	**5**	**6**	**4**	**6**
Kenya	1.51	**6**	1.39	**6**	**13**	**5**	**5**
Nigeria	0.63	**7**	0.76	**7**	**9**	**7**	**7**
Ghana	0.48	**8**	0.17	**9**	**4**	**10**	**27**
Mozambique, Rep. of	0.20	**9**	0.20	**8**	**16**	**6**	**8**
Lesotho, Kingdom of	0.05	**10**	0.04	**10**	**14**	**8**	**13**
Uganda	-0.12	**11**	-0.33	**12**	**17**	**9**	**12**
Senegal	-0.12	**12**	-0.32	**11**	**11**	**12**	**10**
Mali	-0.33	**13**	-0.42	**13**	**20**	**11**	**9**
Togo	-0.60	**14**	-0.52	**15**	**10**	**21**	**11**
Rwanda	-0.66	**15**	-0.44	**14**	**7**	**15**	**21**

Country	Pre-Mobile Money		FII Post-Mobile Money				
	FII Score	FII Ranks	FII Score	FII Ranks	Availability Ranks	Access Ranks	Usage Ranks
Burkina Faso	-0.90	**16**	-1.01	**17**	**21**	**18**	**14**
Zimbabwe	-0.91	**17**	-1.09	**18**	**12**	**13**	**31**
Cote Ivoire	-0.93	**18**	-0.98	**16**	**15**	**23**	**16**
Benin	-1.00	**19**	-1.17	**19**	**18**	**24**	**17**
Zambia	-1.17	**20**	-1.32	**22**	**25**	**16**	**25**
Cameroon	-1.29	**21**	-1.32	**21**	**23**	**22**	**22**
Tanzania, United Rep. of	-1.34	**22**	-1.47	**24**	**24**	**19**	**30**
Malawi	-1.40	**23**	-1.30	**20**	**19**	**25**	**20**
Central African Rep.	-1.51	**24**	-1.34	**23**	**29**	**17**	**18**
Madagascar, Rep. of	-1.59	**25**	-1.51	**25**	**22**	**27**	**19**
Congo, Dem. Rep. of the	-1.64	**26**	-1.56	**26**	**31**	**20**	**26**
Guinea	-1.74	**27**	-1.79	**28**	**26**	**28**	**28**
Niger	-1.75	**28**	-1.59	**27**	**27**	**26**	**24**
South Sudan, Rep. of	-2.13	**29**	-1.94	**29**	**28**	**30**	**23**
Angola	-2.16	**30**	-1.98	**30**	**8**	**31**	**15**
Chad	-2.27	**31**	-2.09	**31**	**30**	**29**	**29**

Figure 4. Graphical Representation of FII Post Mobile Money Considerations



4. Impact of Barriers on Financial Inclusion Index

Barriers to financial inclusion, such as lack of documentation, high costs, lack of trust, and distance can represent significant impediments. These barriers prevent individuals and businesses from fully participating in the formal financial system, hindering their ability to save, invest, and access credit, which in turn limits their economic opportunities and potential for growth (Cámara & Tuesta, 2014). In this section, we investigate the impact of

these barriers on the Financial Inclusion Index. Given the limited data availability on barriers indicators, only 20 countries are included in this analysis.

4.1. 2021 Financial Inclusion Index Pre-Barriers Considerations

To be able to discern the impact of adding barriers dimension on the FII we first performed the analysis for the 20 countries, including the baseline and mobile money indicators :

$$Y^{2021}_{availability,i} = \alpha_1 * ATMs\_adult_i + \alpha_2 * ATMs\_km2_i + \alpha_3 * bankbr\_adults_i + \alpha_4 * bankbr\_km2_i + \alpha_5 * reg\_mb\_adults_i + \alpha_5 * reg\_mb\_km2_i + \varepsilon_i$$

$$Y^{2021}_{access,i} = \beta_1 * own\_credit\_cards_i + \beta_2 * own\_debit\_cards_i + \beta_3 * accts_i + \beta_4 * mb\_accts_i + \varepsilon_i$$

$$Y^{2021}_{usage,i} = \theta_1 * ost\_loans_i + \theta_2 * ost\_deposits_i + \theta_3 * borrowers_i + \theta_4 * depositors_i + \theta_5 * mb\_transac_i + \varepsilon_i$$

4.1.1. *First-Stage PCA Pre-Barriers Considerations*

Availability Dimension

In the availability dimension, the first principal component (PC1) explains 51.99% of the variance, while the second component (PC2) accounts for 30.28%. The third component (PC3) explains 12.21% of the variance, and the remaining components (PC4, PC5, and PC6) have minimal contributions of 3.49%, 2.01%, and 0.03%, respectively.

