An investigation on the Impact of Economic Growth and Financial Stability on Financial Inclusion in Sub-Saharan Africa

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An Investigation on the Impact of Economic Growth and Financial Stability on Financial Inclusion in Sub Saharan Africa

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Abstract

Financial Inclusion is rising globally on the worldwide policy agenda due to its capacity to give people including low-income individuals and unbanked individuals a way to access financial services. The world bank highlighted the high level of financial exclusion in the Sub-Saharan Africa region because almost 60% of the adults are without bank accounts. However, this study seeks to explore the connections that exist between Economic Growth and Financial stability on financial inclusion. The IMF financial Access survey provides data on the different financial inclusion indicators, data on the economic growth and financial stability indicators were obtained from the world bank's Global Financial Development and world development indicators respectively. The financial inclusion status of each country was derived through a two-stage robust principal component analysis (RPCA), considering the availability, usage, and penetration of financial services. Furthermore, relationship between the variables was analyzed using fixed effect regression and an additional technique - random effect regression for further analysis. The findings of the study show that liquid Assets to Deposit and short-term funding (Financial Stability Indicator) and GDP per capita (Economic growth indicator) show a significant and positive impact on financial inclusion.

1. Introduction

1.1 Background to the study

Numerous people worldwide in poverty lack access to reliable financial services like savings, deposits, credit, and insurance. Removing barriers to ensure full participation in the financial system is crucial. While owning a bank account is an initial step towards financial inclusion, it's challenging for low-income individuals. (Ifediora et al., 2022). Financial inclusion ensures vulnerable individuals access essential financial services, potentially advancing Financial Sector Development and the economy's progress (Anarfo et al., 2019). Financial inclusion empowers households to handle financial setbacks and invest in human capital which will allow households to seize the investment potentials in their economy (Kuada, 2019). The Covid-19 outbreak emphasized the need for economic recovery; enhancing financial services access, usage, and quality can substantially contribute to this recovery (Ozili, 2020) identified some reasons why financial inclusion has gained traction among policymakers which include aiding the United Nations' sustainable Development Goals (SDG's), promoting social inclusion, and yielding socioeconomic benefits like economic growth and income stability. (Koudalo and Toure, 2023) highlight financial inclusion's prominence as a challenge in Africa, leading policymakers to implement measures addressing gaps in gaining financial access.

The goal of financial inclusion is to rectify unequal financial service distribution, but concerns exist about its impact on economic growth and stability (Ratnawati et al., 2022). In Sub-Saharan Africa, less than 43% of adults hold bank accounts, hindering SDG targets and causing socioeconomic difficulties (Jima & Makoni, 2023). While developed nations acknowledge financial inclusion's economic impact, its relation to financial stability varies (Ratnawati et al., 2022). The connection between financial inclusion, poverty rates, financial stability, and economic conditions influences its dynamics (Ozili, 2020). Economic Growth signifies wealth expansion and improved living standards (Batrancea et al., 2022). Financial stability demonstrates an economy's resilience against disruptions, involves a well-functioning financial market and liquidity (Jima & Makoni, 2023).

This research aims to contribute to the body of knowledge by computing a financial inclusion index considering availability, penetration, and usage, exploring how the index, and its components relate to economic growth and financial stability in 16 Sub-Saharan African countries. This study contributes to informed policies on financial inclusion, sustainable development, and economic progress.

1.2 Research Question and Objectives

The study aims to address the following research question;

"To what extent does financial Inclusion impact economic growth and financial stability in the Sub-Saharan African Region?"

The objectives of the research are;

- To compute a recent financial inclusion index for some countries in the Sub-Saharan African Region.
- To examine the connection between Financial Inclusion Index (FII) and Financial Stability and Economic Growth.
- To examine the impact of usage, availability, and penetration indicators of financial inclusion individually on Financial Stability and Economic Growth.

In answering the research question, a Robust Principal Component Analysis (RPCA) will be used to obtain the Financial Inclusion Index and the Fixed Effect Regression to analyze the relationship between the variables.

The other parts of the paper will be structured as follows;

- section 2 will include literature review of previous researchers on the subject
- section 3, 4 and 5 will include details of the research methodology, model specifications and implementations

- section 6 will include the discussion and evaluation of the results obtained from section 5
- Section 7 will contain conclusions and future recommendations.

2. Literature Review

2.1 Measuring Financial Inclusion

Various researchers have disagreed over the years on the proper dimensions to measure financial inclusion and the disagreement may affect the best computation for financial inclusion. (Deepti and Vaidhyasubramaniam, 2018) recognized factors such as penetration, availability, and usage of financial services as the most significant indicators of financial inclusion. Financial inclusion penetration refers to the extent by which formal financial institutions are able to reach and provide services to a diverse group of people. Additionally, it shows how well these institutions are able to draw clients and persuade them to open accounts. The percentage of the population with formal bank accounts and the number of people that have mobile money accounts are some of the indicators that can be used to gauge financial inclusion penetration because they show how widely available and accessible financial services are within an economy (The second dimension of financial inclusion deals with the availability of financial services and it refers to the presence and accessibility of financial institutions and ensures easy access and frequent usage of banking services to ensure an inclusive financial system. The indicators of availability include the number of commercial banks and ATM's per 100,000 adults and so on. The third dimension which is the usage shows how well the financial services provided by the financial institutions are utilized (Abdulmumin et al., 2019). (Kebede et al., 2021) indexed financial inclusion using a two-stage unsupervised machine learning technique, their findings demonstrated that bank dominance has different effects of financial inclusion dimensions, it increases availability and accessibility but decreases the usage. The study emphasizes the necessity of prioritizing geographic outreach in order to achieve an inclusive financial system in Africa, emphasizing the significance of physical outreach in fostering overall FI. (Tram et al., 2023) developed a financial inclusion index using bank penetration, usage, and availability of financial services, their study also considered indicators relating to mobile money, they created an index using a two-stage robust principal component analysis that allowed endogenous weight assignment. They obtained data from World Bank and IMF; the index provides a multidimensional approach that maximized the various dimensions of financial inclusion. The study considered availability indicators such as number of ATMs, branches, and mobile money agents per 100,000 adults, usage indicators were measured by the number of bank accounts per 1,000 population. The penetration dimension was measured using indicators such as the number of deposit accounts, number of credit unions and credit cooperatives per 1,000 adults. Accurately measuring financial inclusion remains a challenge due to different perspectives on dimensions and representations, the traditional indexes overlook vital aspects such as the role of electronic cards which are beginning to play significant roles in facilitating transactions and expanding market access, (Nuzzo & Piermattei, 2019) considered the impact of electronic cards and the study on the samples in the Euro area countries and revealed a notable variation, Germany outperformed in terms of financial

