



# DISCUSSION PAPER SERIES

*Economics and business statistics*

## **Financial inclusion: Measure, and nexus with bank market structure in Africa**

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**2020-04**

**Series editors** Dr Nicholas Rohde and Dr Athula Naranpanawa

**ISSN 1837-7750**

# Financial inclusion: Measure, and nexus with bank market structure in Africa

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## Abstract

Financial inclusion is increasingly receiving global policy priority recently because it enables access to financial services such as savings, payments, risk management and credit to households and firms with a wide range of needs. However, we are not aware of any study related to measure of financial inclusion and the effects of bank market power and bank asset concentration on financial inclusion in Africa. Hence, using panel data of 17 African countries over 2004-2015 and applying three stages approach, first normalizing each indicator and then applying two stage principal component analysis, we developed multidimensional measure of financial inclusion. Then, employing endogenous panel threshold model, we examined impacts of bank market power and bank asset concentration on financial inclusion. The findings show that bank market power enhances the availability and accessibility dimensions but reduces usage dimension. Moreover, the negative effect of bank market power on usage dimension is worse under higher regime of bank market power compared to the lower regime counterpart. Furthermore, we demonstrated that the positive impacts of bank asset concentration on overall financial inclusion, availability and usage dimensions are more pronounced under lower regime compared to higher regime of concentration.

*Keywords:* Financial inclusion, measure of financial inclusion, bank market power, bank asset concentration, panel threshold model, Africa

*JEL Classification:* C24; G21; O1; O55; L11

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# 1. Introduction

The notion of financial inclusion emerged with a concept that development should extend to all other spheres than just the level of GDP so that growth could be inclusive and sustainable. This is crucial because the importance of inclusive growth, rather than just economic growth, to achieve stable and sustainable economic growth, is increasingly receiving global consensus (Fosu, 2017). To this end, Alliance for Financial Inclusion (AFI) was founded in 2008 to advance development of financial inclusion policies in developing and emerging countries. By 2010, financial inclusion became a worldwide issue and hence the Global Partnership for Financial Inclusion (GPFI) was founded (Kabakova & Plaksenkov, 2018). Currently, the notion of financial inclusion is given a central role among policy makers, researchers, central banks, and other stake holders, in order to achieve a broad goal of inclusive and sustainable growth (Park & Mercado, 2018).

An inclusive financial system serves vital roles such as offering savings, payments, and risk management services to people with a wide range of needs. An inclusive financial system enables broad access to financial services without economic or non-economic barriers. This kind of inclusive financial service potentially benefits the poor and disadvantaged groups who, without an inclusive financial system, must rely on their own limited savings and earnings to invest in their education and entrepreneurship. In this regard, the fact that the disadvantaged must rely on their limited earnings if a financial system is not inclusive, it contributes to the persistence of inequality and leads to slower economic growth (Demirguc-Kunt & Klapper, 2012; Dev, 2006; Honohan, 2008).

Sarma and Pais (2011) argued that financial inclusion that endures ease of access, availability, and financial services for all segments of a society has different benefits to an economy because it can enhance efficient allocation of resources and concurrently reduce informal sources of credit, which are often exploitative. Inclusive financial systems boost both economic efficiency and welfare by providing opportunities for large segments of the population, enabling them to practice secure saving and facilitate alternate use of financial services (Gopalan & Rajan, 2018). Moreover, financial inclusion is important because poor households and small and medium sized enterprises (SMEs) that have limited, or no collateral and credit history will gain access to financial services (Gopalan & Rajan, 2018). An inclusive financial system also potentially reduces social and economic inequality and a more dynamic economy and higher economic growth (Corrado & Corrado, 2015; Swamy, 2014). Without an inclusive financial system, poor households and SMEs would be excluded from financial services because of market failure related to financial market imperfections, such as asymmetric information, high transaction costs, or lack of adequate legal infrastructure to enforce contracts (Gopalan & Rajan, 2018).

To this end, emphasis is being given so that any policy made at national or international level would not lead to financial exclusion of consumers and firms. For example, there is common understanding that overly cautious anti-money laundering (AML) and countering financing of terrorist (CFT) safeguards may have unintended consequences of excluding legitimate businesses and consumers from financial system because the number of know your customer (KYC) requirements has increased in recent years. To this end according to Financial Action Task Force (FATF), a need has arisen to ensure that such safeguards also support financial inclusion (De Koker & Jentzsch, 2013).

Though there is common consensus on the importance of financial inclusion, there is no clear understanding on what financial inclusion constitutes and how it is measured. Because financial inclusion is multidimensional, what dimensions are included, and the weight assigned to each in defining financial inclusion is not well established. Moreover, it is challenging to develop a common benchmark on the measure of financial inclusion across countries to make

comparisons related to how inclusive financial system of a country is due to problems related to availability of data (Camara & Tuesta, 2014). The other important issue related to financial inclusion is how to measure it. Because financial inclusion is multidimensional, analysing financial inclusion and its relationship with other economic variables does not give the full picture when relying on just some of its dimensions. Moreover, including all indicators of financial inclusion in a regression also leads to problems such as multicollinearity because these indicators are highly correlated. Furthermore, including all the indicators in a regression simultaneously leads to over-parameterisation problem.

Therefore, using a single index to measure financial inclusion to capture as many dimensions as possible is crucial to gain a comprehensive understanding about it. Indexing also enables us to avoid problems of multicollinearity and over-parameterisation attributed to using all the indicators simultaneously in a regression. One of the important questions in indexing strategy of financial inclusion is which indicators to include in the index and what relative weight is attached to each of the indicators included. In this regard, identifying the dimensions of financial inclusion to be included in indexing the overall financial inclusion and determining their relative weight while indexing is critical (Ahamed & Mallick, 2019; Sarma & Pais, 2011, Park & Mercado, 2018).

Little is also known about the relationship between bank market structure and financial inclusion. Specifically, the impacts of bank market power and bank asset concentration on financial inclusion is not well established in the literature. Market power in banking industry shows the degree of bank competition and is used as proxy representing the mark-up of price over marginal costs (Berger et al, 2009; Leon, 2015). Alternatively, market power in banking industry shows the degree to which banks determine the difference between market price of the product and its marginal cost, which is mark-up price. Accordingly, the higher the difference between market price of the product and the marginal cost of the product the more the market power. The effect of banking market power on financial inclusion is mixed in literature. Literature shows that market power reduces financial inclusion because as banks get more market power it leads to higher interest on credit which would lead to lower access for households and firms to credit. Others argue that market power to some extent is important to enhance financial inclusion leading to non-linear relationship between financial inclusion. As such, literature on the impact of market power on financial inclusion mixed (Mudd, 2013; Leon, 2015; Love & Partinez Peria, 2015).

Bank asset concentration measures the degree to which assets of commercial banking industry is held by few banks. Higher market concentration shows that banking industry exhibit more of oligopolistic market structure. Higher bank concentration, in which the banking sector exhibits more of oligopolistic nature has no incentive to promote for financial inclusion through undertaking geographic and demographic outreaches, among others, unless they are state owned or mandated to do so. In other words, it is assumed that market concentration reduces financial inclusion because high bank concentration does not give incentive to enhance financial inclusion. On the contrary, studies show that bank concentration to certain degree enables geographic and demographic outreach of banks. Hence, literature related to the effect of market concentration on financial inclusion is mixed (Chong et al., 2013; Tacneng, 2014; Leon, 2015).

We are not aware of multidimensional measure of financial inclusion in Africa; and the impact of bank market structure on multidimensionally measured financial inclusion in the continent. It is against this background that we first developed multidimensional measure of financial inclusion; and then examined its nexus with bank market power and concentration.

The contribution of this study is three-fold. First, for the first time, we developed measure of financial inclusion using two stage PCA analysis for Africa. Second, we examined the effects of bank market power and bank concentration on financial inclusion. Third, employing

endogenous threshold model, we analysed whether bank market power and concentration impact financial inclusion non-linearly. Fourth, we examined whether bank market power and concentration impact dimensions of financial inclusion differently.

