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# Construction of a Financial Inclusion Index for Kenya.

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# Construction of a Financial Inclusion Index for Kenya

Kelly Akuku Wafula

Submitted in partial fulfillment for the Degree of Master of Science in  
Mathematical Finance at Strathmore University

Institute of Mathematical Sciences  
Strathmore University

Nairobi, Kenya

November 2021

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# Declaration

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08/10/2021

Signature

Date

**Kelly Akuku Wafula**

This thesis has been submitted for assessment with our approval as supervisors according to Strathmore University regulations.



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**Strathmore University**

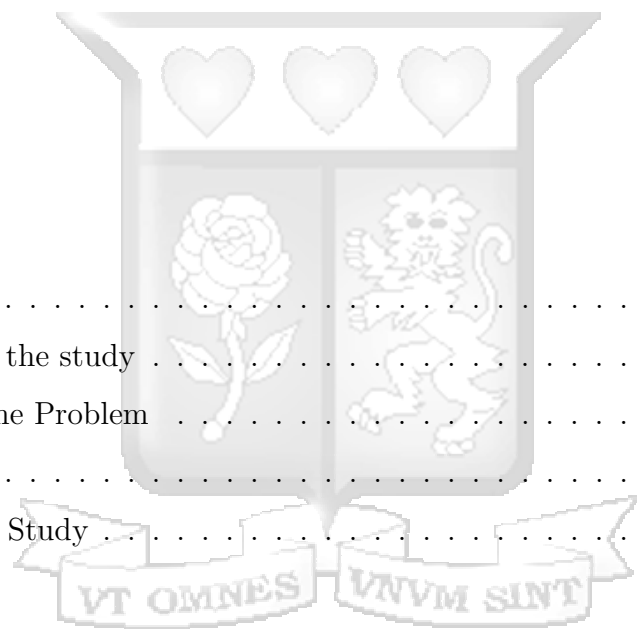
# Abstract

This study constructed a Financial Inclusion Index (FII) to measure access to, availability of and usage of financial services in Kenya using data collected from IMF reports for the period 2013 – 2019. A two-stage principal component analysis (PCA) method was applied in constructing the FII that was found to satisfy the Kaiser-Meyer-Olkin (KMO) measure to both the indicators and the dimensions. The research offers ideas for policy-making by highlighting the contributions of the variables to the dimensions, subsequently, the contributions of the dimensions to the index. Therefore, the FII can act as an analytical tool for surveillance of the variables for a more inclusive financial system.

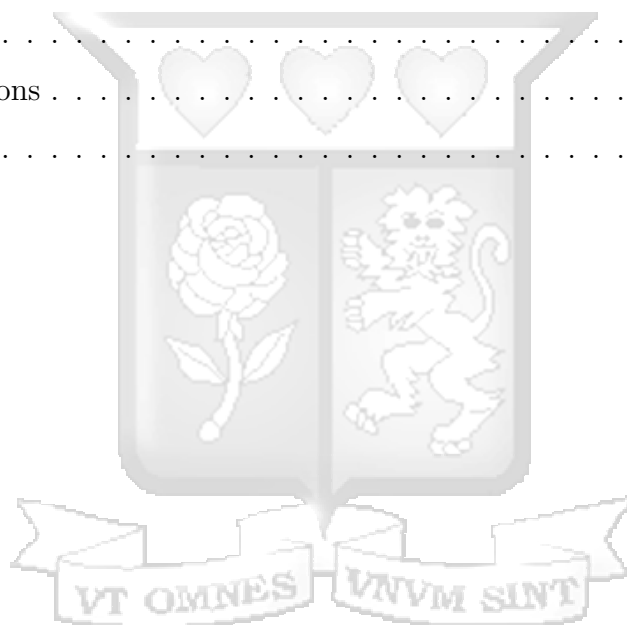


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# Dedication

This research work is dedicated to my daughter (Maya Kaptuya) for her undying love and support throughout the study, and above all the Almighty God for His provisions that were in abundance throughout my studies.



# Abbreviations

CBK	Central Bank of Kenya
CFA	Common Factor Analysis
DTR	Distance to Reference
FI	Financial Inclusion
FII	Financial Inclusion Index
FSD	Financial Sector Deepening
GDI	Gender-Related Development Index
HDI	Human Development Index
HPI	Human Poverty Index
IRA	Insurance Regulations Authority
KBA	Kenya Bankers Association
NGOs	Non-governmental organizations
PC	Principal Component
PCA	Principal Component Analysis
PWD	Persons with Disabilities
SME	Small and Medium-sized Enterprises
UNDP	United Nations Development Program



# Chapter One

## 1 Introduction

### 1.1 Overview

Financial Inclusion is defined as access to affordable and useful financial services and products that cater for daily needs and are delivered in a responsible sustainable way, World Bank (2020). This paper defines an inclusive financial system as one that maximizes access, usage and availability of affordable and formal financial services. Financial Inclusion facilitates day-to-day activities and assists families to plan for random events as well as long-term achievements. According to World Bank (2020), Financial inclusion is fundamental to understanding poverty and it is a building block to boosting prosperity while eradicating poverty. Access to and utilization of formal financial services is a key enabler for financial inclusivity, Findex (2017).

Africa's financial system's limited outreach and its underdevelopment are well documented. Low and volatile high illiteracy rates, income levels, governance challenges, inflationary environments, inadequate infrastructure, the limited competition within the banking industry and high cost of banking in Africa are some of the factors used in explaining the limited outreach and less development of the financial sector, ABD (2013).

Overall progress in financial inclusion has been achieved in Africa between 2011 and 2017, the share of adults with financial accounts in the region grew by 20%, driven largely by growth in mobile money. Although East Africa has seen the most dramatic increase, Central and West Africa have also seen a rapid gain in recent years, bolstered by enabling regulatory policies. Most of these countries also experienced a sharp uptick in financial inclusion rates among women. Within the same period, the number of women with their accounts doubled in Ghana and Kenya while in Senegal it increased by almost seven times the previous rate, Gates Foundation (2019).

Findex (2017) highlights that the state of financial inclusion across the world has improved tremendously over the past years. Adults with accounts have increased by 94% in North America, which was the highest compared to the rest of the continents, while Africa increased by

less than 50%. Adults with accounts in Sub-Saharan Africa between 2011 and 2017 had an increment of 48%. It is noted that unbanked adults are more likely to have low educational attainment. Nigeria was found to have the highest number of non-account holders at 64.5 million and a gender gap of approximately 25% in account ownership. Lesotho and South Africa were the only Sub-Saharan countries in Africa that exhibited a gender gap in favor of women. The gender gaps have implications for women's labor force participation, in particular, entrepreneurship as they restrict women's economic opportunities, Gonzales et al. (2015). Indeed, the literature on banking and entrepreneurship also provides evidence of gender discrimination in entrepreneurs' ability to obtain a loan, Klapper et al. (2010).