inclusion, and Spain showed a substantial improvement. Financial inclusion is considered the outcome variable of interest in this study. (Bashiru et al., 2023) gauge the level of financial inclusion with 33 countries in sub-saharan Africa by constructing a composite index using Principal Component Analysis (PCA), which considers five distinct sub-measures. These sub-measures encompass the density of ATMs per 100,000 adults (ATM), the presence of operational bank branches per 100,000 adults (BRA), the quantity of bank accounts per one thousand adults (BAC), the incidence of individuals borrowing from commercial banks per 100,000 adults (BOR), and the prevalence of individuals depositing with commercial banks per 100,000 adults (DEP). (Amponsah, Agbola, and Mahmood, 2021) conducted a comprehensive study encompassing 44 Sub-Saharan African countries. While the study effectively categorized indicators into dimensions of availability, access, and usage, its limited focus on 17 African countries posed a potential challenge to generalizability.

2.2 The Influence of Economic Growth and Financial Stability on Financial Inclusion

Numerous studies have investigated the intricate relationship between financial inclusion, economic growth, and financial stability. Notably, these studies reveal strong evidence that financial inclusion significantly impacts economic development globally. Furthermore, they confirm that an inclusive economy plays a vital role in fostering financial stability, thus contributing to sustained economic growth (Jima & Makoni, 2023). The study conducted by (Jima and Makoni, 2023) focused on Sub-Saharan Africa and unveiled both long- and short-term relationships between financial inclusion, economic growth, and financial stability. Granger causality tests demonstrated mutual complementarity among these variables, indicating that increasing financial services positively affects both economic performance and financial stability. (Koudalo and Toure, 2023) delved into the relationship between financial inclusion and financial stability across 54 countries. Their research indicated a positive correlation between bank penetration and financial stability. Factors such as income inequality, political stability, and financial openness influenced this relationship. New financial inclusion policies, encompassing bank credit access and financial savings, were identified as supporters of financial stability in African nations. (Ezzahid and Elouaourti, 2021) developed an analytical framework to explore financial inclusion's role in stimulating investment and economic growth in Africa. Their findings underscored the positive impact of financial inclusion on economic growth, despite its limited presence in most African economies. (Abdul Karim et al., 2022) employed a financial inclusion index to analyze its inclusiveness over time. They found that while high financial inclusion might not greatly impact economic growth, it does have a favorable influence in underdeveloped economies like those in Africa and Asia. Notably, strong institutions, governance, and access to finance were identified as crucial factors for achieving the desired positive impact. (Emara and El Said, 2021) emphasized the importance of financial inclusion and governance for enhancing access to finance and promoting economic growth. (Ratnawati et al., 2022) explored the impact of financial inclusion on economic growth, poverty, income inequality, and financial stability in Asian countries. Their findings demonstrated the collective influence of financial inclusion on these variables, advocating for further optimization of this impact. (Ahmad Malik and Yadav, 2022) highlighted the positive association between financial inclusion and Sustainable Development Goals (SDGs),

suggesting that expanding financial services contributes to achieving these objectives. However, they noted that the presence of internet subscribers could hinder this relationship, emphasizing the need for digital literacy initiatives. (Zhang et al., 2022) used panel data analysis to reveal a significant connection between financial inclusion, non-performing loans (NPLs), and economic growth. Their findings recommend implementing policies to manage NPLs and enhance financial inclusion. In essence, these studies collectively underscore the substantial impact of financial inclusion on economic growth and financial stability. They emphasize the need for targeted policies and initiatives to optimize this impact and foster sustainable development.

3. Research Methodology

This section of the research will contain an aggregate of the research processes n and techniques followed in investigating the relationship between Financial Inclusion, Financial Stability and Economic growth. The approach that will be followed is the KDD (Knowledge Discovery in Databases) approach which considers a more detailed knowledge of discovering knowledge from large databases.

3.1 Data Selection

Data on financial inclusion can either be obtained from the World Bank's Global Financial Inclusion Database or the IMF Financial Access Survey Database. The research relied on data from the IMF's Financial Access Survey in line with the works of (Tram et al., 2023), a secondary data source that provides information on the Financial Inclusion indicators from the supply side to obtain data on financial inclusion. This database contains information on the level on inclusiveness among countries all over the world. The Financial Stability and Economic Growth data were obtained from World Bank's Global Financial Development database and World Development Indicators respectively covering a period of 2012 – 2012. The Sub-Saharan region of Africa has 48 countries in total however due to missing points and non-availability of data for many of the countries in the region, only 16 countries were used in the analysis.

3.1.1 Financial Inclusion Index

The financial inclusion index can either be measured using a parametric or non-parametric method, while the non-parametric method involves assigning weights on each indicator based on their intuition and knowledge, the parametric method involves developing an index using a Principal Component Analysis (PCA) (Nguyen, 2020). Financial inclusion will be measured by creating an index using Principal Component Analysis and the financial inclusion index will be measured with the variables in line with the works of (Tram et al., 2023).

Penetration Dimension - An inclusive financial system aims to reach a large number of users which ensures penetration among the target population. It may also be regarded as the Access dimension of Financial Inclusion and the Index will be obtained using the following indicators;

- Number of deposit accounts with commercial banks per 1,000.adults
- Number of registered mobile money accounts per 1,000 adults

Availability Dimension - The availability dimension examines the ability of financial services to be easily available to the unbanked individuals. The availability index will be obtained using the following indicators;

- Number of ATMs per 100,000 adults
- Number of commercial bank branches per 100,000.adults
- Number of registered mobile money agent outlets per 100,000 adults

Usage Dimension - The usage dimension on the other hand examines how well the financial services are utilized by the unbanked population. The usage indicators used for this research include;

- Number of mobile money transactions during the reference year per 1,000 adults
- Outstanding deposits with commercial banks (% of GDP)
- Outstanding loans from commercial banks (% of GDP)

3.1.2 Financial Stability and Economic Growth

Data for Financial Stability was sourced from the World Bank's Global Financial Development database which shows data on the financial system for over 200 economies which is a trustworthy source. The choice of the variables were based on related works on the subject. The indicators that were used for financial stability include Z-score, Bank Non-performing loans to Gross Loans, Bank Capital to Total Assets and Liquid Assets to Deposits and short-term funding which is in line with the study of (Le et al., 2019), on the other hand, data on Economic growth was obtained from the World Bank's World Development Indicators and the indicator used was GDP per capita.