The findings related to the measure of financial inclusion show that the availability dimension of financial inclusion plays the leading role in explaining the overall financial inclusion and usage dimension plays the least role. Moreover, geographic outreach is more important, compared to demographic outreach, in explaining the availability dimension; and bank branches, compared to ATM, explain more of the variations of both the geographic and demographic outreaches. The baseline fixed effect result shows that banking market power enhances availability and accessibility dimensions but reduces usage dimension. Bank concentration enhances both the overall financial inclusion and availability dimension. The threshold model demonstrates that bank market power reduces usage dimension both under lower and higher regimes of market power while the impact gets worse under higher regime of bank market power. Banking concentration positively impacts overall financial inclusion, availability and usage dimensions both under the respective lower and higher regimes of banking concentration, but the impacts are more pronounced under the lower regime.

The remainder of the paper is as follows. Section 2 presents data and sources of data. Section 3 presents measure of financial inclusion. Section 4 presents the empirical model and discussion, and section 5 presents concludes with policy implications.

## 2. Data and sources of data

The sample size of the study is determined by data availability, particularly on financial inclusion indicators and bank market power and concentration, for African countries. Specifically, the data for the availability and accessibility dimensions indicators are available only from 2004 to 2015 and for 17 African countries. Therefore, we use panel data of 17 African countries from 2004 to 2015. Table (1) summarizes definition of variables used in the study and their respective data sources.

**Table 1**  
**Variables and Sources**

Variable name	Definition	Source
<i>Financial inclusion indicators</i>		
ATMperpop	Automated Teller Machines (ATMs) per 100,000 adults	FAS, 2019
ATMperkm2	Automated Teller Machines (ATMs) per 1,000 km <sup>2</sup>	FAS, 2019
Bankperpop	Branches of commercial banks per 100,000 adults	FAS, 2019
Bankperkm2	Branches of commercial banks per 1,000 km <sup>2</sup>	FAS, 2019
Accessibility	Deposit accounts with commercial banks per 1,000 adults	FAS, 2019
Usage	Domestic credit to private sector by banks (% of GDP)	WDI, 2019
<i>Bank competition</i>		
Lerner	Lerner index: a measure of market power in the banking market which is defined as the difference between output prices and marginal costs (relative to prices)	GFDD, 2019
<i>Bank concentration</i>		
Concentration	Five-bank concentration which measures asset of the five largest banks as a share of the overall commercial bank assets	GFDD, 2019
<i>Control variables</i>		
Credit market regulations	Indexed from ownership of banks, private sector credit, and interest rate controls/negative real interest rates	Fraser Institute, 2019

GDP per capita	Log of GDP per capita (constant 2010 US\$)	WDI, 2019
GFC	Global financial crises dummy that takes values 1 if financial crises caused structural break in the country and 0 otherwise	Own computation
Inflation	Inflation, consumer prices (annual %)	WDI, 2019
Legal systems and property rights	Legal systems and security of property rights indexed from judicial independence, impartial courts, protection of property rights, military interference in rule of law and politics, integrity of the legal system, legal enforcement of contracts, regulatory costs of the sale of real property, reliability of police, business costs of crime, and gender disparity adjustment	Fraser Institute, 2019
Overhead cost	Measure the operating expenses of a bank expressed as a share of the value of all the held assets	GFDD, 2019
Trade openness	Trade (% of GDP)	WDI, 2019
Urbanization	Urban population (% of total)	WDI, 2019

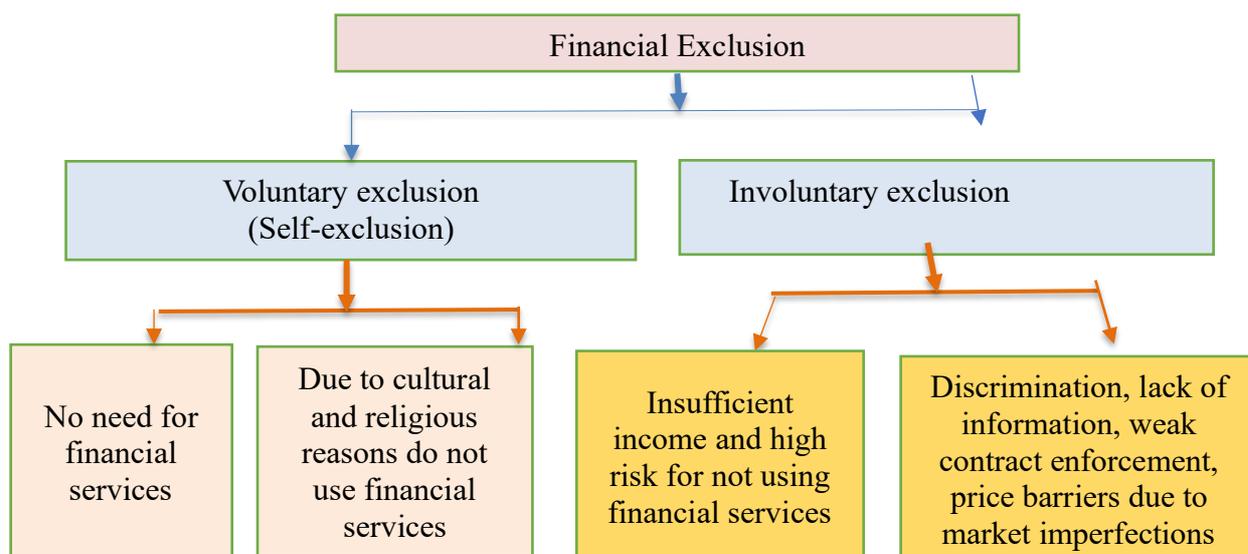
FAS: *Financial Access Survey*, GFDD: *Global Financial Development Database*, IMF; WDI: *World Development Indicators*, World Bank.

### 3. Measure of Financial Inclusion

#### 3.1 Definition of Financial Inclusion

The notion of financial inclusion deals with all initiatives that make formal financial services available, accessible and affordable to all segments of the population. This requires paying attention to specific portions of the population that have been historically excluded from the formal financial sector either because of their income level and volatility, gender, location, type of activity, or level of financial literacy. Some of the dimensions of financial inclusion capture only the supply side of finance, others capture demand side while some capture both supply and demand sides simultaneously. Usage dimension of financial service, for example, is different from access dimension. Access refers to the supply of financial services whereas usage is determined by both demand and supply (Demirguc-Kunt & Klapper, 2012).

Financial exclusion, on the other hand, can be viewed from the point of view of voluntary financial exclusion and involuntary financial exclusion. Voluntary financial exclusion is the condition when certain segments of population or firms choose not to use financial services either because they have no need for them due to reasons related to culture, religion or others. Involuntary financial exclusion, however, is due to insufficient income, high risk profile because of discrimination, financial market failures related to financial market imperfections and others. Following the works of Amidzic et al. (2014), we summarize financial exclusion as in Figure 1.



**Figure 1.** Financial Exclusion

Voluntary financial exclusion may not be addressed and of not policy target. Involuntary financial exclusion, however, is considered as barrier to financial inclusion. Therefore, it needs policy and research initiatives to address them because they can be addressed if policies which enhance income of the poor and tackle the problems of financial failure and financial imperfections are appropriately developed and put into effect.