The eigenvalues for PC1 and PC2 are 3.1193 and 1.8166.

Access Dimension

For the access dimension, PC1 proves to be the most influential, explaining 74.24% of the variance. The subsequent component, PC2, accounts for 20.23% of the variance, while PC3 and PC4 have minimal contributions of 4.92% and 0.61%, respectively.

The eigenvalues for PC1, PC2, PC3, and PC4 are 2.9696, 0.8091, 0.1968, and 0.0244, highlighting the dominant role of PC1 in explaining the variability in the access dimension.

Usage Dimension

The usage dimension exhibits a more distributed variance among the components. PC1 explains 63.46% of the variance, while PC2 accounts for 16.70%. The remaining components, PC3, PC4, and PC5, have contributions of 9.70%, 7.13%, and 3.00%, respectively.

The eigenvalues for PC1, PC2, PC3, PC4, and PC5 are 3.1731, 0.8349, 0.4852, 0.3566, and 0.1502, indicating the importance of PC1 in capturing the variability in the usage dimension.

Table 11. 2021 Principal Component estimates for sub-indices, post mobile money considerations (updated sample)

Components	Eigenvalue	Difference	Proportion	Cumulative
		Availability		
Comp 1	3.1193	1.3028	0.5199	0.5199
Comp 2	1.8166	1.0839	0.3028	0.8227
Comp 3	0.7327	0.5233	0.1221	0.9448
Comp 4	0.2094	0.0891	0.0349	0.9797
Comp 5	0.1204	0.1188	0.0201	0.9997
Comp 6	0.0016	.	0.0003	1.0000
		Access		
Comp 1	2.9696	2.1605	0.7424	0.7424
Comp 2	0.8091	0.6123	0.2023	0.9447
Comp 3	0.1968	0.1725	0.0492	0.9939
Comp 4	0.0244	.	0.0061	1.0000
		Usage		
Comp 1	3.1731	2.3382	0.6346	0.6346
Comp 2	0.8349	0.3497	0.1670	0.8016
Comp 3	0.4852	0.1286	0.0970	0.8986
Comp 4	0.3566	0.2064	0.0713	0.9700
Comp 5	0.1502	.	0.0300	1.0000

4.1.2. *Second-Stage PCA Pre-Barriers Considerations*

The second stage of the PCA for the new set of 20 countries yields the weights for each dimension in the overall Financial Inclusion Index. The weights assigned to the availability, access, and usage dimensions are 0.5689, 0.5715, and 0.5914, respectively.

4.1.3. *Country Rankings Pre-Barriers Considerations*

Mauritius, South Africa, and Namibia emerge as the top three countries, with Mauritius maintaining its position as the country with the highest level of financial inclusion. These countries perform well across all three dimensions.

At the lower end of the spectrum, Tanzania, Guinea, and South Sudan have the lowest Financial Inclusion Index (FII) scores. These countries consistently rank among the bottom five across all dimensions, highlighting the need for targeted interventions to improve the availability, access, and usage of financial services.

Table 12. 2021 Estimation of the FII and Ranking, including mobile money (updated sample)