3.1.3 Definition of Variables

Table 1: Definition of variables

Variables	Definition
Z-Score	The Z-score measures how likely an economy's commercial bank will experience default. A higher Z-score suggests that a system is less likely to become unstable (Jima & Makoni, 2023)
Bank Non-performing loans to Gross Loans	The ratio of defaulted loans, which includes both interest and principal payments that are overdue by 90 days or more, to the total value of gross loans in the loan portfolio.
Bank Capital to Total Assets	This variable represents details of how well the bank's capital can act as a safety net against potential losses in the banking systems.
Liquid Assets to Deposit and short-term funding	The indicator evaluates bank's access to liquid resources in relation to its deposit and short-term funding liabilities. Liquid assets encompass cash, amounts owed by banks, securities held for trading or fair value recognition, loans to other banks, reverse repurchase agreements, and cash used as collateral. Deposits and short-term funding comprise the aggregate of customer deposits (including current, savings, and term deposits) and short-term borrowings, encompassing money market instruments, certificates of deposit, and other types of deposits.
GDP per Capita	This is the gross domestic product for each country per individual using the current exchange rate.
Availability Index	The Availability Index is obtained by using a Principal component analysis on the 3 Availability Indicators used in the research.
Usage Index	The Usage Index is obtained by using a Principal component analysis on the 3 Usage Indicators used in the research.
Penetration Index	The Penetration Index is obtained by using a Principal component analysis on the 2 penetration Indicators used in the research.
Financial Inclusion Index	The financial inclusion Index combines the Penetration, Availability, and Usage Indexes using the Principal Component Analysis.

3.2 Pre-Processing

The pre-processing stage of the research involves preparing and cleaning the data before it is used for conducting the research. The three datasets used for the purpose of the research were imported in a CSV file into R-studio, the various variables that were to be ignored in the research were taken out and countries that had a high amount of missing data were also removed. Missing data and outliers were also dealt with appropriately.

3.3 Data Transformation

After all the datasets went through proper transformation necessary to ensure they can be used for data mining. The process required renaming and rearranging some of the variables. In other to obtain a unified dataset for the analysis, the three different datasets were combined into one for the analysis.

3.4 Data Mining

This stage of the research identifies patters and draws information from the data. The data mining techniques used are explained below;

3.4.1 Robust Principal Component Analysis

This technique was first introduced by Karl Pearson in 1901, it was employed to reduce the dimensionality of the problem by reducing the size of a large number of input variables (Younes et al., 2021).The principal component analysis is a technique used in transforming correlated variables into a set of uncorrelated variables which are commonly referred to as principal components. In doing this, outliers, and problems of missing values such as the dataset for the sub-Saharan African Region is addressed (Mahmoudi et al., 2021). The financial inclusion indicators are derived using a two-stage RPCA approach, following methodologies employed in studies conducted by (Kebede et al., 2021) and (Tram et al., 2023) to construct the financial inclusion index. This two-stage approach aims to avoid overfitting and bias arising from highly correlated variables.

3.4.2 Fixed Effect Regression

The fixed Regression model is used in estimation of a panel data which in this instance is the Economy over a particular period of time. The fixed effect regression helps in analyzing whether a connection exists between the dependent and independent variables in an equation As much as the Random effect regression provides a much more sophisticated result than the Fixed effect Regression model, Fixed Effects regression is seen to be much more preferable than the later because the main distinction is that random effects (RE) and fixed effects (FE) models lies in their assumptions regarding the relationship between the unobserved time-constant effects (υ) and the observed predictors. In RE models, it is assumed that the observed predictors in the model are not correlated with υ, while in FE models, they are allowed to be correlated (Bell et al., 2019).

4. Model Specification

The models that will be used in this research include;

$$\boldsymbol{AvailabilityIndex_{y,c}} = f(Y1_{y,c}, Y2_{y,c}, Y3_{y,c}, \ldots\ldots Yx_{y,c}) \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$\boldsymbol{UsageIndex_{y,c}} = f\left(Y1_{y,c}, Y2_{y,c}, Y3_{y,c}, \ldots\ldots Yx_{y,c}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$\boldsymbol{PenetrationIndex_{y,c}} = f\left(Y1_{y,c}, Y2_{y,c}, Y3_{y,c}, \ldots\ldots Yx_{y,c}\right) \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$\boldsymbol{FII_{y,c}} = f(Y1_{y,c}, Y2_{y,c}, Y3_{y,c}, \ldots\ldots Yx_{y,c} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Each measure of the Availability Index, Usage Index, Penetration Index and Financial Inclusion Index (Dependent Variables) are obtained using the Principal Component Analysis (PCA), $(Y1_{y,c}, \ldots\ldots Yx_{y,c})$ in each equation signifies the (independent Variables) which are the indicators of financial stability and Economic Growth for each of the countries used per year.

4.1 Robust Principal Component Analysis

The purpose of obtaining a financial inclusion index is to access the level of inclusiveness for each of the countries used in Sub Saharan Africa and specifically tackle the problems of using arbitrary weight selection and offers a comprehensive reflection of the level of financial inclusion (Abdul Karim et al., 2022). The first stage of the PCA produces an index for each of the Availability, penetration, and Usage Indicators separately, then in the second stage, the Availability Index, Penetration Index and Usage Index were combined to form a Financial Inclusion Index.

4.1.1 First Stage Robust Principal Component Analysis

In the first stage of the PCA, the penetration dimension was obtained by the linear combination of the indicators - Deposit accounts which represents the Number of deposit accounts with commercial banks per 1,000 adults and MMAccts which represents the Number of registered Mobile Money accounts per 1,000 adults. The availability dimension on the other hand comprised of BankBranches- Number of commercial bank branches per 100,000 adults, ATMs- Number of ATM branches per 100,000 adults and MMAgents- No of registered mobile money agents per 100,000 adults. Lastly, the usage dimension on the other hand was obtained by the linear combination of MMTransactions - Number of mobile money transactions during the reference year per 1,000 adults, OutstandingDeposit – Outstanding deposits with commercial banks and OutstandingLoans - Outstanding loans from commercial banks the equations 5 and 7 respectively represents the Weighted Average of the indicators, j is the number of indicators in each dimension which is 3 for each dimension, λ_j is the jth eigenvalue for each dimension. Y stands for the year and C stands for each economy.