## 1.2 Background to the study

The Kenyan Government has set up new initiatives for financial inclusion through the Financial Sector Deepening (FSD) Kenya. FSD Kenya is an independent trust which works together with the Kenyan Government and the financial service industry to achieve an inclusive financial system by developing financial solutions that address challenges faced by low-income households and under-served groups such as the youth and women. FSD Kenya has set up a series of household surveys that measure both the demand and supply dimensions of financial inclusion and the impact of financial services for the country. The surveys assist identify barriers to financial inclusion as well as assisting the private sector in identifying new market opportunities, FSD (2020).

In Kenya's history, people had to come up with financial solutions. The informal approaches are often effective due to their flexibility and low cost. However, as the economy modernizes most informal lenders tend to reach limits of informal finance. As a result, there has been much emphasis on the expansion of the reach of formal finance. Unfortunately, the impact has been lower than expected. First, many formal services are not relevant to the needs of many Kenyans especially the less fortunate households which find informal solutions better, FinAccess (2019). Second, market conduct is an increasing challenge mainly due to a lack of fair treatment and transparency.

Formal financial inclusion has grown from 29% to 83% in Kenya in 2019 while exclusion has gone down to 11% of the population who use no financial services. Meanwhile, over half the population is still using informal financial solutions. Most regions in Kenya have seen a modest

increment in financial inclusion since 2016. FinAccess (2019), shows major cities reaching almost full financial inclusion with 96% being in Nairobi and 94% in Mombasa. North-Eastern region has seen a jump of close to 60% mainly through the introduction of mobile money. This is also the case for the gaps in inclusion by wealth and gender. Digital revolution has narrowed the gap, which is evident from 6% difference between women and men and the increase in formal access for the less fortunate which has risen from 10% in 2006 to 70% in 2019, FSD (2020).

In 2009 and 2012, the banking industry received a boost with the launch of agency banking and MShwari respectively which opened a new era of banking. Recently, however, the banks are unable to maintain the pace due to inadequate innovation which is now a standard mobile banking offer, FinAccess (2019). This has led to a decline of 4% in the usage of banks by the wealthy. Nevertheless, cost remains the main barrier to the usage of banks, mobile money and insurance.

In 2014 regulation and supervision of payment service providers and payment systems were brought within the jurisdiction of the CBK. This fostered codependence, improved the stability of the systems, acted as a measure to reduce systemic risk and also increased competition (thus consumer protection). To improve on price transparency, commercial banks began disclosing the repayment schedule for loans and the total cost of credit, FSD (2020). The Kenyan Government has overcome policy constraints by committing to increase access to financial providers' capacity to better meet the need of SMEs and expansion of credit information sharing system.

Kenya has experienced a steady increase in borrowing and saving from 2013 to 2019. Over 50% of the population have a loan while 70% of the population are saving either formally or informally. The savings rates have almost remained the same through the years with periodic fluctuations due to liquidation of deposits in times of stress and the change in economic conditions, FSD (2020).

### **1.3 Statement of the Problem**

It has been argued that financial inclusion may effect financial development growth and poverty reduction, Hanning and Jansen (2010). Sayi et al. (2016) documented that a financial Inclusion Index is a measurement tool that provides detailed insight into how adults in a given economy manage risk, make payments, save, borrow and access accounts. The development of a comprehensive Financial inclusion index for Kenya would therefore assist in measuring

progress and identification of priorities. It would also deepen the understanding of an inclusive financial system by testing relationships between financial inclusion and other variables and measuring the impact of policies put in place.

Recent studies show that there have been some efforts to develop a multidimensional index to measure FI level. However, this also opens the debate that these indices are necessary but not sufficient for an all-inclusive idea. Therefore, it can be seen that the measurement of the degree of FI has not yet reached a formal consensus, Park and Mercado (2018). The measurements of FI through studies are not only different in approach, but the indicators selected to calculate the FI index are also different. In addition, the absence of “mobile money” factor in measuring FI is also one of the key points filled in the study and the addition of other services besides banking-related services to the FI index when calculating this index.

Therefore, this study aimed to investigate the contributions of the financial inclusion variables to the overall financial inclusion index and subsequently, the construction of a financial inclusion index for Kenya. The study would also add to the existing research base as well as provide information to policy makers to improve on the areas of weaknesses, thereby encouraging a more inclusive financial system.

## 1.4 Objectives

### Main Objective

To construct a financial inclusion index for Kenya.

### Specific Objective

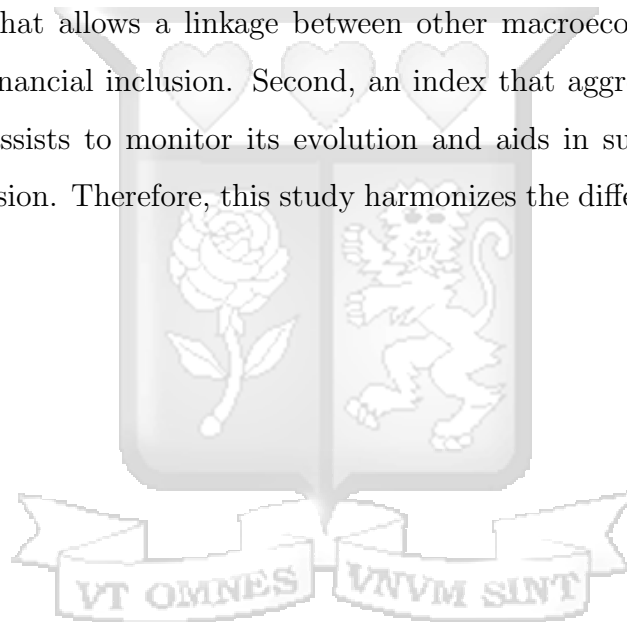
1. To estimate the dimensions (access, availability and usage) using a two-stage PCA methodology.
2. To compute the FI index for the period 2013 to 2019.

## 1.5 Justification of Study

The study aims to create a robust indicator of the depth of financial inclusion based on a sound methodology. The index improves existing financial inclusion indices, for example, by Camara et al. (2014) in three different ways. This is achieved by the inclusion of both the population

and geometric variables, the study expands the scope of variables captured in the dimensions for the construction of the index. The study also uses a parametric method which avoids the problem of weighting assignment, Nguyen (2015). Unlike other studies, the research seeks to compare the depth of financial inclusion in Kenya throughout the years, instead of ranking it with other countries. This is a microscopic level study that shows which variables need to be emphasized.

