

Myth or Magic: The impact of financial technology on financial inclusion in Africa

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Abstract

With the worldwide focus on financial inclusion to decrease poverty levels by banking the unbanked, understanding how to facilitate the banking of the previously unbanked in developing countries has become a globally topical issue. To contribute to this discussion from the perspective of Africa, the following paper endeavours to compute financial inclusion indices (FII) for 36 African countries. The paper leverages a model developed by Cámara and Tuesta (2014), using a two-stage Principal Component Analysis with definitions for financial inclusion variables from Sarma (2008). Upon computing the indices, we then endeavour to study the relationship between financial technology (fintech) and financial inclusion by running a regression analysis between fintech variables and the financial inclusion indices.

As expected, we find that the highest financial inclusion levels are in the Southern and East African regions, with the lowest in Central Africa. The introduction of mobile money has had a significant impact on financial inclusion levels, particularly in East Africa. Our analysis also finds that the usage variable is critical in understanding the depth of financial inclusion. While this is so, there is still a great need for improvements across financial access, usage and availability in Africa. The regression analysis confirms this assessment, showing that overall, the use of mobile accounts has a positive and significant relationship with financial inclusion. At the same time, the use of digital payments for existing accounts also improves financial inclusion but to a lesser extent. The distinction between the impact of mobile banking and digital payments is an important one given that ownership of mobile banking increases the number of people with access to financial services while using digital payments merely deepens and enhances the usage of existing account holders. Macroeconomic factors of economic growth and banking sector development also are significant for financial inclusion, though to a lesser degree.

This paper recommends the study of what impacts the sub-indices both positively and negatively, and how countries can maximise each sub-index, as it is an important focus area for policymakers who are looking to improve financial inclusion levels for their respective countries. We further recommend

the development of a unified taxonomy on financial inclusion and its measurements. The role of policymakers would be to propel forward the formulation of this taxonomy, working with all the relevant stakeholders.

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List of Abbreviations

ATM	Automated Teller Machines
BDEV	Banking sector development
CFA	Common Factor Analysis
DIGPAYUSE	Digital payment use
FAS	Financial Access Surveys
FII	Financial Inclusion Index
Findex	Financial Inclusion Database
Fintech	Financial Technology
GDP	Gross Domestic Product
GDPG	GDP growth
GFC	Gross Fixed Capital Formation
ID4D	Identification for Development
IFI	Index for Financial Inclusion
MFI	Microfinance Institution
MINTACCESSACC	Mobile banking account access
MNO	Mobile Network Operator
OLS	Ordinary Least Squares
PCA	Principal Component Analysis

CHAPTER 1

INTRODUCTION

1.1 Background of study

African economies, like most developing economies, have long struggled with the challenge of large populations with little or no access to traditional banking services. The lack of access to banking services has had dire effects on people's ability to send or receive money in an affordable manner, as well as access other financial products such as insurance, credit and savings. This phenomenon termed financial exclusion, not only affects the individuals but the economies as well. For instance, in countries where the population has access to savings financial products, the money saved can be ploughed back into the economy through investments, with the potential to promote economic growth. Economic growth and development are especially urgent for Africa, given the continent's young and growing population. Globally there has been a concerted effort on improving financial inclusion to promote financial development and thus, enhance economic growth. Initiatives such as the World Bank's 2020 universal financial access initiative indicate the global recognition of the importance of financial inclusion. Therefore, developments within digital financial services are viewed as the solution to improving financial inclusion. Innovations such as M-Pesa in Kenya, Zoono in Zambia and similar others across the continent, have been hailed as instrumental in promoting account ownership in Africa. However, financial inclusion should go beyond merely owning an account. Furthermore, these perceived improvements in financial inclusion are a result of multiple factors that require further study. Therefore, while financial technology (fintech) has been identified as the catalyst for improvements in financial inclusion, very little has been done by way of empirical research to measure the extent of this improvement and the role of fintech in it.

Researchers have long posed the question of how financial inclusion ought to be measured. With more recent studies, the use of financial inclusion indices to measure financial inclusion has become a key topic of interest. Even so, attempts to measure financial inclusion through indices are scarce (Irving Fisher Committee, 2018). An advantage of using an index for measurement is that it allows for relative comparisons and an assessment of improvement over time. Furthermore, an index allows for the study of the relationship between financial inclusion and other variables such as fintech. In light of this gap in research, this study seeks to use Cámara and Tuesta's (2014) Financial Inclusion Index (FII) model to compute financial inclusion indices for 36 African countries. This study will also examine the relationship between fintech and financial inclusion indices using a regression analysis.