$$PenetrationIndex_{y,c} = Š_1 \text{Deposit accounts}_{y,c} + Š_2 \text{MMAccts}_{y,c} + e_{y,c} \text{ ……………..….. } (5)$$

$$PenetrationIndex_{y,c} = \frac{\sum_{j,k=4}^{s} \lambda_j P_{kyc}}{\sum_{j,k=3}^{s} \lambda_j} \text{ …………………………………………………… } (6)$$

$$AvailabilityIndex_{y,c} \; Š_1 Bank\ Branches_{y,c} + Š_2 ATM's_{y,c} + Š_3 \text{MMAgents}_{y,c} + e_{y,c} \text{…} (7)$$

$$AvailabilityIndex_{y,c} = \frac{\sum_{j,k=4}^{s} \lambda_j P_{kyc}}{\sum_{j,k=3}^{s} \lambda_j} \text{ ……………………………………………… } (8)$$

$$UsageIndex_{y,c} = \beta_1 MMTransactions_{y,c} + \beta_2 \text{OutstandingDeposit}_{y,c} + \beta_3 \text{OutstandingLoans}_{y,c} + e_{y,c} \text{ …………………………………………………………… } (9)$$

$$UsageIndex_{y,c} = \frac{\sum_{j,k=3}^{s} \lambda_j P_{kyc}}{\sum_{j,k=3}^{s} \lambda_j} \text{ ………………………………………………………… } (10)$$

4.1.2 Second Stage Robust Principal Component Analysis

In the second stage of the PCA, the same process was followed but the Penetration, Availability and Usage Index was used as the principal components.

$$FII_{y,c} = PenetrationIndex_{y,c} + AvailabilityIndex_{y,c} + UsageIndex_{y,c} + e_{y,c} \text{ ……………………………………………………………………… } (11)$$

$$FII_{y,c} = \frac{\sum_{j=1}^{2} \lambda_j \left(\Psi_{jk} PenetrationIndex_{y,c} + \Psi_{jk} Availability_{y,c} + \Psi_{jk} UsageIndex_{y,c} \right)}{\sum_{j=1}^{2} \lambda_j} \text{ ……………… } (12)$$

4.2 Fixed Effects Regression

In using the fixed effect Regression in analyzing the relationship between the financial inclusion index, economic growth, and financial stability. The Financial Inclusion Index is subject to the regression with the intercept a_{yc} which is particular to each entity and the various independent variables. A model will be formulated based on the formular below;

$$FII_{y,c} = a_{yc} + \beta 1 Zscore_{yc} + \beta 2 \text{NPL}_{yc} + \beta 3 \text{BankCapAssets}_{yc} + \beta 4 \text{LiquidAssetsDeposit}_{yc} + \beta 5 \text{GDPperCapita}_{yc} \text{ ……………………………………… } (13)$$

5. Solution Development

5.1 Data Selection

This data used in this research was obtained from IMF Financial Access Survey Data, World Bank's Global Financial Development database and World bank's World development indicators. When the data for financial inclusion was downloaded, it was uploaded into R studio for proper cleaning and analysis. At the time of the upload into R studio, the data had 792 observations and 194 variables for a period of 2004 up till 2021. The data for the financial stability and Economic Growth indicators were also uploaded into R studio, at the time of the download of the financial stability, it had 13,267 observations and 14 variables, so the data was cleaned to select the variables and observations that will be used for the analysis, the economic growth data on the other hand had been cleaned based on the completeness of the data that was obtained from the FAS data and financial stability data.

5.2 Preprocessing and Transformation

The three datasets went through various preprocessing stages before they were merged to be able to effectively answer the research question.

5.2.1 Financial Access Survey Dataset

The FAS dataset was the first dataset to be analyzed, the 8 indicators that will be useful for the research was selected. The sapply function in R studio was used to check the countries that had a significant number of missing values were removed from the study. Also, the data was filtered to only remain data for only 2012 till 2021. The missing data accounted to a percentage of 29% of the whole dataset. Countries such as Mauritiana, Seychelles, Mauritius and Gambia that showed missing values for indicators for mobile money because it had not been introduced in some of the earlier years and were therefore replaced with zero. The FAS indicators were renamed to avoid mistakes in analyzing the data. For replacing the missing values in the dataset, a mean substitution was used to replace missing data points. So basically, if there is a missing data for **"MMAgents"** for 2014, it will be replaced with the mean of the values for **"MMAgents"** for 2012 for 2013. After cleaning and removing all the missing values, the missing data percentage came to Nil. This is displayed in Fig 1 below;

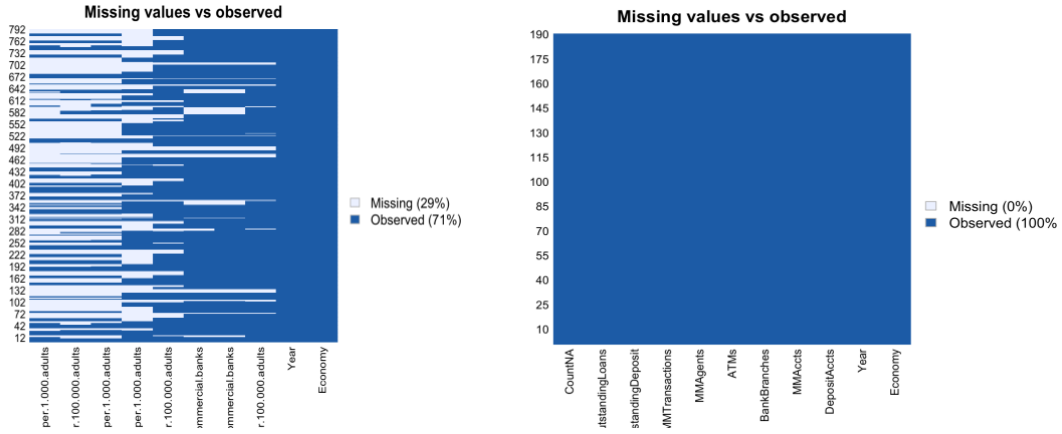

Figure 1: FAS Dataset

5.2.2 Financial Stability Dataset

For the financial stability dataset, the data from the World bank Global Financial indicators was uploaded into RStudio for cleaning and preprocessing. At the time of the upload, the dataset showed missing values of 8% of the entire dataset. The financial stability indicators at the time of upload were initially labelled as s102, s103 but were renamed to ensure proper understanding of the data. Additionally, the data was also filtered to remain only data for sub–Saharan African from 2012 till 2022. Further filtering was applied to include only countries that had complete values in line with the FAS dataset. The missing values were also dealt with using the mean substitution. The missing data % came to NIL as displayed in Fig 2;