The selected dimensions have been proven in the literature to be of importance in the construction of financial indices. However, there is an absence of a standard measure that includes multiple dimensions and information to define financial inclusion. The research incorporates a multidimensional measurement of financial inclusion which is important in several aspects. First, it is a measure that allows a linkage between other macroeconomic variables such as economic growth and financial inclusion. Second, an index that aggregates several indicators into a single measure assists to monitor its evolution and aids in summarizing the complex nature of financial inclusion. Therefore, this study harmonizes the different dimensions utilized by previous studies.



# Chapter Two

## 2 Literature review

### 2.1 Introduction

This Chapter focuses on three areas: Section 2.2 explains the ideology of the methodologies utilized in building Indices, section 2.3 describes the rationale for the chosen sub-indices and the indicators that measure financial inclusion dimensions as supported by empirical evidence and finally section 2.4 gives the research gaps.

### 2.2 Financial Inclusion Research Models

Recent studies have been carried out in the building of FI indices. They have applied both parametric and non-parametric methods.

#### 2.2.1 Non-Parametric Methods

Non-parametric methods that have been utilized to build financial inclusion indices include the Simple arithmetic method (Sarma (2016), Nabard (2009), Mynard et al. (2015) and Sayi et al. (2016)), Geometric mean method as utilized by Nguyen (2015) and Modified Distance to Reference (DTR) method, Mynard et al. (2015). Sarma (2016) used the arithmetic mean as utilized by UNDP in the development of indices such as the Human Development Index (HDI), Gender-Related Development Index (GDI) and Human Poverty Index (HPI). This is also similar to Sayi et al. (2016), the study calculates a measurement for each dimension then the index for the  $i^{th}$  city is then expressed as the normalized Euclidean distance of the sub-indices from the ideal point. The ideal point is equal to one. The dimensions utilized are banking penetration, availability and usage.

Sethy (2016) utilized the same methodology introducing a different weighting element in computing both the dimensions and the index. The dimensions were grouped into two: the demand-side and the supply-side where the demand-side covered access, availability and usage of the banking services. The supply-side captured access to savings, insurance accounts and bank risk.

Following the methodology proposed by UNDP in computing its indices, a financial inclusion index was constructed for India as a geometric mean for the dimensions, Gupte et al.

(2012). The methodology adopted by UNDP to calculate HDI before 2010 attracted a lot of criticism which led to the introduction of the geometric mean in the construction of indices. The introduction of the geometric mean embodies the uneven substitutability across all dimensions, thus addressing serious criticisms of the linear aggregation formula which allowed for perfect substitution in all dimensions, Gupte et al. (2012). The study covered two dimensions: penetration of banks and usage.

In Mynard et al. (2015), the Philippines Financial Inclusion index was constructed based on a modified DTR which focused on two dimensions: access and usage. FII index is constructed for banking outreach, where FII lies between zero which depicts no inclusion and one which represents full inclusion. The actual value for each dimension is divided by the overall mean of that indicator, and subsequently, the mean of all the dimensions provides the proposed demand-side or supply-side composite index. Separate composite FIIs using both the data sets are then calculated for the different years.

The financial inclusion index built from the above-mentioned non-parametric methods failed to capture the percentage contribution of individual components to the index. This makes the proposed indices unsuitable for identifying the strengths of the specific dimensions in the index. The weighting method utilized in non-parametric methods has received criticism since they rely on a researcher's intuition. Recent research has therefore relied on parametric methods to construct indices.

### **2.2.2 Parametric Methods**

Parametric methods used in the construction of the indices include Principal Component Analysis and Common Factor Analysis (CFA). Massara et al. (2014) and Amidzic et al. (2014) attempted to build a composite financial inclusion index using CFA. Empirical evidence supports that PCA is preferred over Common Factor Analysis as an indexing strategy because it does not necessitate making assumptions on the raw data, for example, the selection of the underlying number of common factors.

Pineiro (2013) attempted to construct a financial inclusion index for Mexico using dimensions such as access, usage, financial education, consumer protection and social development. The paper highlights that Principal Components are linear combinations of original indicators,

which are uncorrelated and have a maximum variance. In the paper, PCA is used to reduce the number of clusters. Wards method is then applied for hierarchical cluster analysis. Finally, the study distinguishes the differences between states and geographical regions through explanatory data analysis.

Camara et al. (2014) measured the Financial Inclusion of several countries using a two-stage PCA method. The study utilized three dimensions: access, usage and barriers. In the study, the methodology was found to be statistically sound for index construction and highly recommended for high-dimensional data. The study, however, did not utilize the availability of financial products to capture the financial inclusion indices.

Nguyen (2015) focused on measuring financial inclusion for developing countries using the PCA methodology. In the study, the dimensions were grouped into two: demand-side and supply-side. The supply-side dimensions were access and availability while the demand-side dimension was usage. The study then verified the strength of the Financial Inclusion Index. This was achieved by examining the correlation between the household-based indicator from the Global Findex database and the financial inclusion index generated by PCA methodology. The strength was found to be 51%, thus concluding that PCA is a recommendable methodology.

### **2.3 Financial Inclusion Dimensions and Indicators**

Sarma (2016) categorized countries depending on the value of FII where an index of above 0.6 was for high financial inclusion, medium financial inclusion was between 0.4 to 0.6 and low financial inclusion was less than 0.4. She finally ranked 45 countries that had all three sub-indices available and a further 81 countries that had only two sub-indices available in chronological order of the FII to indicate their relative positions among other countries. Following Sarma (2016), several researchers, have calculated the FII for specific states (Nguyen (2015), Camara et al. (2014), Sayi et al. (2016)) and some like Nabard (2009) estimated values of the Financial Inclusion Index at the district level in India.

In (Sarma (2016), Chattopadhyay et al. (2011), Charkravarty et al. (2010) and Kuri et al. (2011)), the accessibility dimension focused on one demographic indicator (Number of Bank accounts per 1000 adults), availability dimension focused on two demographic indicators (Number of Branches per 1000 adults and Number of ATMs per 1000 adults) and the usage

dimension utilized one proxy indicator (Volume of Deposits + Loans as a percentage of GDP). Similarly, Gupte et al. (2012), considers the demographic indicators in each dimension and in addition to the demographic indicators she also considers the geographic indicators. However, under penetration, she does not include the number of bank accounts per 1000 adults. Arora (2010) on the other hand utilizes only two dimensions accessibility and availability and fails to capture the number of bank accounts per 1000 adults in the accessibility dimension.