1.2 Statement of Research Problem

Studies have shown that access to financial services can drastically improve the financial standing of people in an economy, and help them avoid poverty traps (Adato, Carter, & May, 2006); (Beck et al., 2009); (Demirgüç-Kunt & Klapper, 2012b); (Arun & Kamath, 2015). Access to financial services means that those previously excluded are now able to participate in the economy and to smooth out their risks using savings and insurance products. The inverse of this, one widely prevalent in Africa, has meant that a large portion of the African population is trapped in poverty and is unable to participate in economic activities actively. The advent of M-Pesa in Kenya, then on the rest of East Africa, has created the expectation of fintech to bank the unbanked. Chief among these is the expectation of fintech to leapfrog a large population in the continent from having little or no interactions with the formal financial services sector, to leading the use of technological innovations in accessing financial services.

In 2014, the Global Findex estimated that only 34% of the banking age population in Africa (aged 15+) had access to financial services, 12% of which was attributable to mobile money financial services (Demirguc-kunt, Klapper, & Singer, 2017). This finding exacerbated the sentiment of fintech being the solution to financial exclusion in the continent. Optimism over the ability of fintech to bank the unbanked is evident in the investment capital that its innovations are attracting. WeeTracker Research asserts that in 2017 alone, there was an investment of \$167 million in the African fintech market, a 29% year-on-year increase from 2016. While the impact of fintech in the banking sector is evident, the extent of it is rarely quantified. The lack of quantification is partly due to the difficulty of quantifying financial inclusion itself. However, recent attempts to construct financial inclusion indices are indicative of the need identified by researchers to quantify financial inclusion (Sarma, 2008); (Gupte, Venkataramani, & Gupta, 2012); (Chakravarty & Pal, 2013); (Cámara & Tuesta, 2014); (Park & Mercado, 2018). While these indices have been created to quantify financial inclusion in other economies, very few quantifications have occurred in African economies. Given the growing sentiments about fintech and its attributed abilities in Africa, the need to quantify both financial inclusion and the impact of fintech has never been more urgent.

1.3 Research questions, objectives and hypotheses

This study aims to examine the following: What are the levels of financial inclusion in the identified African countries and how have they improved over time? To what extent has this improvement been driven by fintech innovations?

To the best of the author's knowledge, this is the first comparative study to compute the financial inclusion index on all the three periods of Findex data, as well as review the relationship between fintech and financial inclusion in Africa.

The objectives of this paper are to:

- i. Compute financial inclusion indices for 36 African countries over three periods
- ii. Examine the relationship between fintech and financial inclusion

Based on the second objective, the paper poses the following hypothesis:

H0: Fintech has no impact on financial inclusion levels

H1: Fintech has an impact on financial inclusion levels

1.4 Significance of the study

This study is necessary for several reasons. For countries, the ability to use an index when measuring financial inclusion allows for year-on-year comparisons on the level of financial inclusion. The computation of financial inclusion indices for 36 African countries, over three periods, allows for the assessment of improvements in these countries over time. Furthermore, it presents an opportunity for cross-country comparisons on financial inclusion levels, as is done with other indices such as the HDI.

This study is useful for policymakers who want to establish the factors that will help improve their individual financial inclusion levels through improving the individual sub-indices. It is essential for the private sector so that investments are directed towards financial inclusion innovations that will be most profitable and useful to the economies. The study is also important for researchers as it creates an opportunity for further research on the use of indices in measuring financial inclusion in Africa. Furthermore, it begins the dialogue on establishing a more precise definition and taxonomy of what constitutes both financial inclusion and fintech.

1.5 Scope and limitations of the study

This study will include only 36 African countries due to data challenges. The period of assessment begins in 2011 and looks at the three periods when the World Bank collects global data (2011, 2014, 2017). Finally, this study confines the definition of fintech only to entail digital finance, as this is the most prevalently used form of fintech in Africa.

1.6 Organization of the study

The rest of the study is organised as follows: Chapter two gives an overview of current literature on financial inclusion and fintech. Chapter three outlines the dataset used, and the methodology

employed in the study. Chapter four presents the results of the research and notes the implications of the results. The closing chapter concludes the paper, provides the limitations to consider and recommendations for future studies on the subject matter.