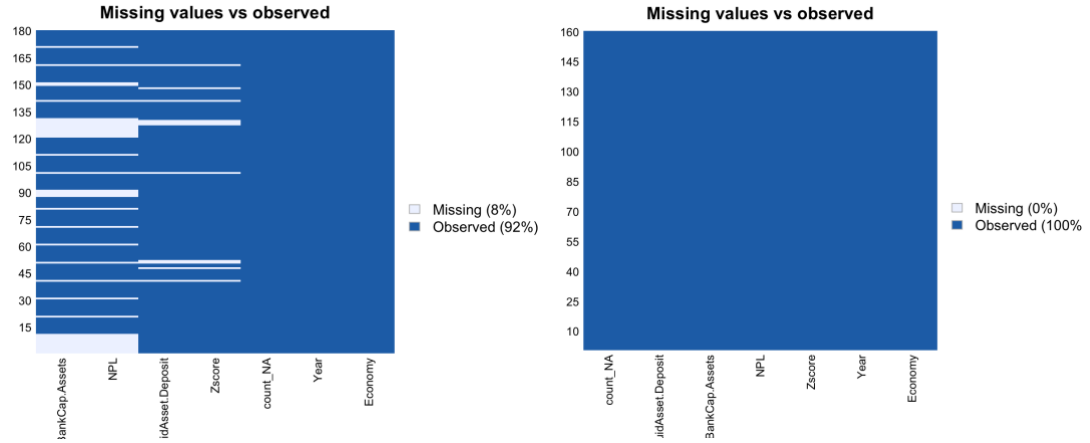

Figure 2: Financial Stability Dataset

5.2.3 Economic Growth Dataset

The Economic Growth dataset on the other hand had already been filtered to only show data for the countries that were chosen based on the Financial Access Survey dataset. The dataset showed no missing values at all.

5.2.4 Financial Inclusion Index

Before computing the Financial Inclusion Index, the appropriateness of the data for testing was evaluated, the Bartlett's test of sphericity was used to examine whether the correlation matrix is identical. The value should be significant ($p < 0.05$) for the data to be suitable for the PCA. The Kaiser-Meyer-Olkin test was conducted as well. The results of the Bartlett's test showed of a p-value of 0.643 (> 0.5) which indicated that the data was appropriate for performing a principal component analysis. The high p-value also indicates that the correlation matrix is not significantly different from the identity matrix. The KMO produced an overall MSA of 0.7% and all the individual variables showed MSA (Measure of Sampling accuracy) values greater than 0.5% which shows the data is suitable for analysis. Overall, the results from Bartlett's test and the Kaiser-Meyer-Olkin measure show that the data is appropriate for principal component analysis.

```
> cortest.bartlett(CorIMFFAS,n = nrow(CorIMFFAS))
$chisq
[1] 25.06471

$p.value
[1] 0.6243109

$df
[1] 28


Kaiser-Meyer-Olkin factor adequacy
Call: KMO(r = CorIMFFAS)
Overall MSA =  0.7
MSA for each item =
     DepositAccts           MMAccts       BankBranches              ATMs          MMAgents     MMTransactions OutstandingDeposit   OutstandingLoans
             0.77              0.80              0.60              0.72              0.70              0.70              0.73              0.63
>
```

Figure 3: Results of the Bartlett Test of sphericity and KMO factor adequacy

The first stage of the PCA involved performing principal component analysis on the availability, usage, and penetration dimension individually, the eigenvalues (λ_j) and the scores P_{kyc} that were obtained from using the **"pcacov"** were substituted based on the formulars 6, 8 and 10 above to estimate the level of inclusivity for each country in the sub-Saharan African region over the period for the research. The results produced **"AvailabilityIndex"**, **"PenetrationIndex"** and **"UsageIndex"** which were be used in the second stage of the PCA. In the second stage of the PCA, the values obtained from the first stage using the availability, usage, and penetration and using formular 9 above and Financial Inclusion Index was obtained.

	FII.Group.1	FII.x	Usage.Group.1	Usage.x	Penetration.Group.1	Penetration.x	Availability.Group.1	Availability.x
10	Mauritius	0.8077622	Mauritius	0.6204628	Mauritius	0.66683740	Mauritius	0.3691366
13	Seychelles	0.7791787	Seychelles	0.3667817	Seychelles	0.68954528	Seychelles	0.5659658
11	mibia	0.5802717	mibia	0.4501315	mibia	0.42113283	mibia	0.3512918
14	South Africa	0.5102000	South Africa	0.3634196	South Africa	0.48485769	South Africa	0.3361915
6	Kenya	0.4281550	Kenya	0.3257069	Kenya	0.52039835	Kenya	0.2710319
1	Botswa	0.4101179	Botswa	0.3088570	Botswa	0.37959031	Botswa	0.3086508
4	Gha	0.3543523	Gha	0.2846501	Gha	0.29564929	Gha	0.2950625
3	Eswatini, Kingdom of	0.3186370	Eswatini, Kingdom of	0.2461968	Eswatini, Kingdom of	0.23981228	Eswatini, Kingdom of	0.3082119
7	Lesotho, Kingdom of	0.3127394	Lesotho, Kingdom of	0.2935966	Lesotho, Kingdom of	0.20771823	Lesotho, Kingdom of	0.2674210
12	Rwanda	0.3009907	Rwanda	0.2694378	Rwanda	0.21014028	Rwanda	0.2762387
15	Uganda	0.2778493	Uganda	0.2668322	Uganda	0.19679101	Uganda	0.2573516
16	Zambia	0.2737299	Zambia	0.2570651	Zambia	0.17033363	Zambia	0.2697315
2	Cameroon	0.2319445	Cameroon	0.2530175	Cameroon	0.09639321	Cameroon	0.2497818
9	Malawi	0.2285391	Malawi	0.2422736	Malawi	0.11823138	Malawi	0.2495390
5	Guinea	0.2164914	Guinea	0.2357017	Guinea	0.09232071	Guinea	0.2501487
8	Madagascar, Rep. of	0.2071837	Madagascar, Rep. of	0.2358452	Madagascar, Rep. of	0.08762275	Madagascar, Rep. of	0.2412507

Figure 4: Mean Statistics of the Financial Inclusion Index per country

5.2.5 Combined Dataset

When all the datasets was cleaned appropriately, the figures obtained from the first and second stage of PCA were combined with the financial stability and Economic growth indicators to form a new Dataset known as **"FULLDS".** The "**FULLDS"** showed no missing values as the data had already been cleaned before they were combined. All the variables except Economy and Year which were had their structure changed to numeric. The boxplot function in the RStudio was used to check if there were outliers in the dataset.