Following Yadav et al. (2020), Velan et al. (2021) used five supply-side and three demand-side indicators for measuring financial inclusion across the Indian states. The supply-side financial inclusion indicators used in the study were one measuring penetration and three measuring availability. Usage was captured using the percentage of total credit and deposit as the proportion of the state's GDP.

## 2.4 Research Gaps

In each of the previous attempts, the index was computed using select dimensions. An attempt to measure financial inclusion should consider as many FI dimensions and FI indicators as possible. Therefore, the present paper attempts to include all dimensions and indicators within the dimensions that have been considered so far by various authors. Therefore, this index will be more representative of the extent of financial inclusion in Kenya.

Further, the existing indices covered a period up to 2017 (Sarma (2016), Gupte et al. (2012), Charkravarty et al. (2010), Kuri et al. (2011), Nabard (2009)). The current study has constructed the index using the recently available databases from the IMF. The database gives access to additional information on the variables in the various dimensions. This makes the study more current and reflective of the initiatives adopted by the Government, Banks and NGOs throughout the years. Further, since the index is computed identically over 7 years the result is comparable and highlights the impact of financial inclusion in Kenya during this period.

# Chapter Three

## 3 Research Methodology

### 3.1 Data

The study uses data on access from the International Monetary Fund's Website. It is a source of data that offers raw information on a panel of 189 countries. The study will focus on the annual data for the period 2013 to 2019.

### 3.2 Financial Inclusion Indicators

The study will focus on accessibility, availability and usage as indicators of financial inclusion.

1. Accessibility: A good financial system should have many users Nguyen (2015), the study, therefore, utilizes: the number of registered mobile money accounts, institutions of commercial banks, number of insurance corporations and Number of deposit-taking microfinance institutions.
2. Availability: According to Sarma (2016) and Nguyen (2015) the bank transaction points should be readily available for the users. The study, therefore, employs the use of commercial bank branches per 1,000  $km^2$ , commercial bank branches per 100,000 adults, ATMs per 1,000  $km^2$ , ATMs per 100,000 adults, Number of registered mobile money agents outlets per 100,000 adults and Number of registered mobile money agents outlets per 1,000  $km^2$ .
3. Usage: Outstanding deposits with commercial banks as a % of GDP, Outstanding loans from commercial banks as a % of GDP, Number of mobile money transactions (during the reference year) per 1,000 adults, Value of mobile money transactions (during the reference year) (% of GDP), credit cards per 1,000 adults and debit cards per 1,000 adults.

<b>Variable</b>	
<i>Access</i>	
No. of banks	institutions of commercial banks
No. of DTMFI	number of deposit-taking microfinance institutions.
NO. of reg. mobile money outlets	the number of registered mobile money accounts
No. of insurance corp.	number of insurance corporations
<i>Availability</i>	
No. of branches\1,000 km <sup>2</sup>	number of commercial bank branches per 1,000 km <sup>2</sup>
No. of branches\100,000 adults	number of commercial bank branches per 100,000 adults
No. of ATMs\1,000 km <sup>2</sup>	ATMs per 1,000 km <sup>2</sup>
No. of ATMs\100,000 ad.	ATMs per 100,000 adults
No. of reg. mobile money outlets\100,000 ad	mobile money outlets per 100,000 adults
No. of reg. mobile money outlets\1,000 km <sup>2</sup>	mobile money outlets per 1,000 km <sup>2</sup>
<i>Usage</i>	
Outstanding deposits(% of GDP)	Deposits Outstanding with commercial banks as a % of GDP
Outstanding loans(% of GDP)	loans outstanding from commercial banks as a % of GDP
No. of mobile money transactions\1,000 ad	Number of mobile money transactions per 1,000 adults
Value of mobile transactions(% of GDP)	transactions value of mobile money as a % of GDP.
No. of credit cards\1,000 adults	Number of credit cards per 1,000 adults
No. of debit cards\1,000 adults	Number of debit cards per 1,000 adults

Figure 1: Dimension's Variables

### 3.3 Principal Component Analysis

Early literature on PCA dates Pearson in 1901 and Hotelling in 1933. Pearson, in his attempt to explain PCA Methodology, concluded that the best fitting straight line is the one that captures maximum variance. Both attempt to preserve as much variability as possible while translating into finding new variables. It was not until electronic computers became available widely that it became feasible to use data-sets that were not trivially small Everitt (2001).

The selection of relevant variables is a key element in indexing financial inclusion. Standard reduction methods of variable selection, such as elimination of less informative variables, result in loss of information. Weight assignment to variables is essential to capture maximum information in the index. A reliable financial index should capture relevant information from all the variables Camara et al. (2014) while avoiding strong biasedness towards one of the indicators.

Thus, the study seeks to determine the best weighted combination of indicators by use of a two-stage PCA method to estimate a financial inclusion index. The data set is divided into three sub-indices to get undistorted information as well as for methodological purposes. After

estimation of the sub-indices, the weights assigned to the variables are estimated. Finally the financial inclusion index is estimated using the dimensions.

### 3.4 Development of the FI Index

$$FI_i = w_1 Y_i^{ac} + w_2 Y_i^{av} + w_3 Y_i^u + \epsilon_i \quad (1)$$

Where  $i$  is the year

$Y_i^{ac}$ ,  $Y_i^{av}$  and  $Y_i^u$  is the accessibility, availability and usage dimension respectively.

$$Y_i^{ac} = \beta_1 banks_i + \beta_2 insurance_i + \beta_3 mobile_i + \dots + u_i \quad (2)$$

$$Y_i^{av} = \vartheta_1 branches_i + \vartheta_2 ATMS_i + \vartheta_3 outlets_i + \dots + e_i \quad (3)$$

$$Y_i^u = \gamma_1 deposits_i + \gamma_2 loans_i + \gamma_3 mtransactions_i + \dots + v_i \quad (4)$$