CHAPTER 2

Literature Review

2.1 Introduction

This chapter presents the literature reviewed while conducting the study and is organised into four more sections. Section two provides an overview of financial inclusion and fintech in Africa. The third section outlines the theoretical framework of both financial inclusion and fintech. The fourth section reviews the empirical literature on the determinants of financial inclusion. The final section gives a summary of the chapter.

2.2 Overview of FI and Fintech in Africa

Financial inclusion in the Sub-Saharan Africa region is said to be influenced by both demand-side factors (level of income, location and literacy), and supply-side factors (interest rate and bank innovation, proxied by ATM usage) (Oyelami, Saibu, & Babatunde, 2017). Historically, the supply of financial services in Africa has been known to lag demand. In the study of financial inclusion in Africa, Demirgüç-Kunt and Klapper (2012b) observed that only 23% of adults have a formal account, with countries showing considerable variations. This number, although higher, was still found to be a mere 34% in 2017 (Demirguc-kunt et al., 2017). In Eastern and Southern Africa, fixed fees and high costs of opening and maintaining accounts were cited as one of the critical barriers (Gebregziabher & Makina, 2015). As a case in point, countries like Uganda have annual fees associated with a cheque account amounting to more than 25% of per capita GDP (Beck, Demirguc-kunt, Soledad, & Peria, 2006). More recent studies in Africa posit that variables such as level of education, GDP per capita, population and interest rate can positively influence financial inclusion in the region, though without categorizing the variables into demand and supply-side factors (Olaniyi & Adeoye, 2016); (Zins & Weill, 2016); (Soumaré, Tchana, & Kengne, 2016). Overall, the high banking fees, low levels of education, low GDP rates per capita and high population sizes have all been cited as factors that have affected the level of financial inclusion in Africa.

Despite the challenges stated above, nowadays, both individuals and enterprises within the African continent enjoy more financial services, especially credit from financial institutions (Hariharan & Marktanner, 2012). While this is so, a visible gap in financial depth (measured through private credit to GDP) relative to other developing economies is still observed. As a case in point, Demirgüç-Kunt and Klapper (2012b) found that in 2010, private credit to GDP was 24% in Sub-Saharan Africa and 39% in North Africa, compared with 77% for all other developing economies and 172% for high-income economies (Demirgüç-Kunt & Klapper, 2012b). Even in countries with high financial depth, financial inclusion levels are still observed as low. Countries such as South Africa are key

demonstrators of this. While the country has a ratio of private credit to GDP of over 142%, only 54% of adults have a formal account, and only 9% of adults have credit from regulated financial institutions (Gebregziabher & Makina, 2015). In assessing the plausible causes of low financial inclusion levels in Africa, the CGAP (2009) observed that the restriction of bank branch geographical expansion into rural areas, which have minimal and poor infrastructure, has affected the supply of financial services.

One of the leading developments in Africa (which has been catalytic in the improvement of financial service delivery) has been the access to and use of mobile phones. An ITU study observed that there were ten times as many mobile phones as landlines in Sub-Saharan Africa, and 60% of the population had mobile phone coverage (Aker & Mbiti, 2010). “Mobile phone subscriptions increased by 49% annually between 2002 and 2007 in Africa, compared to 17% per year in Europe” (Aker & Mbiti, 2010). As a result, mobile phone owners have exceeded the number of people who own bank accounts in the region (Etim, 2014). Two sectors, banking and telecommunications, have capitalised on this increased penetration to lead the creation and adoption of mobile-based fintech services, particularly money transfers (Ehrbeck, Pickens & Tarazi, 2012). This is encouraging, given that the impact of mobile phones on economic growth in a sample of African countries from 1988 to 2007 was observed to be positive (Kpodar & Andrianaivo, 2011). Mobile phone coverage expansion has been the lowest in Ethiopia, Somalia, and the landlocked countries of Central and West Africa (Aker & Mbiti, 2010). Despite this rise in mobile financial services, traditional financial services are still a relevant form of financial inclusion. The population of adults having an account with a formal financial service is highest in Mauritius (80%) and South Africa (54%), followed by Angola, Mozambique, Kenya, Zimbabwe, and Morocco (~40%), (Olaniyi, 2015).