Country	FII	Ranks	Availability	Ranks	Access	Ranks	Usage	Ranks
Mauritius	9.91	**1**	6.75	**1**	5.07	**1**	5.37	**9**
South Africa	4.51	**2**	1.40	**3**	3.33	**2**	3.05	**14**
Namibia	3.83	**3**	1.49	**2**	2.21	**3**	2.91	**11**
Nigeria	0.66	**4**	0.08	**5**	0.83	**5**	0.23	**12**
Mozambique, Rep. of	0.26	**5**	-0.59	**11**	0.97	**4**	0.06	**10**
Mali	-0.40	**6**	-0.84	**15**	0.02	**6**	0.11	**8**
Ghana	-0.52	**7**	0.98	**4**	-0.58	**9**	-1.27	**5**
Senegal	-0.56	**8**	-0.46	**8**	-0.61	**10**	0.09	**13**
Uganda	-0.57	**9**	-0.57	**10**	-0.03	**7**	-0.39	**18**
Togo	-0.59	**10**	-0.22	**6**	-0.81	**13**	-0.01	**17**
Burkina Faso	-1.07	**11**	-0.83	**14**	-0.80	**12**	-0.24	**2**
Cote Ivoire	-1.43	**12**	-0.49	**9**	-1.33	**18**	-0.67	**4**
Cameroon	-1.45	**13**	-0.90	**16**	-0.69	**11**	-0.93	**3**
Malawi	-1.47	**14**	-0.74	**13**	-0.82	**14**	-0.99	**7**
Zimbabwe	-1.55	**15**	-0.39	**7**	-0.55	**8**	-1.72	**20**
Benin	-1.59	**16**	-0.70	**12**	-1.29	**17**	-0.77	**1**
Zambia	-1.73	**17**	-1.00	**19**	-0.86	**15**	-1.13	**19**
South Sudan, Rep. of	-1.96	**18**	-1.05	**20**	-1.34	**19**	-1.01	**15**
Guinea	-2.08	**19**	-0.99	**18**	-1.27	**16**	-1.34	**6**
Tanzania, United Rep. of	-2.18	**20**	-0.94	**17**	-1.47	**20**	-1.37	**16**

4.2. 2021 Financial Inclusion Index Post-Barriers Considerations

Below are the results of the Two-Stage PCA analysis and derived Country Rankings when considering barriers indicators.

4.2.1. First-Stage PCA Post-Barriers Considerations

Availability Dimension

The percentage variance explained and the eigenvalues are identical to those on the pre-barriers model, as no indicator were added nor removed from the availability dimension.

Access Dimension

The percentage variance explained and the eigenvalues are identical to those on the pre-barriers model, as no indicator were added nor removed from the access dimension.

Usage Dimension

The percentage variance explained and the eigenvalues are identical to those on the pre-barriers model, as no indicator were added nor removed from the usage dimension.

Barriers Dimension

In the barriers dimension, the first principal component (PC1) explains 78.44% of the variance, while the second component (PC2) accounts for 11.21%. The third and fourth components (PC3 and PC4) have minimal contributions of 5.64% and 4.71%, respectively.

The eigenvalues for PC1 and PC2 are 3.1377 and 0.4482, confirming the dominant role of PC1 in capturing the variability within the barriers dimension.

Table 13. 2021 Principal Component estimates for sub-indices, including mobile mony and barriers

Components	Eigenvalue	Difference	Proportion	Cumulative
		Availability		
Comp 1	3.1193	1.3028	0.5199	0.5199
Comp 2	1.8166	1.0839	0.3028	0.8227
Comp 3	0.7327	0.5233	0.1221	0.9448
Comp 4	0.2094	0.0891	0.0349	0.9797
Comp 5	0.1204	0.1188	0.0201	0.9997
Comp 6	0.0016	.	0.0003	1.0000
		Access		
Comp 1	2.9696	2.1605	0.7424	0.7424
Comp 2	0.8091	0.6123	0.2023	0.9447
Comp 3	0.1968	0.1725	0.0492	0.9939
Comp 4	0.0244	.	0.0061	1.0000
		Usage		
Comp 1	3.1731	2.3382	0.6346	0.6346
Comp 2	0.8349	0.3497	0.1670	0.8016
Comp 3	0.4852	0.1286	0.0970	0.8986
Comp 4	0.3566	0.2064	0.0713	0.9700
Comp 5	0.1502	.	0.0300	1.0000
		Barriers		
Comp 1	3.1377	2.6895	0.7844	0.7844
Comp 2	0.4482	0.2224	0.1121	0.8965
Comp 3	0.2258	0.0375	0.0564	0.9529
Comp 4	0.1883	.	0.0471	1.0000

4.2.2. *Second-Stage PCA Post-Barriers Considerations*

The inclusion of the barriers dimension has led to changes in the weights assigned to the availability, access and usage dimensions. The weights for the availability and access dimensions have decreased from 0.5689 to 0.5012 and from 0.5715 to 0.5020, respectively, indicating a reduced importance of these dimensions when accounting for barriers. Similarly, the weight for the usage dimension has decreased from 0.5914 to 0.5131. The newly introduced barriers dimension has a weight of 0.4832, suggesting its significant contribution to the overall Financial Inclusion Index.