#### 3.4.1 Estimation of the Dimensions (First Stage of the PCA)

These are the three endogenous variables  $Y_i^{ac}$ ,  $Y_i^{av}$  and  $Y_i^u$  together with the parameters in the following equations. Since the dimensions are unobserved they will be estimated together with the parameters  $\beta$ ,  $\vartheta$  and  $\gamma$ . Let  $R_p$  is a  $pp$  correlation matrix of the  $p$  standardized variables for each dimension and  $\lambda_j$  is the  $j^{th}$  eigenvalue. Where  $j$  is equal to the number of Principal Components(PC) and  $j = 1, \dots, p$ . The eigenvector of the correlation matrix is presented as  $p$  and the assumption  $\lambda_1 > \lambda_2 > \dots > \lambda_p$  and denote  $P_k (k = 1, \dots, p)$  as the  $k^{th}$  PC. The respective estimator for each dimension to the weighted averages:

$$Y_i^{ac} = \frac{\sum_{k,j=1}^p \lambda_j^{ac} P_{ki}^{ac}}{\sum_{j=1}^p \lambda_j^{ac}} \quad (5)$$

$$Y_i^{av} = \frac{\sum_{k,j=1}^p \lambda_j^{av} P_{ki}^{av}}{\sum_{j=1}^p \lambda_j^{av}} \quad (6)$$

$$Y_i^u = \frac{\sum_{k,j=1}^p \lambda_j^u P_{ki}^u}{\sum_{j=1}^p \lambda_j^u} \quad (7)$$

Where  $P_k = X \lambda_j \lambda_j$  is the variance of the  $k^{th}$  principal component (weights) and  $X$  is the matrix of the explanatory variables.

#### 3.4.2 Estimation of the Weights of the three dimensions (Second Stage of the PCA)

Here the overall financial inclusion index is computed by replacing  $Y_i^{ac}$ ,  $Y_i^{av}$  and  $Y_i^u$  and applying a similar procedure to the one in the first stage.

$$FI_i = \frac{\sum_{k,j=1}^p \lambda_j P_{ki}^u}{\sum_{j=1}^p \lambda_j} \quad (8)$$

The largest weight  $\lambda_1$  is assigned to the first principle component and the subsequent in a chronological manner.

A linear combination of the three dimensions and the eigenvectors of the respective correlation matrices  $\phi$  is formed:

$$P_{1i} = \phi_{11}Y_i^{ac} + \phi_{12}Y_i^{av} + \phi_{13}Y_i^u \quad (9)$$

$$P_{2i} = \phi_{21}Y_i^{ac} + \phi_{22}Y_i^{av} + \phi_{23}Y_i^u \quad (10)$$

$$P_{3i} = \phi_{31}Y_i^{ac} + \phi_{32}Y_i^{av} + \phi_{33}Y_i^u \quad (11)$$

Thus FI is computed as,

$$FI_i = \frac{\sum_{j=1}^3 \lambda_j (\phi_{j1}Y_i^{ac} + \phi_{j2}Y_i^{av} + \phi_{j3}Y_i^u)}{\sum_{j=1}^3 \lambda_j} \quad (12)$$

The weights:

$$w_k = \frac{\sum_{j=1}^3 \lambda_j (\phi_{jk})}{\sum_{j=1}^3 \lambda_j} \quad (13)$$

where  $k = 1, 2, 3$



# Chapter Four

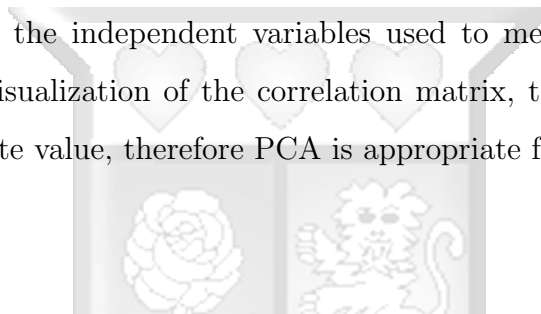
## 4 Results and Discussion

### 4.1 Introduction

This chapter focuses on the results and the discussions of the analysis carried out. Section 4.2 focuses on correlation within the dataset, section 4.3 measures the sampling adequacy, section 4.4 explains the computation of the sub-indices while section 4.5 shows how the FII was built.

### 4.2 Bartlett's Sphericity Test

The correlation matrix for the independent variables used to measure financial inclusion is reported in figure 2. By visualization of the correlation matrix, the values outside the main diagonal are high in absolute value, therefore PCA is appropriate for the chosen variables.



<i>Variables</i>	<i>V[1]</i>	<i>V[2]</i>	<i>V[3]</i>	<i>V[4]</i>	<i>V[5]</i>	<i>V[6]</i>	<i>V[7]</i>	<i>V[8]</i>	<i>V[9]</i>	<i>V[10]</i>	<i>V[11]</i>	<i>V[12]</i>	<i>V[13]</i>	<i>V[14]</i>	<i>V[15]</i>	<i>V[16]</i>
No. of banks	1.00															
No. of DTMFI	-0.68	1.00														
NO. of reg. mobile money outlets	-0.69	0.90	1.00													
No. of insurance corp.	-0.68	0.85	0.87	1.00												
No. of branches\1,000 km2	-0.32	0.62	0.56	0.47	1.00											
No. of branches\100,000 adults	0.32	0.03	-0.23	-0.47	0.17	1.00										
No. of ATMs\1,000 km2	0.37	0.12	-0.05	0.09	0.65	0.26	1.00									
No. of ATMs\100,000 ad.	0.79	-0.58	-0.71	-0.71	0.09	0.55	0.64	1.00								
No. of reg. mobile money outlets\100,000	-0.68	0.92	1.00	0.89	0.57	-0.22	-0.02	-0.70	1.00							
No. of reg. mobile money outlets\1,000 kr	-0.69	0.90	1.00	0.87	0.56	-0.23	-0.05	-0.71	1.00	1.00						
Outstanding deposits(% of GDP)	0.12	0.01	-0.02	-0.17	0.77	0.37	0.65	0.59	-0.02	-0.02	1.00					
Outstanding loans(% of GDP)	0.82	-0.43	-0.58	-0.52	0.08	0.48	0.67	0.87	-0.56	-0.58	0.43	1.00				
No. of mobile money transactions\1,000	-0.66	0.95	0.95	0.94	0.66	-0.22	0.17	-0.61	0.96	0.95	0.05	-0.43	1.00			
Value of mobile transactions(% of GDP)	-0.42	0.71	0.52	0.62	0.85	0.08	0.60	-0.06	0.54	0.52	0.48	0.11	0.73	1.00		
No. of credit cards\1,000 adults	-0.13	0.53	0.37	0.20	0.91	0.56	0.65	0.31	0.39	0.37	0.80	0.27	0.46	0.75	1.00	
No. of debit cards\1,000 adults	0.42	0.03	0.09	0.28	0.39	-0.28	0.77	0.33	0.11	0.09	0.30	0.47	0.23	0.34	0.21	1.00

Figure 2: Correlation Matrix for the variables

Bartlett's Sphericity was carried out to check if the observed correlation matrix drifts significantly from the identity matrix. The null hypothesis states that the variables for the matrix are orthogonal. Therefore, PCA cannot perform compression of the available information if the null hypothesis is true. For measurement of the relationship between variables the absolute value of the correlation matrix is computed, Camara et al. (2014). If the variables are highly

correlated, the absolute value will be equal to zero, thus the null hypothesis is rejected.