We follow Sarma and Pais (2011), Park and Mercado (2018) and Ahamed and Mallick (2019) and define financial inclusion multidimensionally as the process that eases availability, accessibility and usage of financial services for all segments of a society. Capturing multidimensional aspect of financial inclusion is vital for a comprehensive understanding. Therefore, we use three dimensions of financial inclusion: availability, accessibility and usage dimensions. Availability dimension covers demographic outreach and geographic outreach subdimensions. Demographic outreach is captured by number of ATM per 100,000 adults and number of bank branches per 100,000 adults while geographic penetration is proxied by number of ATM per 1000 km<sup>2</sup> and number of bank branches per 1000 km<sup>2</sup>. Accessibility is measured by number of adults who have saving account per 1000 adults. Usage dimension is proxied by credit to private sector as percentage of GDP. Figure 2 summarizes the financial inclusion dimensions used for this study.



adults). Availability dimension of financial inclusion, however, cannot be fully captured without including geographic penetration is measured by banks branches per 1000km<sup>2</sup> and ATMs per 1000km<sup>2</sup>. Moreover, they attached a weight of 2/3 to bank branches and 1/3 to ATMs in computing the availability dimension. This judgemental attaching of weights to different indicators of availability may be different from what these indicators contribute in explaining the variations in the data; hence, they may lead to bias in developing the availability index. Furthermore, they attached a weight of 1, 0.5, and 0.5 to accessibility, availability, and usage dimensions, respectively. The weight that they assigned to dimensions of financial inclusion may be different from what each dimension contributes in explaining the variation in the data; and hence it potentially suffers from judgemental bias.

Literature around financial inclusion falls broadly into two categories: microeconomic level analyses of financial inclusion that deals with household and firms level (Wang & Guan, 2017; Fungacova & Weill, 2015; Chikalipah, 2017) and macroeconomic level analysis of financial inclusion that focuses more on cross-country level (Gopalan & Rajan, 2018; Emenalo et al., 2018; Sarma & Pais, 2011). While both categories of empirical literature are relevant for policy making and address the socio-economic problems related to financial inclusion, the approach and methodology that the two strands follow are different. The first strand focuses on more specific evidence from randomised control trials or quasi-randomised impact evaluations of financial inclusion. The second strand, however, focuses on macroeconomic level studies using national level data or panel data comparison to develop general relationship between financial inclusion and other macroeconomic variables (Park & Mercado, 2018).

A randomised control trial approach cannot be used to study impact of macroeconomic policies and institutional country features. Moreover, it is doubtful that randomised control trials conducted in a particular setting can be applied to a different setting because this methodology might lack external validity (Allen et al., 2016). Though relatively ample literature exists on the first strand, the literature that follows the second strand is limited. In the case of Africa, we are not aware of any study undertaken on measure of financial inclusion at macroeconomic level. Moreover, while financial inclusion is multidimensional, the existing literature studied financial inclusion by measuring it only from the point of view of a particular dimension such as access to finance. The current study, therefore, focuses on the second strand of financial inclusion at macroeconomic level using panel data for African countries with the purpose of developing a multidimensional measure of financial inclusion and examining the effects of bank market power and concentration on financial inclusion.

### 3.3 Financial Inclusion Indexing Strategy

Financial inclusion has different dimensions such as availability, accessibility and usage. It is not recommended to use all these dimensions in a regression because they are highly correlated, and potentially lead to over-parameterisation problem. Moreover, it is important to develop an index for financial inclusion to allow for comparison over time and across countries. Before indexing financial inclusion, we normalize all the indicators of financial inclusion following Ahamed & Mallick (2019), Park and Mercado (2018) and Cámara and Tuesta (2014) so that the scale in which they are measured is irrelevant. Accordingly, we normalize the indicators of financial inclusion as follows:

$$X_{it,n} = \frac{X_{it} - X_{\min}}{X_{\max} - X_{\min}} \quad (1)$$

where  $X_{it}$ ,  $X_{\min}$ ,  $X_{\max}$ , and  $X_{it,n}$  are the actual, minimum, maximum, and normalized values of indicator  $X$ , respectively, for country  $i$  at time  $t$ .  $X_{it,n}$  lies between zero and one indicating the performance of a country in terms of financial inclusion from indicator  $X$  point of view; and

hence it is measured monotonically. The closer  $X_{it,s}$  is to one, the more inclusive financial system is in terms of indicator  $X$  while the closer it is to zero, the more excluding financial system it is in terms of the indicator.

After normalizing each of the indicators, we developed composite index of financial inclusion from its dimensions. Non-parametric and parametric methods are the two commonly used approaches to construct composite indices from indicators. In the case of non-parametric approach, researchers use their own intuition in determining the relative importance of each indicator and hence exogenously assigning weight to each indicator as per their intuition. The drawback of this approach is that subjective assigning of weight may dramatically change the result by biasing against some indicators relative to their actual weight because indices are sensitive to subjective assigning of weights (Cámara & Tuesta, 2014).

The two commonly used parametric approaches for indexing are principal component analysis (PCA) and common factor analysis (CFA). Literature shows that PCA is preferred over CFA because there is no need to make additional assumptions about the raw data such as selecting the underlying common factors (Cámara & Tuesta, 2014). Therefore, we employ PCA parametric approach of indexing availability dimension from demographic and geographic outreaches; and then overall financial inclusion from availability, accessibility and usage dimensions.

To construct the index of financial inclusion, after normalizing each of the indicators of financial inclusion, we postulate that the latent variable financial inclusion (FI) is linearly determined by availability, accessibility and usage dimensions as follows:

$$FI_{it} = \tilde{\omega}_1 Availability_{it} + \tilde{\omega}_2 Accessibility_{it} + \tilde{\omega}_3 Usage_{it} + \varepsilon_{it} \quad (2)$$

Thus, total variation in the latent variable, financial inclusion, is due to variation in causal variables (availability, accessibility and usage) and variation due to error term ( $\varepsilon_{it}$ ). According to Camara and Tuesta (2014), if the model is well specified, the expected value of error term is zero and hence the variance of the error term is small compared to the variance of the latent variable—financial inclusion.

### *i. First Stage Principal Component Analysis*

After normalizing each indicator, as explained in equation (1), we developed financial inclusion index to maximize the information from data set included in the index. In doing so, we applied two stage PCA as indexing strategy for financial inclusion following literature (Cámara & Tuesta 2014; Park & Mercado, 2018; Ahamed & Mallick, 2019).

The first-stage PCA aims at developing availability dimension of financial inclusion from four indicators which in turn are sub-divided into demographic outreach (number of ATMs per 100,000 population and number of bank branches per 100,000 population) and geographic outreach (number of ATM per 1000 km<sup>2</sup> and number of bank branches per 1000 km<sup>2</sup>). In the first stage PCA, hence, we developed index of availability dimension as follows:

$$Availability_{it} = \beta_1 ATMperpop_{it} + \beta_2 Bankperpop_{it} + \beta_3 ATMperkm2_{it} + \beta_4 Bankperkm2_{it} + v_{it} \quad (3)$$

$$Availability_{it} = \frac{\sum_{j,k=1}^p \lambda_j P_{kit}}{\sum_{j,k=1}^p \lambda_j} \quad (4)$$

where  $\lambda_j$  ( $j = 1, \dots, p$ ) is eigenvalue  $j$  being the number of principal components and  $P_k = X\lambda_j$  ( $k=1, \dots, p$ ) is  $k$ th principal component where  $X$  is the indicators matrix. In this case, the number of principal components  $j$  coincides with the number of normalised indicators (of availability dimension)  $p$ . Specifically,  $p=j=4$ . We assume that  $\lambda_1 > \lambda_2 > \dots > \lambda_p$  because weights assigned to each component decrease so that the larger proportion of variation in each dimension is explained by the first principal component and so on.