Despite these changes, the overall ranking of the dimensions' contributions to financial inclusion remains relatively consistent, with usage being the most influential, followed by access, availability, and barriers.

4.2.3. *Country Rankings Post-Barriers Considerations*

Comparing the rankings pre and post accounting for barriers reveals their impact on the assessment of financial inclusion in Sub-Saharan Africa. The overall rankings remain largely consistent, with Mauritius, South Africa, and Namibia maintaining their positions as the top three countries in both scenarios.

However, there are some notable shifts in the relative positions of other countries. For example, Ghana's ranking improves from the 7th position before barrier considerations to the 5th position, suggesting that the country performs relatively well in terms of overcoming barriers to financial inclusion, as evidenced by its 4th rank in the barriers dimension.

On the other hand, countries like Uganda and Cote Ivoire experience a decline in their rankings when barriers are considered. Uganda moves from the 9th position to the 13th, while Cote Ivoire drops from the 12th to the 15th position. This highlights the significant challenges these countries face in terms of barriers to financial inclusion, as reflected in their relatively low ranks in the barriers dimension (18th and 14th, respectively).

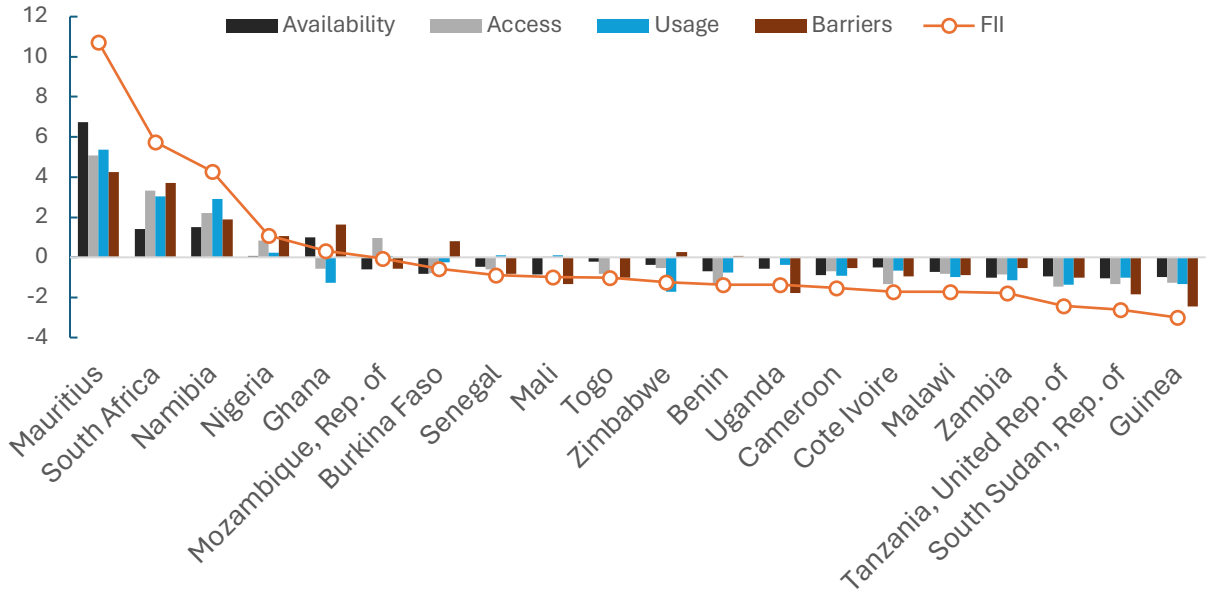
Considering barriers also sheds light on the persistent challenges faced by some countries, such as South Sudan and Guinea, which continue to rank at the bottom of the index in both scenarios. This underscores the need for targeted interventions to address the specific barriers to financial inclusion in these countries, as they rank 19th and 20th, respectively, in the barriers dimension.

The inclusion of the barriers dimension in the Financial Inclusion Index provides a more comprehensive understanding of the factors affecting financial inclusion in Sub-Saharan Africa. It highlights the importance of addressing and overcoming barriers to foster greater financial accessibility and usage, alongside efforts to improve availability, access, and usage of financial services.