In this study, the null hypothesis is rejected at the 5% level since the  $p - value = 0.004528 < 0.05$ . Thus, the correlations between the data-set are significantly large which implies that PCA can be performed on the data-set efficiently.

### 4.3 KMO Measure of Sampling Adequacy (MSA)

The study utilized the KMO measurement to check if the original variables can be factorized efficiently to build the sub-indices. The overall KMO measure for the accessibility dimension is 0.66, availability dimension 0.62 and usage dimension 0.79. This is sufficient for factorization of the indicators as it satisfies  $KMO > 0.5$ , Nguyen (2015).

### 4.4 Financial Inclusion Dimensions

In the attempt to find the weights, eigenvalues were calculated as displayed by table A2. The principal components analysis is based on the rule that eigenvalues greater than 1 are considered for analysis, Pineiro (2013). Therefore, the first principal components (PCs) are considered for analysis. This is also supported by figures 4a, 5a and 6a which show the contribution of each variable to the different PCs. Figures 4b, 5b and 6b show the contributions of the variables in each dimension to PC1.

Figure 3 shows that the weights assigned to each variable are derived from the information in the first PCs. Registered mobile money outlets have the highest assigned weight in comparison with the other variables for the accessibility dimension. Similarly, the number of registered mobile money outlets per  $1000km^2$  is the highest for the availability dimension. For the usage dimension, the number of credit cards per 1000 adults has the highest assigned weight followed by the value of mobile transactions as a percentage of GDP.

<b>Variable</b>	<b>PC1</b>	<b>Weight</b>
<i>Access</i>		
No. of banks	-0.823	20.236
No. of DTMFI	0.945	26.667
NO. of reg. mobile money outlets	0.951	27.019
No. of insurance corp.	0.935	26.077
<i>Availability</i>		
No. of branches\1,000 km2	0.384	4.943
No. of branches\100,000 adults	-0.455	6.955
No. of ATMs\1,000 km2	-0.244	2.003
No. of ATMs\100,000 ad.	-0.866	25.121
No. of reg. mobile money outlets\100,000 ad	0.950	30.278
No. of reg. mobile money outlets\1,000 km2	0.957	30.701
<i>Usage</i>		
Outstanding deposits(% of GDP)	0.778	20.736
Outstanding loans(% of GDP)	0.356	4.339
No. of mobile money transactions\1,000 ad	0.557	10.626
Value of mobile transactions(% of GDP)	0.875	26.244
No. of credit cards\1,000 adults	0.910	28.378
No. of debit cards\1,000 adults	0.531	9.676

Figure 3: Weights for the variables

## 4.5 Overall Financial Inclusion Index

In the second stage, PCA Method is applied as in the first stage on the dimensions to estimate their weights in the overall FI Index. The eigenvalues for the three PCs are 1.724, 0.99 and 0.286 respectively for PC1, PC2 and PC3, figure 7a. The first PC is retained for the study since it is the only eigenvalue greater than one. It is then utilized to estimate the weights assigned to the dimensions. Further KMO measure is applied to the correlations data of the dimensions,  $KMOMeasure = 0.64$ , satisfies  $KMO > 0.5$ , Camara et al. (2014). PCA assigns the highest weight to availability; 0.923, followed by usage; 0.921 and finally access; 0.155, figure 7b. This is used to estimate the overall FI Index for Kenya.

$$FI_i = 0.155Y_i^{ac} + 0.923Y_i^{av} + 0.921Y_i^u + \epsilon_i \quad (14)$$

Where  $i$  is the year.

Table A3 shows the changes in the financial inclusion index for the period 2013 to 2019.

# Chapter Five

## 5 Conclusions and Recommendations

### 5.1 Conclusions

Financial inclusion is an important tool in economic development and the eradication of poverty. It also prevents social exclusion. The right to access formal financial services should be prioritized as a way of risk mitigation and for advancement in recurrent duties. Financial inclusion is a multidimensional concept that cannot be captured by a single indicator, instead, it is captured using a large set of indicators to get all aspects that affect the measurement.

The study established that availability is the most important dimension for determining the level of financial inclusion in Kenya. The variables that have the highest contributions to availability are the number of registered mobile money outlets both per  $1000km^2$  and per  $100,000adults$ . The study also established that mobile money outlets had the most impact on the accessibility dimension. This can be used to further test the impact of mobile money on Financial Inclusion.

In the usage dimension, the number of credit cards per  $1000adults$  had the most impact which implied that there was an increase in credit card acquisition in Kenya. Outstanding deposits as a percentage of the GDP were found to be higher than the outstanding loans as a percentage of the GDP which implies that most Kenyans are saving more and borrowing less.

The methodology used in this study was found to be sufficient by applying the KMO measure to both the indicators and the dimensions. The creation of such an index is useful to shed some light on the determinants of financial inclusion as well as its contribution to economic growth and development.

### 5.2 Recommendations

Improvements and technical innovations in constructing the FII are possible, therefore, this paper could further stimulate interest to conduct more studies related to financial inclusion in Kenya by looking into its research gaps and addressing them accordingly. The FII can be used in econometric models requiring a measure of financial inclusiveness. It can serve as a dependent variable in regression models to identify the key drivers of financial inclusion. Al-

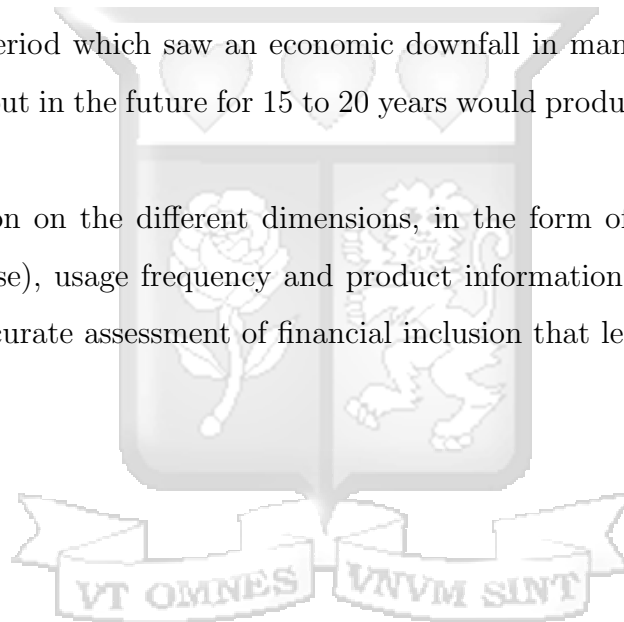
ternatively, the FII can be used as an explanatory variable to test whether financial inclusion significantly contributes to specific outcomes.