Specifically, given that the eigenvectors of the respective correlation matrices are denoted by  $\delta$ , the principal components are given as follows:

$$\begin{aligned} PC_{1it} &= \delta_{11}ATMperpop_{it} + \delta_{12}Bankperpop_{it} + \delta_{13}ATMperkm2_{it} + \delta_{14}Bankperkm2_{it} \\ PC_{2it} &= \delta_{21}ATMperpop_{it} + \delta_{22}Bankperpop_{it} + \delta_{23}ATMperkm2_{it} + \delta_{24}Bankperkm2_{it} \\ PC_{3it} &= \delta_{31}ATMperpop_{it} + \delta_{32}Bankperpop_{it} + \delta_{33}ATMperkm2_{it} + \delta_{34}Bankperkm2_{it} \\ PC_{4it} &= \delta_{41}ATMperpop_{it} + \delta_{42}Bankperpop_{it} + \delta_{43}ATMperkm2_{it} + \delta_{44}Bankperkm2_{it} \end{aligned}$$

Accordingly, availability can be given as follows:

$$Availability_{it} = \frac{\sum_{j=1}^4 \lambda_j (\delta_{j1}ATMperpop_{it} + \delta_{j2}Bankperpop_{it} + \delta_{j3}ATMperkm2_{it} + \delta_{j4}Bankperkm2_{it})}{\sum_{j=1}^4 \lambda_j} \quad (5)$$

Hence availability can be given as the weighted average of the four indicators as below:

$$Availability_{it} = \omega_1 ATMperpop_{it} + \omega_2 Bankperpop_{it} + \omega_3 ATMperkm2_{it} + \omega_4 Bankperkm2_{it} \quad (6)$$

where the relative weight of each indicator is given by:

$$\omega_k = \frac{\sum_{j=1}^4 \lambda_j \delta_{jk}}{\sum_{j=1}^4 \lambda_j}, \quad k=1,2,3,4 \quad (7)$$

## ii. Second Stage Principal Component Analysis

After developing availability dimension in the first stage PCA, we developed overall financial inclusion index in the second stage PCA, from availability, accessibility and usage dimensions, following the same approach we followed in the first stage PCA. Accordingly, given that  $\tilde{\lambda}_j$  ( $j = 1, \dots, p$ ) is eigenvalue  $j$  being the number of principal components and the eigen vectors of the respective correlation matrices denoted by  $\Psi$ , overall financial inclusion (FI) is given as follows:

$$FI_{it} = \tilde{\omega}_1 Availability_{it} + \tilde{\omega}_2 Accessibility_{it} + \tilde{\omega}_3 Usage_{it} \quad (8)$$

where the relative wait of each financial inclusion dimension,  $\tilde{\omega}_k$ , are given by:

$$\tilde{\omega}_k = \frac{\sum_{j=1}^3 \tilde{\lambda}_j \Psi_{jk}}{\sum_{j=1}^3 \tilde{\lambda}_j} \quad k=1,2,3 \quad (9)$$

Equation (8) shows that the aggregate financial inclusion index is the weighted sum of individual financial inclusion dimensions. A financial inclusion index that incorporates these dimensions is constructed in such a way that its values lie between zero and one, and monotonically representing how inclusive a country's financial system is.

Financial inclusion in this study captured only availability, accessibility, and usage dimensions. We did not cover affordability dimension of financial inclusion because of unavailability of data in our case study for the time under consideration. Moreover, the study focused on formal intermediary financial institutions (commercial banks); it was beyond the scope of this study to capture the other forms of access to financial services such as mobile banking and informal financial institutions.

## 3.4 Results of Measure of Financial Inclusion

### 3.4.1. First-stage PCA: Availability index

Table (2) presents the result of the first stage PCA. Principal component analysis reports two components: principal correlations and eigenvectors. The first panel shows eigenvalues of the correlation matrix, ordered from largest to smallest. Eigenvalues are the variances of the components and sum up to the total variances of the variables in the analysis. The variables are standardised to have a variance of one because we are analysing correlation matrix. Therefore,

we have a total variance of four, which is equal to the total variables under consideration, hence the eigenvalues add up to four ( $3.1710 + 0.5818 + 0.2433 + 0.0040 = 4$ ). The third column (difference) shows the difference between two consecutive eigenvalues. The fourth column, proportion, shows the proportion of variation in the data that respective components explain; it is given by the ratio of the respective eigenvalues to the total variance in the data. Accordingly, the first component explains 79.27% (i.e.  $[3.1710 / 4] * 100$ ) of the total variation in the data. The second, the third and fourth components explain 14.54%, 6.08% and 1.00% of the variations in the data, respectively. The last column shows the cumulative of the successive proportions and sums to unity because the total sum of the proportion of variation in the data explained by all components is one.

The second panel shows the corresponding eigenvectors of the eigenvalues which are principal components and uncorrelated. Therefore, the information contained in one principal component is not partly represented in another component. Therefore, all four principal components combined explain the total variation in all the variables. Hence, the unexplained variances column in the panel 2 are all zero. Moreover,  $Rho = 1.00$  in the first panel implies that all the variation in all the data are explained.

**Table 2.**

First-stage PCA - Availability Index

Number of Observation = 204 Number of components = 4 Rho = 1.000					
Component	Eigenvalue	Difference	Proportion	Cumulative	
Comp1	3.1710	2.5892	0.7927	0.7927	
Comp2	0.5818	0.3384	0.1454	0.9382	
Comp3	0.2433	0.2394	0.0608	0.9990	
Comp4	0.0040	.	0.0010	1.0000	
Principal components/correlation					
Variable	Comp1	Comp2	Comp3	Com4	Unexplained
ATMperpop	0.4493	0.7041	0.5421	0.0921	0
ATMperk2	0.5270	-0.4235	0.2321	-0.6993	0
Bankperpop	0.4977	0.3128	-0.8049	-0.0815	0
Bankperk2	0.5223	-0.4765	0.0664	0.7041	0

Table 2 shows that only the first principal component, PC1, has an eigenvalue greater than 1 and explains 79.27% of variation in the data. The remaining three principal components (PC2, PC3 and PC4) have eigenvalue less than 1 each and jointly explain the remaining 20.73% of variation in the data. Based on literature, we used only PC whose eigenvalue is greater than 1 in computing index of availability dimension of financial inclusion. Therefore, we used PC1 in computing availability dimension of financial inclusion. Given that the parametric approach we used, PCA, assigns weights (factor loadings) to each indicator in calculating the availability dimension of financial inclusion, ATM per 1000 km<sup>2</sup> has the highest weight (0.5270) while ATM per 100,000 adults is assigned the least weight (0.4493). Accordingly, availability dimension of financial inclusion is given as follows:

$$Availability_{it} = 0.4493 * ATMperpop_{it} + 0.5270 * ATMperkm2_{it} + 0.4977 * Bankperpop_{it} + 0.5223 * Bankperkm2_{it}$$

On average, geographic outreach is more important in explaining availability dimension compared to demographic counterpart. This is intuitive given that Africa is sparsely populated; and hence geographic outreach plays crucial role in explaining the availability dimension of

financial inclusion. Moreover, on average, bank branch outreach has more weight compared to ATM outreach. Literature show that bank branches enhance extensive margin of financial services while ATM enhances intensive margin. Therefore, the result is intuitive because financial services which promote extensive margin of financial services explain more proportion of variation in the data compared to those promoting intensive margin.

### 3.4.2. Second-stage PCA: Financial Inclusion Index

Table (3) summarizes the result of the second stage PCA results. The result shows that only the first principal component has eigenvalue greater than one, which explains 91.72% of variation in the data. The remaining two principal components, PC2 and PC3, have eigenvalue less than one each and jointly explain the remaining 8.28% of total variation in the data. Following the same argument as in the first stage PCA, we used principal component that has eigenvalue greater than 1 to compute overall financial inclusion from availability, accessibility, and usage dimensions. The PCA approach of indexing assigns factor loadings (weights) of each dimension in indexing overall financial inclusion. The results show that availability is assigned the highest weight, 0.5881. Accessibility is assigned the second highest weight, 0.5807, while usage is assigned the least weight, 0.5630. Using the weights assigned to the dimensions, we developed the overall financial inclusion index (FI) as follows:

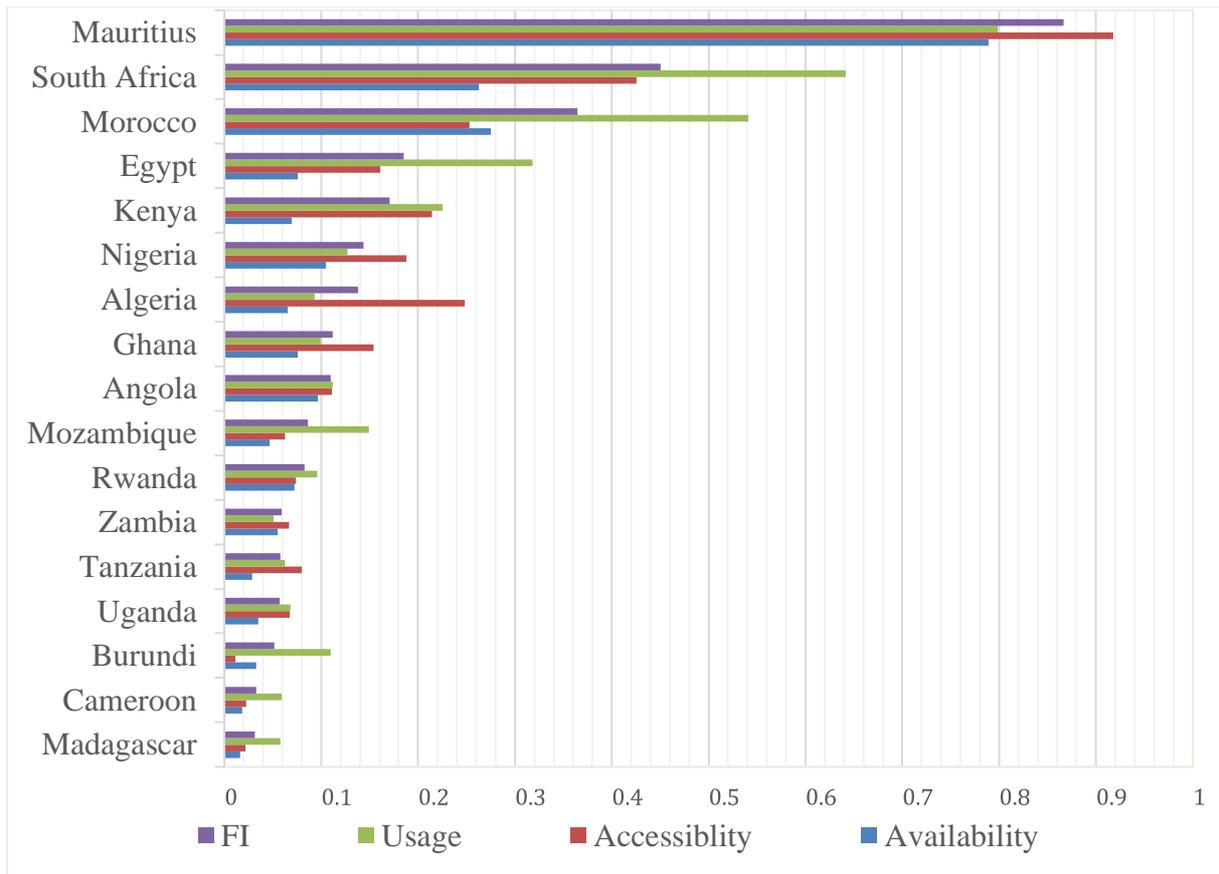
$$FI_{it} = 0.5881 * Availability_{it} + 0.5807 * Accessibility_{it} + 0.5630 * Usage_{it}$$

**Table 3.**

Second-stage PCA - Financial Inclusion Index

Number of Observation = 204				
Number of components = 3				
Rho = 1.000				
Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.7517	2.5612	0.9172	0.9172
Comp2	0.1905	0.1327	0.0635	0.9807
Comp3	0.0578	.	0.0193	1.0000
Principal components/correlation				
Variable	Comp1	Comp2	Comp3	Unexplained
Availability	0.5881	-0.2833	-0.7576	0
Accessibility	0.5807	-0.5041	0.6393	0
Usage	0.5630	0.8159	0.1319	0

Figure 3 presents the overall financial inclusion index and its dimensions averaged over 2004-2015 for each of 17 African countries. Mauritius experiences the most inclusive financial system while Madagascar experiences the least. Overall, Mauritius, South Africa, and Morocco enjoy most inclusive financial system. Madagascar, Cameroon and Burundi, on the other hand experience least financial system. The figure also shows that some countries are better than others in terms of some of the dimensions while performing less in terms of other dimensions.



**Figure 3.** Financial Inclusion and its dimensions, average value for countries, 2004-2015

## 4. Empirical Model and Results

### 4.1. Do bank market power and bank concentration enhance financial inclusion?

The empirical model we are considering takes the following form:

$$FI_{it} = \alpha_0 + \mu_j \text{bankmarketstructure}_{ijt} + X'_{it}\beta + \alpha_i + \varepsilon_{ijt},$$

$i=1, 2, \dots, N; t=1, 2, \dots, T; j=1, 2, \dots, J.$  (1)

where  $FI_{it}$  and  $X'_{it}$  are financial inclusion and vector of control variables of country  $i$  at time  $t$ ;  $\text{bankmarketstructure}_{ijt}$  and  $\varepsilon_{ijt}$  are indicator of market structure  $j$  (bank market power and bank asset concentration) and the corresponding error term of country  $i$  at time  $t$ .  $\alpha_i$  is country fixed effect.

**Bank Market Power:** The measure of bank market power is proxied by different indicators in literature. Some of these indicators are Ranzar Rosse-H-Statistic (H-statistic), Boone Indicator and Lerner Index (Degryse et al., 2012; Leon, 2015; Bozkurt et al., 2018). Due to unavailability of data for the first two measures of bank competition, in our case, we use Lerner Index as a measure of bank market power in this study. Following Berger et al. (2009), Lerner Index is written as follows:

$$\text{Lerner}_{it} = \frac{P_{it} - MC_{it}}{P_{it}}$$

where  $P_{it}$  and  $MC_{it}$  are price and marginal cost of firm  $i$  at time  $t$ , respectively. Alternatively,  $P_{it}$  is the price of total assets proxied by the ratio of total revenues (interest and non-interest income) to total asset of bank  $i$  at time  $t$ ; whereas  $MC_{it}$  is marginal cost of producing additional good of bank  $i$  at time  $t$ .

Lerner Index is interpreted as the inverse of market competition in the banking industry: the higher Lerner Index is, the lower market competition is, and vice versa (Ahamed & Mallick, 2019). Lerner Index represents the mark-up of price over marginal costs and is an indicator of the degree of market power (Berger et al, 2009; Leon, 2015). In other words, it is the measure of market power in banking industry as it measures the difference between market price of the product and its marginal cost, which is mark-up price. Accordingly, the higher the difference between market price of the product and the marginal cost of the product the more the market power. Hence, Lerner Index captures the degree to which a bank can increase price beyond its marginal cost (Ahamed & Mallick, 2019).

We expect that greater bank market power, which means lower competition in the banking sector, leads to lower financial inclusion because there is no incentive for firms who have more monopoly power to promote financial inclusion except under some specific conditions such as if the banks are government owned or mandated to promote financial inclusion. Therefore, banking industry where market power is lower promotes financial inclusion compared to in countries where market power is higher.

**Bank Concentration:** Measures the degree to which the asset of the banking industry is held by limited number of banks. In this study, bank concentration is proxied by the five-bank concentration which measures the assets of five largest commercial banks as a share of total commercial banking assets. Literature shows that market concentration of the financial sector determines financial inclusion (Sarma & Pais, 2011; Gopalan & Rajan, 2018). Higher bank concentration in which the banking sector exhibit more of oligopolistic market structure has no incentive to promote for more financial inclusion through undertaking more geographic and demographic outreach, among others, unless they are state owned or mandated to do so. In other words, market structure in which bank concentration is lower promote financial inclusion than market structure where bank concentration is high. Therefore, we expect more inclusive financial system under lower bank asset concentration.