Two mobile financial sector models are significant in the African region: the additive and transformative. Additive models allow customers with existing bank accounts to access their accounts, send and receive money over the internet using their mobile phones. The transformative models, on the other hand, allow the unbanked to access financial products without having existing bank accounts, mainly through their mobile phones (Etim, 2014). These services are commonly provided by mobile network operators (MNOs), microfinance institutions (MFIs) and non-bank agencies. While mobile banking has led to innovations in Sub-Saharan Africa, it is very fragmented. Some of the schemes that were developed have already disappeared, and some of the new ones are yet to take root. Even so, there are cases where it has worked sustainably. For example, Mbiti and Weil (2011) detail how Safaricom reported that “within eight months of M-Pesa’s inception in 2007, over 1.1 million Kenyans had registered to use it their service, and over USD 87 million had been transferred over the system. By September 2009, over 8.5 million Kenyans had registered to use the

service and USD 3.7 billion (equivalent to 10 percent of Kenya's GDP) had been transferred over the system since inception". Daniel (2015) argues that mobile money has done well in Kenya because it contributes to the financial inclusion process by providing a range of market instruments and enabling access to financial services. Mutsune (2015) supports this assertion and indicates that M-Pesa allows ordinary Kenyans to send money across the country cheaply and reliably using a mobile device. This creates an environment conducive to the vibrant economic activity by aiding time-sensitive farming activities. In Zimbabwe, Chitokwindo, Mago and Hofisi (2014) found that with mobile banking, the poor can now enjoy the same basket of financial services as the rich. The mobile banking system in Zimbabwe is ideal for remote areas given that it is an easily accessible, cheaper and a more convenient means of sending and receiving money. In Madagascar, in the year 2010, only 5.2% of the adult population had an account at a formal financial institution. About 70% of Madagascar's population lives and farms in rural and remote areas; therefore reaching this group was essential. Two and a half years after launching the initial mobile money operations mid-2010, mobile money companies registered 1.7 million subscribers, exceeding the 1.4 million number of bank and MFI customers (Riquet, 2013). In Tanzania, Ishegoma (2011) found that mobile banking had played a significant role in improving financial inclusion. As a result of mobile banking adoption, 79% of the population were using the mobile banking system technology in accessing financial services.

2.3 Theoretical Framework: FI and Fintech

In academic literature, initial definitions of financial inclusion were focused on its social impact. Leyshon and Thrift (1995) defined financial exclusion in terms of the social effects of the exclusion of some groups and individuals from access to formal financial systems. Sinclair (2001) attempted to refine this definition by focusing on the inability of individuals to access necessary financial services in an appropriate form. Only recently has the definition started focusing on the economic aspects. Sarma (2008) defined financial inclusion as the enablement of ease of access, availability, and usage of formal financial systems for society. While Amidžić, Massara and Mialou (2014) saw it as a situation where individuals and firms have access to basic financial services. Cámara and Tuesta (2014), on the other hand, define an inclusive financial system as one that maximises access and usage of financial services while minimising involuntary barriers to financial inclusion. They distinguish between voluntary exclusion (a situation where the individual can have access but chooses not to due to personal, religious or cultural reasons) and involuntary exclusion in society. In line with these more economic measures of financial inclusion, this paper focuses on the quantification of financial inclusion.