Table 14. 2021 Country Rankings Comparisons Pre and Post Barriers Considerations, including mobile money

	FII Pre-Barriers		FII Post-Barriers					
Country	FII Score	FII Ranks	FII Score	FII Ranks	Availability Ranks	Access Ranks	Usage Ranks	Barriers Ranks
Mauritius	9.91	1	10.74	1	1	1	1	1
South Africa	4.51	2	5.74	2	3	2	2	2
Namibia	3.83	3	4.27	3	2	3	3	3
Nigeria	0.66	4	1.08	4	5	5	4	5
Mozambique, Rep. of	0.26	5	-0.05	6	11	4	7	11
Mali	-0.40	6	-1.00	9	15	6	5	17
Ghana	-0.52	7	0.34	5	4	9	17	4
Senegal	-0.56	8	-0.89	8	8	10	6	12
Uganda	-0.57	9	-1.36	13	10	7	10	18
Togo	-0.59	10	-1.01	10	6	13	8	15
Burkina Faso	-1.07	11	-0.55	7	14	12	9	6
Cote Ivoire	-1.43	12	-1.70	15	9	18	11	14
Cameroon	-1.45	13	-1.53	14	16	11	13	10
Malawi	-1.47	14	-1.71	16	13	14	14	13
Zimbabwe	-1.55	15	-1.23	11	7	8	20	7
Benin	-1.59	16	-1.35	12	12	17	12	8
Zambia	-1.73	17	-1.77	17	19	15	16	9
South Sudan, Rep. of	-1.96	18	-2.61	19	20	19	15	19
Guinea	-2.08	19	-3.00	20	18	16	18	20
Tanzania, United Rep. of	-2.18	20	-2.41	18	17	20	19	16

Figure 5. Graphical Representation of FII Post Mobile Money and Barriers Considerations



VII. Conclusion

This thesis has developed a comprehensive, multidimensional index to measure financial inclusion in Sub-Saharan Africa, incorporating an expanded set of indicators across the key dimensions of availability, access, usage, and barriers. By employing a robust two-stage principal component analysis methodology, the study provides a rigorous, data-driven assessment of financial inclusion that captures the complex interplay between these dimensions while being easily interpretable and comparable across countries and over time.

The main findings reveal significant variations in financial inclusion levels across Sub-Saharan African countries, with Mauritius, South Africa, and Namibia consistently emerging as the top performers, while countries like the Central African Republic, Democratic Republic of the Congo, and Chad rank at the bottom of the index. The evolution of the index from 2011 to 2021 highlights the uneven progress in financial inclusion across the region, with some countries making substantial strides while others have stagnated or even regressed.

Notably, the incorporation of mobile money indicators in the index underscores the transformative role of digital financial services in advancing financial inclusion in Sub-Saharan Africa. This finding emphasizes the potential of innovative technologies to bridge the financial access gap and reach underserved populations.

Furthermore, the inclusion of the barriers dimension provides a more nuanced understanding of the challenges impeding financial inclusion in the region. Countries that perform poorly on indicators related to cost, documentation, distance, and trust tend to have lower overall financial inclusion scores, even if they have made progress in improving availability and access. This insight highlights the importance of addressing demand-side barriers alongside supply-side interventions to foster inclusive financial systems.

The findings of this study have important policy implications for Sub-Saharan African countries seeking to promote financial inclusion. By providing a comprehensive and granular assessment of financial inclusion across multiple dimensions, the index can serve as a

valuable tool for policymakers to diagnose bottlenecks, prioritize reforms, and track progress over time. The results underscore the need for holistic, multi-pronged strategies that address challenges related to financial infrastructure, product design, consumer protection, and financial literacy.

Moreover, the study contributes to the growing body of research on financial inclusion measurement by proposing an enhanced methodology that is specifically tailored to the Sub-Saharan African context. By incorporating a wider range of indicators and dimensions, including those related to digital financial services and barriers, the index offers a more comprehensive and policy-relevant assessment of financial inclusion compared to existing measures that often rely on a narrower set of supply-side indicators.

In conclusion, this thesis advances our understanding of financial inclusion in Sub-Saharan Africa by providing a robust, multidimensional measure that captures the complex realities of the region. The insights generated by the index can inform evidence-based policymaking and support targeted interventions to promote inclusive finance as a key enabler for poverty reduction, gender equality, and sustainable economic growth. As Sub-Saharan African countries continue to grapple with the challenges of financial exclusion, this research offers a valuable tool to assess progress, identify gaps, and unlock the untapped potential of inclusive financial systems in driving shared prosperity across the continent.

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