### **Control Variables**

We control for variables that are found to be potential determinants of financial inclusion in literature. We include credit market regulation, which is an index of ownership of banks, private sector credit, and interest rate controls/negative real interest rates, as a proxy of freedom of credit market as one of the determinants of financial inclusion in literature (Bozkurt et al., 2018). GDP per capita, log form, is included to control for the economic performance of the countries (Fungacova & Weill, 2015; Grohmann et al., 2018). We also control for the quality of institution using legal systems and security of property rights which is indexed from judicial independence, impartial courts, protection of property rights, military interference in rule of law and politics, integrity of the legal system, legal enforcement of contracts, regulatory costs of the sale of real property, reliability of police, business costs of crime, and gender disparity adjustment as one of the determinants of financial inclusion (Leon, 2015; Grohmann et al., 2018). Global financial crises, which takes 1 for years 2008 and 2009 and zero otherwise, is included to control for the recent 2008/9 global financial crises (Gopalan & Rajan, 2018). Inflation is included to control for the macroeconomic stability of a country (Rraci,2010; Emenalo et al., 2018) while overhead cost, which is measured as the operating expenses of a bank expressed as a share of the value of all held assets, is included to capture the operating expenses of banking industry (Gopalan & Rajan, 2018). We included openness, proxied trade

(% of GDP), to control the openness of countries to external economies (Emenalo et al., 2018). Urbanization, which is measured by urban population (% of total), is included as potential determinant of financial inclusion following literature (Allen et al., 2016; Bozkurt et al., 2018).

Table (5) presents effects of bank market power and concentration on financial inclusion. Columns (1) to (4) and columns (5) to (8) present the effects of bank market power and market concentration on overall financial inclusion, availability, accessibility and usage dimensions, respectively. As discussed earlier, availability, accessibility and usage dimensions represent the physical outreach, deposit and credit dimensions, respectively. Column (1) shows that bank market power does not significantly impact overall financial inclusion. However, column (5) shows bank concentration, which is measured by percentage of asset of the largest five banks in total banking industry, significantly enhances overall financial inclusion.

Now, we analyse the results by unbundling financial inclusion into physical outreach, deposit and credit dimensions. Column (2) and (3) show that market power significantly raises physical outreach and deposit dimension of financial inclusion, respectively. However, column (4) demonstrates that market power of banks reduces credit dimension of financial inclusion. Column (6) shows that bank concentration enhances physical outreach dimension of financial inclusion. However, as shown under columns (7) and (8), it does not significantly affect deposit and credit dimensions of financial inclusion.

**Table 4.**

## Effect of bank market power and concentration on financial inclusion

Variables	Bank market power				Bank asset concentration			
	(1) Fi	(2) Availability	(3) Accessibility	(4) Usage	(5) FI	(6) Availability	(7) Accessibility	(8) Usage
Lerner	0.0371 (0.0460)	0.0896** (0.0367)	0.182** (0.0713)	-0.178*** (0.0637)				
Concentration					0.0009* (0.0005)	0.0010** (0.0004)	0.0004 (0.0008)	0.0011 (0.0007)
Credit market regulations	0.0005 (0.0036)	-0.0008 (0.0029)	-0.0077 (0.0055)	0.0104** (0.0050)	-2.31e-05 (0.0035)	-0.0022 (0.0028)	-0.0107* (0.0055)	0.0135*** (0.0049)
GDP per capita	0.234*** (0.0395)	0.199*** (0.0315)	0.157** (0.0612)	0.326*** (0.0548)	0.279*** (0.0395)	0.267*** (0.0317)	0.238*** (0.0628)	0.300*** (0.0559)
GFC	-0.0014 (0.0071)	-0.0014 (0.0057)	-0.0097 (0.0111)	0.0075 (0.0099)	-0.0022 (0.0071)	-0.0032 (0.0057)	-0.0126 (0.0112)	0.00971 (0.0100)
Inflation	-0.0002 (0.0003)	8.02e-05 (0.0002)	0.0002 (0.0004)	-0.0009** (0.0004)	-0.0003 (0.0003)	-4.66e-06 (0.0002)	8.00e-05 (0.0005)	-0.0009** (0.0004)
Legal system and property right	0.0056 (0.0055)	0.0059 (0.0044)	-0.0045 (0.0085)	0.0149* (0.0076)	0.0042 (0.0055)	0.0046 (0.0044)	-0.0043 (0.0087)	0.0121 (0.0078)
Overhead cost	-1.50e-05 (0.0015)	-0.0002 (0.0012)	-0.0020 (0.0023)	0.0023 (0.0021)	-0.0004 (0.0015)	-0.0008 (0.0012)	-0.0028 (0.0024)	0.0028 (0.0021)

Trade openness	2.91e-05 (0.0003)	-0.0004* (0.0002)	-0.0004 (0.0004)	0.0010** (0.0004)	-6.55e-05 (0.0003)	-0.0006** (0.0002)	-0.0005 (0.0005)	0.0010** (0.0004)
Urbanization	0.0052** (0.0023)	0.0041** (0.0019)	0.0177*** (0.0036)	-0.0071* (0.0032)	0.0047** (0.0021)	0.0024 (0.0017)	0.0136*** (0.0033)	-0.0023 (0.0029)
Constant	-1.756*** (0.218)	-1.489*** (0.174)	-1.574*** (0.337)	-2.036*** (0.302)	-2.103*** (0.268)	-1.942*** (0.215)	-1.943*** (0.426)	-2.192*** (0.380)
Observations	204	204	204	204	204	204	204	204
R-squared	0.539	0.570	0.473	0.393	0.545	0.570	0.454	0.375
Number of id	17	17	17	17	17	17	17	17

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The overall results show that impacts of market power and asset concentration of banks depend on dimensions of financial inclusion under consideration. The fact that market power and asset concentration impact dimensions of financial inclusion differently implies that relying only on overall financial inclusion may lead to a wrong conclusion related to impact of market structure of banking industry. In the same argument, relying only on some dimensions of financial inclusion may also lead to a wrong conclusion on overall impact of banking market structure on financial inclusion. Therefore, it is crucial to consider effect of banking market structure on overall financial inclusion and its sensitivity to dimensions of financial inclusion as well.

## 4.2. Does Threshold of Bank Market Power and Concentration Matter?

In this section, we modify the baseline empirical model by introducing panel threshold model to investigate whether there is non-linear nexus between financial inclusion and market structure of banking industry as follows:

$$FI_{it} = \mu_{j1} \text{Bankmarketstructure}_{ijt} I(q_{ij} \leq \gamma) + \mu_{j2} \text{Bankmarketstructure}_{ijt} I(q_{ij} > \gamma) + X'_{it} \beta_1 I(q_{ij} \leq \gamma) + X'_{it} \beta_2 I(q_{ij} > \gamma) + \alpha_i + \varepsilon_{ijt} \quad (6)$$

where  $I(\cdot)$  is an indicator function which takes value 1 if the argument in parenthesis is valid, and 0 otherwise.  $q_{ij}$  is threshold variable, threshold level of bank market power or bank asset concentration, used to split the data into different regimes of bank market power or bank concentration. The threshold parameter is  $\gamma \in \Psi$ ; where  $\Psi$  is strict subset of the support of  $q_{ij}$ .