While a few scholars who define financial inclusion in economic terms have built models to measure its levels, there is no standard measure. Consequently, measures of financial inclusion often vary across studies (Park & Mercado, 2018). The most prevalent measurement method has been the construction of an index. There are two commonly used approaches when constructing a composite financial inclusion index: non-parametric and parametric methods, with the point of difference being how weights are assigned (Cámara & Tuesta, 2014). Non-parametric methods assign weights exogenously, based on the intuition and discretion of the researcher. Parametric method proponents use academic literature to prove the sensitivity of indices to arbitrary weight assignment (Lockwood, 2004). Using a parametric method, Honohan (2007) constructed a financial access indicator that captures the fraction of the adult population in each economy with access to formal financial services (Park & Mercado, 2018). The model endeavoured to explain only one variable in the World Bank defined financial inclusion indicators. In a more expanded model, Amidžić, Massara and Mialou (2014) constructed a composite financial inclusion indicator for multiple variables: outreach (geographic and demographic penetration); usage (deposit and lending); and quality (disclosure requirement, dispute resolution, and cost of usage) (Abdulummin, Etudaiye-Muhtar, Jimoh, & Sakariyahu, 2019). However, the model that most recent computations build on is the non-parametric index for financial inclusion (IFI) created by Sarma (2008). Scholars have widely used the IFI in assessing the extent of financial inclusion in Indian states and Turkey (Sarma & Pais, 2008); (Yorulmaz, 2013); (Yorulmaz, 2018). The model works as follows: it first constructs sub-indices for each dimension of financial inclusion (access, availability, and usage). It then creates an aggregated index as the normalized inverse of Euclidean distance (Park & Mercado, 2018). This approach is preferred for its ease of computation as it uses equal weights for each dimension under study. According to Sarma (2015), the lack of available data to fully characterise the availability and usage dimensions is the reason why dimensional weights are set at arbitrary values. However, other scholars disagree with this view and have argued that it is possible to construct weights endogenously, given that the indicators are correlated and there exists a latent structure. Attempts to improve the criteria employed in the allocation of weights by the IFI have led to further creations of financial inclusion indices (Arora, 2010); (Gupte et al., 2012); (Chakravarty & Pal, 2013). This paper takes the position that the index created by Cámara & Tuesta (2014) consolidates the different indices to form a more robust statistical measure and weight-allocation method. The model uses a two-stage Principal Component Analysis (Pearson, 1901), where in the first stage three sub-indices (access, usage and availability) that make up the financial inclusion measure are estimated. In the second stage, the dimension weights and overall financial inclusion index are endogenously estimated using the sub-indices computed in the first stage as explanatory variables. The financial inclusion index is thus a weighted average of the three sub-indices (Park & Mercado, 2018).

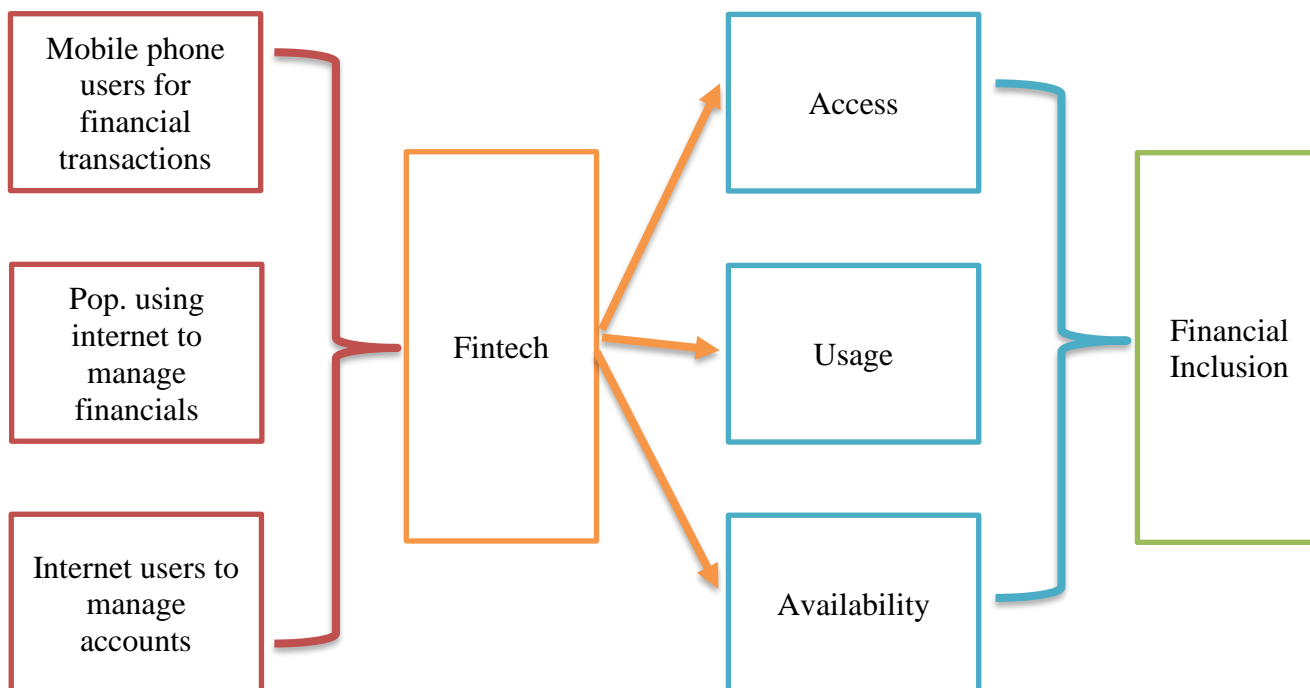
While this analysis uses Cámara and Tuesta's (2014) quantitative model, this paper disagrees with the chosen sub-indices it uses. In the model, Cámara and Tuesta (2014) advocate for the inclusion of barriers to financial access as a dimension of financial inclusion, arguing that they reflect demand-side measures of financial services. However, Park and Mercado (2018) disagree. Barriers to financial inclusion explain the reasons why people are not financially included. This measure is considered inappropriate in a study of financial inclusion as it combines the reasons why people have and do not access to financial services. It thus confuses the conceptual clarity of financial inclusion. The multidimensional model developed by Sarma (2008) could be amended to include demand-side indicators. In other words, the lack of demand-side measures in existing financial inclusion measures does not fully justify the inclusion of a barriers dimension in the aggregate financial inclusion measure (Park & Mercado, 2018), since demand-side data can be included in other ways. This paper aligns with this view and opts to use the definition of financial inclusion found in Sarma (2008), viewing financial inclusion as a process that enables ease of access, usage and availability of financial services. The advantage of this definition is that it can use both supply and demand factors to build the concept of financial inclusion, based on several indicators: access, usage and availability, all of which can be assessed separately.