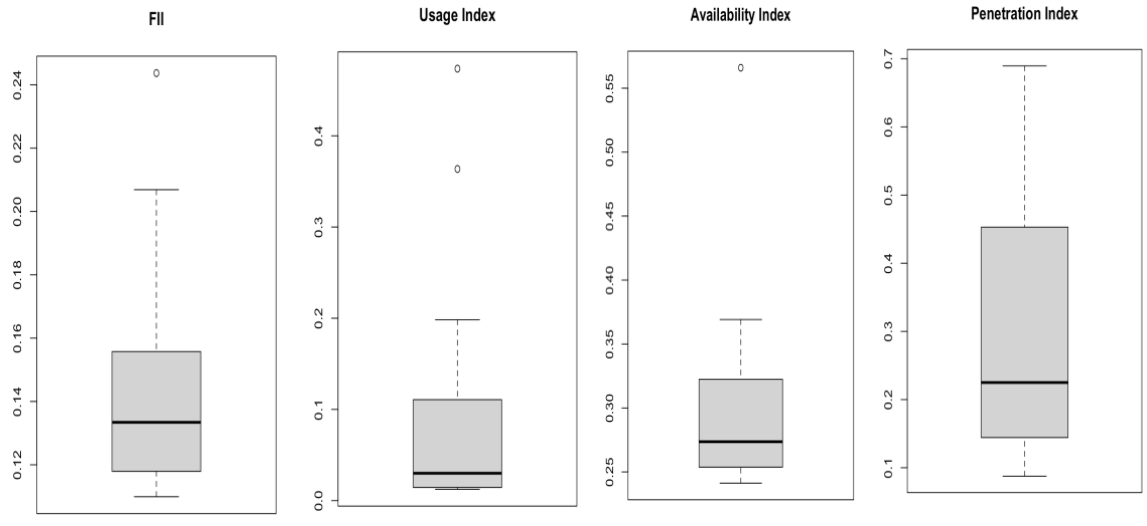

Figure 5: Boxplot of the Indexes

5.2.6 Correlation

After checking for outliers, correlation among the various variables were examined. The Financial Inclusion Index showed a positive correlation with PenetrationIndex, UsageIndex, Availability Index and the financial stability indicator GDP per capita . The Penetration index demonstrated a positive correlation with the availability Index, Financial Inclusion Index, Usage Index and GDP per capita. The Usage index was positively corelated with the Penetration Index, Availability Index, FII, ZScore and GDP per capita. Finally, the availability index was positively correlated with Liquid Asset deposit and GDP per capita.

	PenetrationIndex	UsageIndex	AvailabilityIndex	FII	Zscore	NPL	BankCap.Assets	LiquidAsset.Deposit	GDP.per.capita..current.US..
PenetrationIndex	1.000000000	0.76711928	0.763892093	0.936632135	-0.003438991	-0.1874147	-0.1823779191	-0.1692012043	0.80597648
UsageIndex	0.767119282	1.00000000	0.513361377	0.882403396	0.044924616	-0.2910842	-0.2908603707	-0.0586570465	0.61940000
AvailabilityIndex	0.763892093	0.51336138	1.000000000	0.838836561	-0.076625483	-0.2020157	-0.2934953788	0.0021144763	0.92359774
FII	0.936632135	0.88240340	0.838836561	1.000000000	-0.009028017	-0.2662190	-0.2991560008	-0.0758516411	0.87158770
Zscore	-0.003438991	0.04492462	-0.076625483	-0.009028017	1.000000000	-0.1186683	0.3544118275	-0.0418560270	-0.17139073
NPL	-0.187414707	-0.29108424	-0.202015693	-0.266218992	-0.118668324	1.0000000	0.3268679997	0.1524915893	-0.26767195
BankCap.Assets	-0.182377919	-0.29086037	-0.293495379	-0.299156001	0.354411827	0.3268680	1.0000000000	-0.0006833028	-0.42263935
LiquidAsset.Deposit	-0.169201204	-0.05865705	0.002114476	-0.075851641	-0.041856027	0.1524916	-0.0006833028	1.0000000000	-0.04295365
GDP.per.capita..current.US..	0.805976481	0.61940000	0.923597737	0.871587697	-0.171390731	-0.2676720	-0.4226393492	-0.0429536460	1.00000000

Figure 6: Correlation of variables

5.3 Data Mining and Validation

5.3.1 Fixed Effect Regression – For implementing the Fixed Effect regression, the PLM package in RStudio was installed, 4 different models were estimated with the data. The independent variables were constant (NPL, Zscore, BankCap.Assets, LiquidAsset.Deposit and GDP.per.capita) but different dependent variables – PenetrationIndex, AvailabilityIndex, UsageIndex and Financial Inclusion Index. The results will give estimated coefficients for the various timely variables and fixed effects that are unique to each entity in the results. The model assumes that the slope of the regression plot is constant. It is important to specify the **"within"** in the model to show that it is a fixed effect regression.

5.3.2 Random Effect Regression - The step to implement the random Effect regression is the same as the Fixed effect but **"Random"** should be specified when formulating the Model in RStudio. In the random effect regression, random effects are incorporated into the model to account for unobserved variabilities among the various variables.

5.3.3 VIF Test for Multicollinearity - The Variance Inflation Factor (VIF) test is used to determine whether a regression model contains multicollinearity. Multicollinearity occurs when there is a strong correlation between two or more predictor variables within a model, leading to unstable and imprecise regression coefficients. The VIF is generated for each predictor variable in the model and assesses the degree to which multicollinearity has inflated a predictor's variance.

5.3.4 Hausman Test - To assess which of two regression models—typically a fixed effects (FE) model and a random effects (RE) model—is better suitable for the data, the Hausman Test is utilized. The test determines if the fixed effects assumption is preferable to the random effects assumption in terms of validity.

6. Discussion of Results, Evaluation

6.1 Fixed Effect Model Estimation

6.1.1 Usage Dimension – The fixed effect estimation on the model showed that all the other financial stability and Economic growth indicators except Liquid asset capital have a statistically significant impact on the Usage dimension of financial Inclusion. Although, the overall model is statistically significant based on the F-statistic which is higher than the 5% significance level, the model's explanatory power is relatively low which is signified with the low R-squared value of 0.0976 showing that the independent variables explain only a small portion of the changes in the usage dimension.

6.1.2 Availability Dimension – The availability dimension also showed a similar result as the usage dimension, only the liquid asset deposit demonstrates a positive and significant effect on the availability index, this was displayed with the p-value of 0.03455. The GDP per capita also has a positive coefficient but is not statistically significant. The model's explanatory power although weak, the model's F-statistic is 2.1452 with a p-value of 0.063622, showing the model is significant at a 5% significant level.