The threshold model represents a potential for a jumping character or structural break in the relationship between financial inclusion and banking market structure (bank market power or concentration). In this regard, the threshold model accommodates different nexus in terms of signs, magnitudes, and significance in distinct regimes between financial inclusion and banking market structure. Testing for the presence of threshold is undertaken employing bootstrap procedure (Hansen, 1999; Wang, 2015). Investigating for the presence of threshold effect is identical to testing whether the coefficients, of the banking market structure, are the same in each regime, in terms of signs, magnitudes, and significance. Accordingly, the null and alternative hypotheses, linear model versus single threshold model, are given as follows:

$$H_0 : \mu_{j1} = \mu_{j2} \quad H_A : \mu_{j1} \neq \mu_{j2}$$

Table (5) presents the threshold estimators and threshold effect tests under overall financial inclusion, physical outreach, deposit and credit dimensions of financial inclusion for bank market power and bank asset concentration. Threshold estimator reports the threshold levels of the variables, which are bank market power and bank asset concentration, and their corresponding lower and upper values. Threshold effect test presents whether there is a threshold effect of the variable under consideration, bank market power or bank concentration. The null hypothesis is that there is no single threshold effect while the alternative hypothesis implies that there is threshold effect. As such, the null hypothesis implies that the relationship between financial inclusion and bank competition and/or bank concentration is linear while the alternative hypothesis implies that the relationship is nonlinear. We test the hypothesis based on the P-value of the test. Alternatively, we undertake the test using the F-stat: we reject the null hypothesis of no threshold effect if the F-stat is larger than the respective critical value (at 1, 5 and 10 critical values).

Table (5) demonstrates that we reject the null hypothesis of no threshold effect of banking market power under overall financial inclusion and usage dimension as the P-value and F-stat dictate. The threshold values are 0.3418 and 0.3426 for the overall financial inclusion and usage dimension, respectively. In the case of banking concentration, we reject the null hypotheses of no threshold effect under overall financial inclusion, availability and usage dimensions. Their threshold levels are 0.3200, 0.2901 and 0.2798, respectively.

**Table 5.**

Panel threshold estimator and threshold effect test

	Lerner			Concentration						
Threshold estimator										
Model (Th-1)	Threshold	Lower	Upper							
FI	0.3418	0.3374	0.3467				0.3200	0.3078	0.3219	
Availability	0.2901	0.2838	0.3148				0.2901	0.2838	0.3164	
Accessibility	0.2209	0.2198	0.2224				0.2262	0.2255	0.2271	
Usage	0.3426	0.3361	0.3454				0.2798	0.2781	0.2822	
Threshold effect test										
Threshold (single)	Fsta	Prob	Crit10	Crit5	Crit1	Fstat	Prob	Crit10	Crit5	Crit1
FI	81.56	0.0700	73.2277	91.3556	112.1660	70.42	0.0233	57.9249	65.0623	81.5190
Availability	73.55	0.1133	75.0501	80.2853	95.3111	76.87	0.0733	70.4665	81.5267	118.0368
Accessibility	60.90	0.1933	72.0699	80.5074	102.4354	63.89	0.1800	72.0505	82.2104	100.5436
Usage	74.86	0.0167	56.3253	63.8506	80.0304	49.94	0.0667	41.9331	52.2763	63.9569

Tables (6) and (7) show panel threshold regression results of the effects of bank market power and concentration on financial inclusion, respectively, following the threshold estimators and threshold tests, for the models which exhibit threshold effect. Columns (1) and (2) of Table (6) show that the effect of bank market power on overall financial inclusion changes only sign but not significance under the two regimes of banking market power. Under lower regime banking market power, where there is more competition, its coefficient is positive while under the higher regime, when there is more of monopoly and hence less of competition, its coefficient turns to be negative. Bank concentration, as shown by columns (1) and (2) of Table (7), significantly raises overall financial inclusion both under lower and higher regimes of bank concentration; nevertheless, the impact is more pronounced under the lower regime.

**Table 6.**  
Threshold regression result of banking market power

Variables	(1)	(2)	(3)	(4)
	Fi		Usage	
	$q_{FI} \leq 0.3418$	$q_{FI} > 0.3418$	$q_{usage} \leq 0.3426$	$q_{usage} > 0.3426$
Lerner	0.0631 (0.0588)	-0.0366 (0.0904)	-0.265*** (0.0825)	-0.289** (0.127)
Credit market regulation	0.0008 (0.0041)	-0.0034 (0.0050)	0.0100* (0.0057)	0.0035 (0.0070)
GDP per capita	0.0527 (0.0434)	0.0915** (0.0405)	0.112* (0.0609)	0.151*** (0.0568)
GFC	0.0164** (0.0081)	-0.0257** (0.0106)	0.0340*** (0.0113)	-0.0314** (0.0149)
Inflation	-1.98e-05 (0.0003)	0.0001 (0.0004)	-0.0008* (0.0004)	-0.0005 (0.0005)
Legal system and property right	-0.0039 (0.0052)	0.0131* (0.0068)	0.0017 (0.0073)	0.0262*** (0.0096)
Overhead cost	0.0018 (0.0013)	-0.0207*** (0.0039)	0.0045** (0.0019)	-0.0195*** (0.0055)
Trade openness	0.0011*** (0.0003)	0.0004 (0.0004)	0.0022*** (0.0004)	0.0016*** (0.0005)
Urbanization	0.0154*** (0.0025)	0.0134*** (0.0024)	0.0061* (0.0035)	0.0038 (0.0034)
Constant	-0.910*** (0.228)		-1.030*** (0.320)	
Observations	204		204	
R-squared	0.676		0.563	
Number of id	17		17	

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Unbundling financial inclusion into its dimensions, we demonstrated bank market power and concentration, under their respective regimes, impact dimensions of financial inclusion differently. Columns (3) and (4) of Table (6) show that bank market power significantly reduce usage dimension under both higher and lower regimes, but the impact gets worse under the higher regime. Bank concentration significantly raises availability dimension under both lower and higher regimes but more pronounced effect under lower regime as shown under (3) and (4) of Table (7). Columns (5) and (6) of the Table show that bank concentration enhances usage dimension only under lower regime. In other words, the effect of bank concentration on usage

dimension turns to be insignificant after the threshold level. The findings imply that though concentration enhances availability and usage dimensions of financial inclusion, the impact falls for availability dimension and becomes insignificant for usage dimension after their respective threshold levels are attained.

Table 7. Threshold regression result of banking asset concentration

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Fi		Availability		Usage	
	$q_{FI} \leq 0.3200$	$q_{FI} > 0.3200$	$q_{availability} \leq 0.2901$	$q_{availability} > 0.2901$	$q_{usage} \leq 0.2798$	$q_{usage} > 0.2798$
Concentration	0.0017*** (0.0005)	0.0014*** (0.0005)	0.0013*** (0.0004)	0.0010*** (0.0004)	0.0017** (0.0007)	0.0011 (0.0007)
Credit market regulation	0.0009 (0.0040)	-0.0045 (0.0048)	-0.0047 (0.0032)	0.0023 (0.0030)	0.0043 (0.0066)	0.0244*** (0.0052)
GDP per capita	0.156*** (0.0413)	0.201*** (0.0409)	0.126*** (0.0339)	0.132*** (0.0329)	0.208*** (0.0628)	0.190*** (0.0609)
GFC	0.0098 (0.0088)	-0.0230** (0.0098)	0.0088 (0.0086)	-0.0078 (0.0064)	0.0439*** (0.0166)	-0.0033 (0.0114)
Inflation	-0.0002 (0.0003)	-4.75e-05 (0.0004)	0.0001 (0.0003)	5.60e-05 (0.0003)	-0.0005 (0.0005)	-0.0012** (0.0005)
Legal system and property right	-0.0050 (0.0053)	0.0053 (0.0076)	0.0021 (0.0042)	0.0068 (0.0053)	0.0039 (0.0078)	0.0283*** (0.0095)
Overhead cost	0.0013 (0.0014)	-0.0169*** (0.0035)	0.0007 (0.0011)	-0.0127*** (0.0026)	0.0044** (0.0020)	-0.0115*** (0.0043)
Trade openness	0.0007** (0.0003)	-0.0002 (0.0004)	-0.0005* (0.0002)	0.0002 (0.0002)	0.0015*** (0.0004)	0.0015*** (0.0005)
Urbanization	0.0135*** (0.0023)	0.0105*** (0.0022)	0.0098*** (0.0018)	0.0087*** (0.0017)	0.0013 (0.0034)	0.0018 (0.0031)
Constant	-1.454*** (0.248)		-1.233*** (0.213)		-1.658*** (0.393)	
Observations	204		204		204	
R-squared	0.700		0.693		0.504	
Number of id	17		17		17	

Standard errors in parentheses \*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

## 5. Conclusion

In this study, we developed a multidimensional measure of financial inclusion and examined the effect of banking market power and bank asset concentration on financial inclusion. We measured financial inclusion using two-stage PCA. In the first stage PCA, we developed availability dimension of financial inclusion from four indicators: number of bank branches per 100,000 adults, number of ATMs per 100,000 adults, number of bank branches per 1000km<sup>2</sup> and number of ATMs per 1000km<sup>2</sup>. The first two indicators represent demographic outreach while the last two denote geographic penetration. In second stage PCA, we developed index of overall financial inclusion from availability, accessibility, and usage dimensions.