The study highlights that the addition of new indicators into the construction process can extend the measures of the financial inclusion index. This should help in understanding Financial Inclusion in Kenya better, hence, aiding in creating the right policies.

### 5.3 Limitations

The study is restricted to the period 2013 to 2019. This is due to the introduction of MShwari in November 2012 which increased the uptake in mobile banking services. The study used mobile banking variables to measure financial inclusion across all the dimensions. It is also because of the Covid period which saw an economic downfall in many economies. Therefore, a similar study carried out in the future for 15 to 20 years would produce more accurate results.

More refined information on the different dimensions, in the form of dis-aggregated data by geo-location (county-wise), usage frequency and product information on access points, would be useful for a more accurate assessment of financial inclusion that leads to policy recommendations.

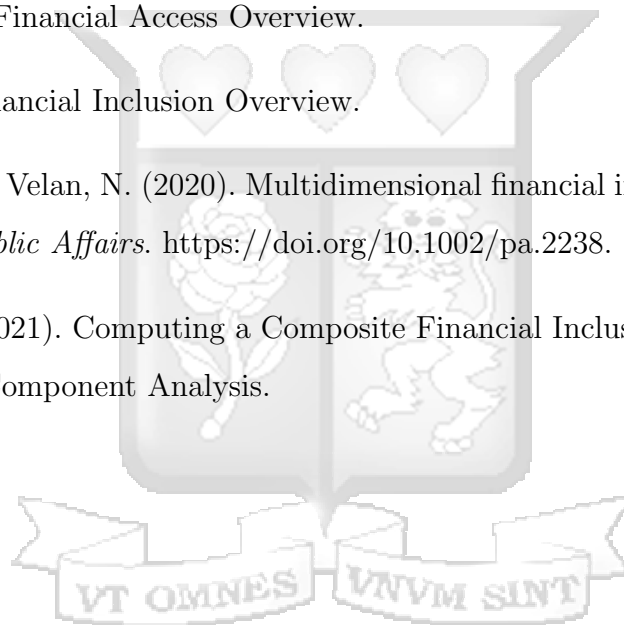


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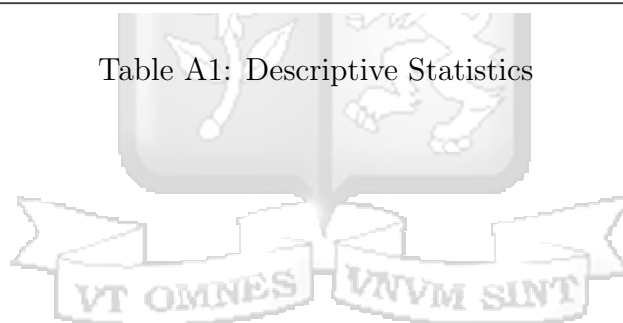
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## Appendix I: Descriptive Statistics

Variable	Mean	Std. Dev	Min	Max
<b>Access Dimension</b>				
No. of banks	42.42857143	0.728431359	41	43
No. of DTMFI	11.85714286	1.884415137	9	14
NO. of reg. mobile money outlets	165,573.14	38,353.46	113,130	224,108
No. of insurance corp.	51.28571429	1.979486637	49	53
<b>Availability Dimension</b>				
No. of branches\1,000 km2	2.857142857	0.349927106	2	3
No. of branches\100,000 adults	5.142857143	0.349927106	5	6
No. of ATMs\1,000 km2	4.714285714	0.451753951	4	5
No. of ATMs\100,000 ad.	9.142857143	0.638876565	8	10
No. of reg. mobile money outlets\100,000 ad	564	94.67840303	432	701
No. of reg. mobile money outlets\1,000 km2	291.1428571	67.54348561	199	394
<b>Usage Dimension</b>				
Outstanding deposits(% of GDP)	37.42857143	2.871393035	32	42
Outstanding loans(% of GDP)	33.57142857	2.920721186	28	37
No. of mobile money transactions\1,000 ad	45,598.57	10,884.90	27,944	57,528
Value of mobile transactions(% of GDP)	44.57142857	2.194613071	40	48
No. of credit cards\1,000 adults	7.857142857	0.832993128	6	9
No. of debit cards\1,000 adults	422.8571429	61.59180969	331	522

Table A1: Descriptive Statistics



## Appendix II: PCA Stage 1

Component	Eigen value	Propotion	Cumulative
<i>(1) Access - Estimate <math>Y^{ac}</math></i>			
No. of banks	3.350	83.746	83.746
No. of DTMFI	0.404	10.097	93.843
NO. of reg. mobile money outlets	0.153	3.815	97.659
No. of insurance corp.	0.094	2.341	100.000
<i>(2) Availability - Estimate <math>Y^{av}</math></i>			
No. of branches\1,000 km2	2.982	49.704	49.704
No. of branches\100,000 adults	2.110	35.174	84.878
No. of ATMs\1,000 km2	0.739	2.319	97.197
No. of ATMs\100,000 ad.	0.134	2.232	99.430
No. of reg. mobile money outlets\100,000 ad	0.034	0.570	100.000
No. of reg. mobile money outlets\1,000 km2	0.000	0.000	100.000
<i>(3) Usage - Estimate <math>Y^u</math></i>			
Outstanding deposits(% of GDP)	2.917	48.619	48.619
Outstanding loans(% of GDP)	1.689	28.063	76.682
No. of mobile money transactions\1,000 ad	0.920	15.330	92.011
Value of mobile transactions(% of GDP)	0.331	5.512	97.524
No. of credit cards\1,000 adults	0.126	2.095	99.618
No. of debit cards\1,000 adults	0.023	0.382	100.000