6.1.3 Penetration Dimension - The results of the relationship between PenetrationIndex and the independent variables show that Zscore, NPL, and BankCap.Assets have no significant impact on the PenetrationIndex because their p-values surpass 0.05. However, with a p-value of 9.772e-06, LiquidAsset.Deposit has a positive and highly significant effect on PenetrationIndex. GDP per capita on the other hand, has an insignificant coefficient estimate (p-value = 0.9022) and a minor impact on PenetrationIndex. The R-squared value of 0.21502 indicates that the independent variables that were significant account for approximately 21.5% of the variation in PenetrationIndex. The F-statistic for the model is 7.61505 with a p-value of 2.3741e-06, suggesting that the model is highly significant at the 5% level.

6.1.4 Financial Inclusion Index - The association between FII and the independent variables also show that, all the independent variables had p-values that are higher than 0.05,and therefore do not have statistically significant effects on the Financial Inclusion Index. However, with a p-value of 2.305e-05, LiquidAsset.Deposit had a positive and highly significant impact on FII. The R-squared value of 0.18006 show that the independent variables explain approximately 18% of the variation in the dependent variable. The model's F-statistic is 6.10499, with a p-value of 3.8301e-05, indicating that the model is highly significant at the 5% level.

Usage Index vs Independent Variables

```
Call:
plm(formula = log(UsageIndex) ~ Zscore + NPL + BankCap.Assets +
    LiquidAsset.Deposit + GDP.per.capita..current.US.., data = PanelData,
    model = "within")

Balanced Panel: n = 16, T = 10, N = 160

Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-0.2594170 -0.0477799 -0.0064013  0.0456258  0.3972861

Coefficients:
                              Estimate  Std. Error t-value Pr(>|t|)
Zscore                      3.6645e-03  6.1318e-03  0.5976 0.551065
NPL                        -2.0401e-03  4.5266e-03 -0.4507 0.652906
BankCap.Assets              7.2636e-03  8.5576e-03  0.8488 0.397460
LiquidAsset.Deposit         4.3872e-03  1.3251e-03  3.3108 0.001185 **
GDP.per.capita..current.US.. -1.7451e-05  1.5111e-05 -1.1548 0.250148
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    1.5341
Residual Sum of Squares: 1.3844
R-Squared:      0.097579
Adj. R-Squared: -0.032266
F-statistic: 3.00601 on 5 and 139 DF, p-value: 0.013131
```

Availability Index vs Independent Variables

```
Oneway (individual) effect Within Model

Call:
plm(formula = log(AvailabilityIndex) ~ Zscore + NPL + BankCap.Assets +
    LiquidAsset.Deposit + GDP.per.capita..current.US.., data = PanelData,
    model = "within")

Balanced Panel: n = 16, T = 10, N = 160

Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-0.1068754 -0.0205479 -0.0037985  0.0221492  0.1700823

Coefficients:
                              Estimate Std. Error t-value Pr(>|t|)
Zscore                      1.8752e-03 2.5527e-03  0.7346  0.46382
NPL                         1.3248e-03 1.8844e-03  0.7030  0.48321
BankCap.Assets              9.8216e-04 3.5625e-03  0.2757  0.78319
LiquidAsset.Deposit         1.1775e-03 5.5164e-04  2.1346  0.03455 *
GDP.per.capita..current.US.. 9.4055e-06 6.2908e-06  1.4951  0.13715
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    0.25844
Residual Sum of Squares: 0.23993
R-Squared:      0.071637
Adj. R-Squared: -0.06194
F-statistic: 2.1452 on 5 and 139 DF, p-value: 0.063622
```

Penetration Index vs Independent Var

```
Oneway (individual) effect Within Model

Call:
plm(formula = log(PenetrationIndex) ~ Zscore + NPL + BankCap.Assets +
    LiquidAsset.Deposit + GDP.per.capita..current.US.., data = PanelData,
    model = "within")

Balanced Panel: n = 16, T = 10, N = 160

Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-0.6215507 -0.1197417  0.0060697  0.1420035  0.4219590

Coefficients:
                              Estimate Std. Error t-value  Pr(>|t|)
Zscore                      7.0840e-03 1.3129e-02  0.5396    0.5904
NPL                         1.4726e-02 9.6921e-03  1.5194    0.1309
BankCap.Assets              2.5255e-02 1.8323e-02  1.3783    0.1703
LiquidAsset.Deposit         1.3026e-02 2.8372e-03  4.5911 9.772e-06 ***
GDP.per.capita..current.US.. 3.9814e-06 3.2355e-05  0.1231    0.9022
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    8.0854
Residual Sum of Squares: 6.3469
R-Squared:      0.21502
Adj. R-Squared: 0.10208
F-statistic: 7.61505 on 5 and 139 DF, p-value: 2.3741e-06
```

FII vs Independent Variables

```
Oneway (individual) effect Within Model

Call:
plm(formula = log(FII) ~ Zscore + NPL + BankCap.Assets + LiquidAsset.Deposit +
    GDP.per.capita..current.US.., data = PanelData, model = "within")

Balanced Panel: n = 16, T = 10, N = 160

Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-0.2916360 -0.0652688 -0.0092858  0.0708617  0.3280528

Coefficients:
                              Estimate  Std. Error t-value  Pr(>|t|)
Zscore                      4.9643e-03  7.7125e-03  0.6437    0.5208
NPL                         5.3648e-03  5.6934e-03  0.9423    0.3477
BankCap.Assets              1.2321e-02  1.0764e-02  1.1447    0.2543
LiquidAsset.Deposit         7.3027e-03  1.6667e-03  4.3816 2.305e-05 ***
GDP.per.capita..current.US.. -2.3624e-06  1.9006e-05 -0.1243    0.9013
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    2.6711
Residual Sum of Squares: 2.1901
R-Squared:      0.18006
Adj. R-Squared: 0.062085
F-statistic: 6.10499 on 5 and 139 DF, p-value: 3.8301e-05
```

Figure 7: Results of the Fixed Effect Regression

6.2 VIF Test for Multicollinearity

The table below shows the result of the Variance Inflation factor analysis to check for multicollinearity among the financial stability and Economic growth Indicators;

Table 2: VIF test results

	VIF Test on Financial Inclusion Index	
	VIF	**1/VIF**
Zscore	1.236164	0.8089540
NPL	1.266065	0.7898486
BankCap.Assets	1.511501	0.6615939
LiquidAsset.Deposit	1.027409	0.9733224
GDP.per.capita	1.252621	0.7983262

All the indicators have Moderate collinearity The close proximity of all VIF values to 1 suggests that there is little to no multicollinearity among the predictor variables in the model. This is encouraging because it means that the predictor factors do not have a strong correlation with one another.