The result of the first stage PCA shows that geographic outreach of banking branches is the most important indicator in explaining availability dimension, while demographic outreach of ATMs plays the least role. On average, geographic outreach (bank branches per 1000km<sup>2</sup> and ATMs per 1000km<sup>2</sup>) are more important than their demographic counterparts (bank branches per 100,000 adults and ATMs per 100,000 adults) in explaining the availability dimension. This is intuitive given that Africa is sparsely populated; and hence geographic outreach plays crucial role in explaining availability dimension of financial inclusion. Moreover, on average, bank branch outreach (both demographic and geographic sub-dimensions) explain more variation in data compared to ATM outreach. Literature shows that bank branches enhance extensive margin of financial services while ATM promotes intensive margin. Therefore, the result is intuitive because financial services which promote extensive margin of financial services explain more proportion of variation in the data compared to those promoting intensive margin. The second stage PCA result shows that availability dimension is the most important dimension in explaining the overall financial inclusion, while usage dimension plays the least role.

After developing the measure of financial inclusion, we examined the effects of bank market power and bank asset concentration on financial inclusion. The findings show that bank asset concentration enhances overall financial inclusion. However, bank market power does not significantly affect overall financial inclusion. Unbundling financial inclusion into its dimensions, availability, accessibility and usage, we showed that bank market power enhances both availability and accessibility dimensions of financial inclusion but reduces the credit dimension. Bank asset concentration enhances physical outreach of financial inclusion but does not significantly affect deposit and credit dimensions of financial inclusion.

We further examined whether banking market power and bank concentration have non-linear impact on financial inclusion employing endogenous threshold model. Banking market power does not significantly affect overall financial inclusion under both lower and higher regimes of banking market power but the sign of the coefficient turns from positive under lower regime to negative under higher regime. Bank concentration positively and significantly affect overall financial inclusion both under lower and higher concentration regimes while the impact is more pronounced under lower regime.

Unbundling financial inclusion into availability, accessibility and usage, we found that banking market power has threshold effect only on the usage dimension. Accordingly, it reduces credit dimension both under lower and higher regimes, but negative impact is severe under higher regime. Bank asset concentration has non-linear impacts on availability and usage dimensions, not on the accessibility dimension. Accordingly, bank concentration enhances availability dimension under both lower and higher regimes, but the impact is more pronounced under lower regime of concentration bank asset. Bank concentration enhances usage dimension significantly only under lower regime of concentration.

To sum up, the impacts of bank market power and bank concentration various across dimensions of financial inclusion and regimes of bank market power and concentration. Market

power enhances availability and usage dimensions but reduces usage dimension. Moreover, threshold effect shows that negative effect of market power on usage worsens under higher regime of market power. Furthermore, market power has threshold impact on overall financial inclusion, though not statistically significant, where coefficient turns from positive under lower regime to negative under higher regime. The results suggest that though certain degree of market power is important for some dimensions of financial inclusion, the negative impact may outweigh after threshold is achieved. Overall, positive impact of bank concentration on overall financial inclusion and availability dimension more pronounced under lower regime compared to the higher regime counterpart. Bank asset concentration enhances usage dimension only under lower regime. The results clearly demonstrate certain level of concentration is important for enhancing inclusive financial inclusion, but concentration beyond threshold is not desirable.

The implication of the results is clear. The fact that market power and asset concentration impact dimensions of financial inclusion differently implies that relying only on the overall financial inclusion may lead into a wrong conclusion. In similar argument, relying only on some dimensions of financial inclusion potentially leads to a wrong conclusion on the overall impacts of bank market power and bank asset concentration on financial inclusion. Hence, it is vital to consider the impacts of bank market power and concentration on overall financial inclusion and investigate sensitivity of the results to dimensions of financial inclusion as well.

The fact that market power enhances the availability and accessibility dimensions of financial inclusion but reduces usage dimension, and its impact on usage deteriorates after threshold level has clear policy implication. The implication is that it is important to set some degree of market power that balances the positive and negative effects. The fact that positive impacts of bank asset concentration on financial inclusion, on average, is more pronounced in lower regimes compared to the higher regime counterparts imply that though more bank asset concentration is desirable its positive impacts on financial inclusion fall after some threshold levels implying that more bank asset concentration is not desirable after threshold. This is intuitive in Africa. Given that banking industry in Africa operate at small scale and are fragile (Beck et al., 2015;), more asset concentration is vital to promote financial inclusion through demographic outreach, geographic penetration, promoting saving and extending credit among others.

## Appendix

### Appendix A

Table A1.

Mean values of the main variables for each country

Country	ATMperadult	ATMperkm2	Bankperadult	Bankperkm2	Deposit	Credit	Lerner	Concentration
Algeria	4.8866	0.5470	5.0599	0.5515	583.8936	14.6927	0.5415	89.9657
Angola	9.7481	1.0288	6.4131	0.6636	261.5144	16.5901	0.4034	86.5696
Burundi	0.5920	1.2169	2.2962	4.3971	27.6796	16.3862	0.3094	100.0000
Cameroon	1.9120	0.4715	1.4848	0.3578	54.3043	11.2306	0.3452	84.2270
Egypt	7.7409	4.5227	4.2646	2.4293	379.1023	37.3888	0.1636	69.4816
Ghana	5.2224	3.4547	4.9760	3.2643	362.1214	15.2731	0.3880	68.2040
Kenya	6.7369	2.8914	4.3051	1.8127	504.1751	28.0193	0.3920	60.2064
Madagascar	1.3305	0.2841	1.4697	0.3059	52.7946	11.0797	0.2800	99.8686
Mauritius	40.0328	191.8309	20.4943	98.0706	2154.3680	85.9377	0.3480	73.5993
Morocco	18.6363	9.7500	17.9466	9.4008	595.1102	59.9036	0.2927	83.1457
Mozambique	5.4124	0.9406	2.9983	0.5108	147.7389	20.3216	0.2513	94.9804
Nigeria	8.9770	9.1206	5.5207	5.3736	442.8791	18.0829	0.2211	68.6189
Rwanda	2.2441	5.8675	3.8612	9.7352	174.2840	14.9422	0.2668	93.4237
South Africa	47.7757	14.1472	8.6877	2.5564	998.7781	70.0592	0.1748	99.2059
Tanzania	3.6320	1.0734	1.8341	0.5302	189.5636	11.5841	0.3127	69.5110
Uganda	3.0713	2.7361	2.1025	1.8598	158.9478	12.1600	0.3082	73.3526
Zambia	5.7556	0.6059	3.7577	0.3790	158.5408	10.4196	0.3082	77.0968

**Table A2.**

Country List: Based on World Bank, 2018 Classification<sup>4</sup>

Low Income Economies (\$995 or less)	Lower Middle-Income Economies (\$996 to \$3,895)	Middle Income Economies Upper Middle-Income Economies (\$3,896 to \$12,055)
Burundi	Angola	Algeria
Madagascar	Cameroon	Mauritius
Mozambique	Egypt, Arab Republic	South Africa
Rwanda	Ghana	
Tanzania	Kenya	
Uganda	Morocco	
	Nigeria	
	Zambia	

<sup>4</sup> World Bank's countries classification based on their income can be found here: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>

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