Table A2: Eigenvalues for the corresponding Principal Components

### Accessibility Dimension

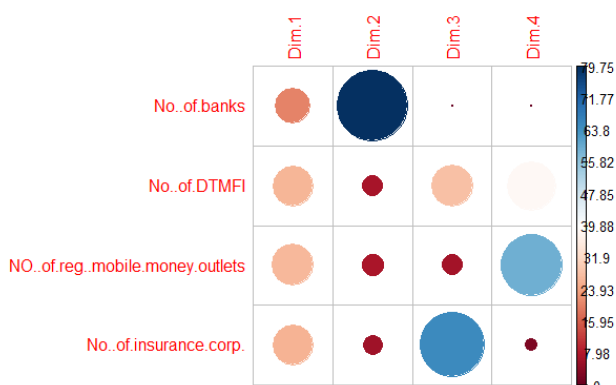


Figure 4a

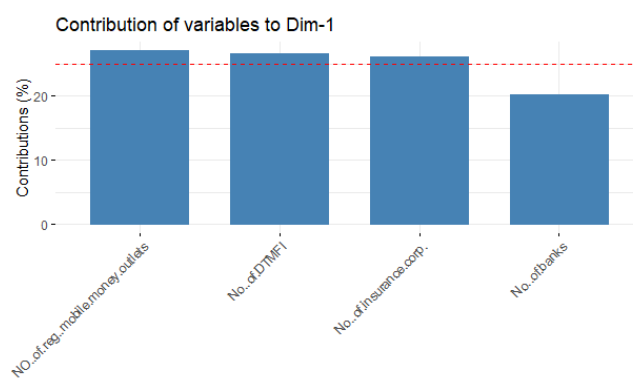


Figure 4b

# Availability Dimension

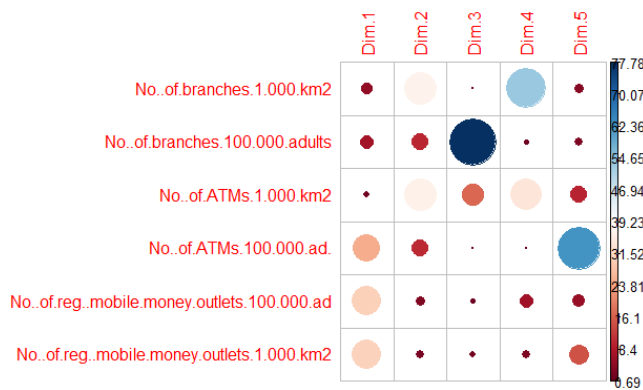


Figure 5a

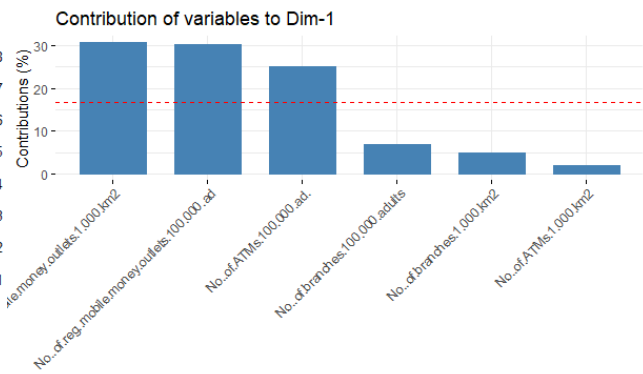


Figure 5b

# Usage Dimension

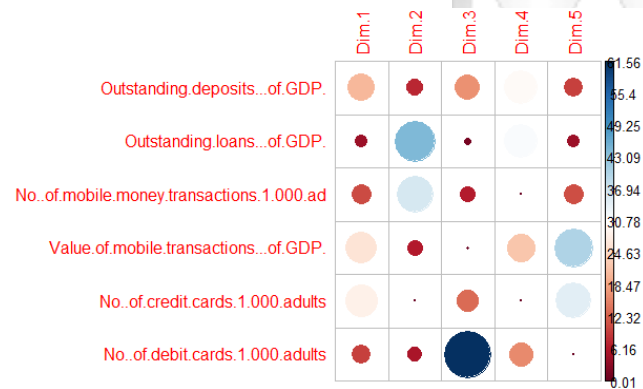


Figure 6a

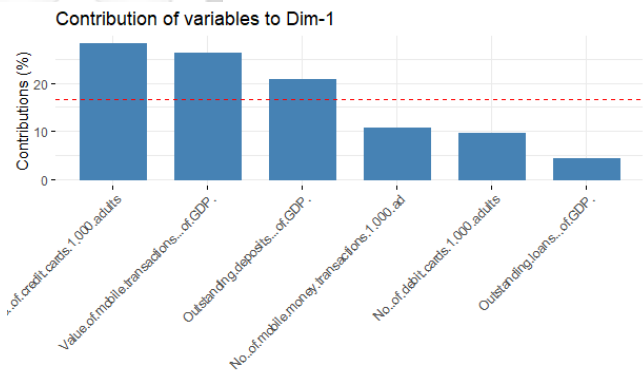


Figure 6b

# Appendix III: PCA Stage 2

## Financial Inclusion Index

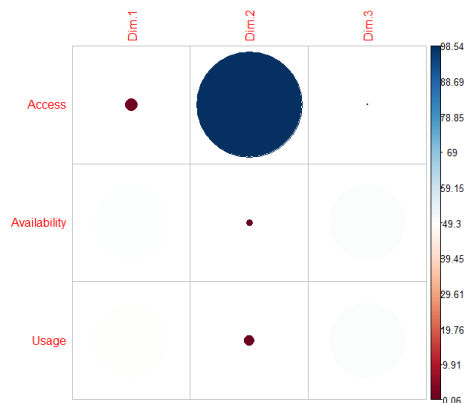


Figure 7a

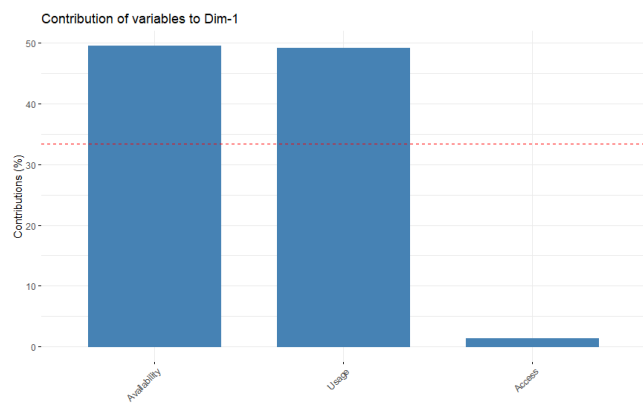


Figure 7b

Year	Accessibility	Availability	Usage	FII
2013	0.97	0.211	0.963	0.855
2014	0.967	0.642	0.099	0.455
2015	0.63	0.413	0.248	0.005
2016	0.717	0.095	0.475	0.754
2017	0.941	0.439	0.053	0.134
2018	0.317	0.639	0.282	0.134
2019	0.89	0.838	0.02	0.804

Table A3: Changes in Financial inclusion measurement