6.3 Hausman Test – The results of the Hausman test are displayed in the table below;

Table 3: Hausman test results

	Usage Index	**Availability Index**	**Penetration Index**	**FII**
Chisq probability	16.301	25.689	65.931	312.08
p-value	0.006036	0.0001025	7.183e-13	2.2e-16

Null Hypothesis (H_0) – Both the Fixed Effect (FE) and Random Effect (RE) models are consistent, they provide consistent estimates of the coefficients.

Alternative Hypothesis (H_1) - One of the Models is more appropriate than the other.

Usage Dimension : Model 1 vs Model 5 – The null hypothesis was not rejected because the P-value (0.006036) is lower than the level of significance of 1% and 5%. It therefore indicates that both models provide consistent estimates of the coefficients so the Null hypothesis H0 was accepted.

Availability Dimension : Model 2 vs Model 6 - The null hypothesis was not rejected because the P-value (0.0001025) is much lesser than significance level of 1% and 5%. It therefore indicates that both models provide consistent estimates of the coefficients so the Null hypothesis H0 was accepted.

Penetration Dimension : Model 3 vs Model 7 – The null hypothesis is rejected in this instance because it had a p-value of 7.183e-13 also suggesting no consistency between the random effect and fixed effect model.

FII : Model 4 vs Model 8 – The extremely low p-values of less than 2.2e-16 implies that the null hypothesis is rejected and conclude that one of the models is inconsistent.

6.4 Estimating the Random Effect Regression on the Penetration Index and Financial Inclusion Index

The random effects model was used to investigate the relationship between the dependent variable FII and the various independent variables. Individual effects (factors that are common to each individual) comprise 70.4% of the variance, whereas idiosyncratic effects (factors that are specific to the observation) contribute 29.6%. Theta is a parameter that calculates the proportion of variation explained by individual differences. Only "LiquidAsset.Deposit" and "GDP per capita" have substantial effects on the dependent variable, indicating that the intercept term is highly statistically significant. The independent factors account for roughly 24.0% of the variation in FII with an overall F-statistic of 48.7018 and a low p-value. In conclusion, "LiquidAsset.Deposit" and " GDP per capita." are significant predictors of FII using the random effect model.

In the same vein, the random effect model was used in estimating to relationship between the Penetration index and all the independent variables, the individual effects (factors that are common to each individual) comprise 74.1% of the variance, whereas idiosyncratic effects (factors that are specific to the observation) contribute 25.9%. The Liquid asset deposit and GDP per capital had statistically significant effect on the penetration index, indicated by the low p-values of 0.0006528 *** and 3.92e-06 *** respectively. Both variables are therefore significant variables using the random effect model.

6.5 Discussion

The examination on the level of financial inclusion in the SSA region identified Mauritius as the most financially inclusive country with an inclusive percentage of 80% based on the sample of the countries that were investigated, although it is classified as an upper middle-income country. Seychelles, Namibia, and South Africa also had high levels of financial inclusivity. The countries with the lowest level of financial inclusion include Madagascar, Guinea, Malawi, and Cameroon respectively. The KMO (Kaiser-Meyer-Olkin factor adequacy) test was done to examine the suitability of the data for principal component analysis. The result shows the suitability of the data for testing, it had an overall measure of sample accuracy of 0.7 and the MSA for each item was relatively high. The mean statistics shows the upward trends of financial inclusion from 2012 till 2021.

The penetration, usage, availability indicators had a significant and positive correlation on the Economic growth indicator (GDP per capita) and showed a positive correlation with the overall

financial inclusion index and the implication is that the continuous usage of financial services is meaningful in impacting economic growth in the Sub-Saharan African region. A similar positive correlation was found in the works of (Ifediora et al., 2022).The Usage and Availability Index showed a positive but insignificant correlation with Zscore and Liquid Assets to deposits respectively implying that the usage of financial services are positively correlated with the likelihood of default in commercial banks.

The fixed effect model showed that only the Liquid Assets to Deposit and short-term funding demonstrated a statistically significant and positive impact on all the dependent which suggests that the Liquid Assets to Deposit and short-term funding impacts the availability, usage, penetration, and the overall financial inclusion index. Although, the Hausman tests provided an insightful result which is the fact that the random effect model might provide a better fit for the penetration and overall financial inclusion index. The results for the random effects model was introduced to show the effect of the unobserved, individual-specific factors might affect the connections between the variables. The results for the random effect model showed that for the Penetration Index and Financial Inclusion Index the GDP per capita and liquid asset to deposit showed statistically significant connections with the independent variables. The previous studies tend to find a positive link between financial inclusion, economic growth, and financial stability, in as much as some other studies found no link between them. The results from this paper show that there exists a positive link between Financial Inclusion, Economic Growth and Financial Stability.

This research re-emphasizes that governments in SSA countries should continually encourage the usage, penetration, and availability of financial services as these factors will positively impact the health of their financial systems. This may involve implementing initiatives that promote banking behaviors among underserved populations and those residing in rural areas.

As much as the outcomes indicate that financial inclusion has an effect on both variables, it's worth noting that the R-squared results for the fixed and random effects yielded relatively low results which could potentially suggest that the chosen models may not have accurately captured the underlying patterns within the data.

6.5 Limitation

The limitation of the research was the fact that the Financial Access Survey data had so many missing points which were replaced with mean substitutions which may affect the results obtained from the analysis. The world bank world development indicators had missing data points that was also replaced with mean substitution. Also, the Sub-Saharan African region contains almost 46 states but as a result of the missing data problems, only 16 countries were considered for the research.

7. Conclusion and Future Work

In investigating the extent to which Economic growth and financial stability affects Financial Inclusion in Sub Saharan Africa region, this study utilized a two-stage principal component analysis to obtain an Index for the penetration, availability, and usage dimensions of financial inclusion. The research made use of a Fixed effect regression to measure the relationship between the variables. The findings showed two main variables that influence financial inclusion. All the aspects of financial inclusion which included penetration, usage, availability, and the overall financial inclusion index was significantly impacted by liquid Assets for short term and deposit funding which is a financial stability indicator. Additionally, the financial inclusion Index and Penetration Index showed a significant correlation with GDP per capita which is an Economic Growth Indicator when a Random Effect regression was carried out for further analysis. The use of the Fixed and Random Effect helped to understand the various effects of the unobserved individual specific factors on the connections between the variables and provided clarification on the importance of the variables that impacted Financial Inclusion. In as much as the analysis of this connection was possible, the research considered only 16 states out of 48 states in the region, future work should consider using more appropriate techniques to replace the missing values in more countries to improve the sample size. Also, other methods of examining the relationship between the variables should be considered such as the Generalized Method of Moments (GMM).

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