The recent surge in fintech innovations that are leading to new, more efficient and accessible delivery channels for financial products and services (Irving Fisher Committee, 2018), has led to a need to define digital finance, its subsets and their role in financial inclusion. The CGAP defines digital financial inclusion as “digital access to, and the use of formal financial services by the excluded and underserved population” (Ozili, 2018). The GSMA found that about 89 markets had launched innovative digital financial services via mobile phones, making it available in 61% of the developing markets (GSMA, 2014). The term ‘fintech’ denotes ‘financial technology’, a subset of digital finance, and is defined as the delivery of financial and banking services through modern technological innovation led by computer programs and algorithms (Ozili, 2018). Digital financial services are said to have positive effects on financial inclusion in emerging and advanced economies (Asian Development Bank, 2016); (IFC, 2017); (Ozili, 2018). The expansion of digital payment platforms has opened the opportunity to link the poor with providers of savings, credit, and insurance products (Shofawati, 2019). “For financial and monetary system regulators, digital financial inclusion also helps to reduce the amount of physical cash in circulation and is instrumental in reducing high inflation levels in developing and poor countries” (Ozili, 2018). However, the use of digital finance may not lead to greater financial inclusion, but greater financial data inclusion (Asian Development

Bank, 2016); (Ozili, 2018). While digital inclusion is an essential facilitator of financial inclusion, it does not guarantee financial inclusion.

The ability of digital inclusion to facilitate financial inclusion can only be realised if the cost of transacting on digital platforms are low or negligible for the poor (Ozili, 2018). This is following financial theory, which states that where the financially excluded have a mobile phone and affordable internet connectivity, higher supply of digital finance is predicted to have positive effects on financial inclusion, all other things being equal (Ozili, 2018). However, this is not always the case as consumers who may have access to the digital financial system, are sometimes distrustful of the new channel and therefore do not actively use it. This lack of trust in digital finance channels results in reduced usage of digitally-led financial inclusion programs in developing countries and thus renders them less effective. Furthermore, there is evidence that despite the benefits of digital financial services, “many countries in the developing world still face considerable challenges in attaining merchant acceptance of digital payments” (Ozili, 2018). The Asian Development Bank (2016) also found that low levels of financial literacy and poor awareness of digital finance channels can reduce customers’ interest in new financial innovations.

Diagram 1: Financial technology and Financial Inclusion



Source: World Bank, own design

2.4 Empirical Literature

Studies have shown that when people participate in the financial system, they are better able to save, invest, as well as absorb financial shocks (Mas & Radcliffe, 2009); (Demirgüç-Kunt et al., 2015). This ability to manage risk and access financial services through the financial system is broadly known as financial inclusion. “Financial inclusion, at its most basic level, has been said to start with having a bank account. However, it does not stop there. Only with regular use do people fully benefit from having an account” (Demirguc-Kunt et al., 2015). The World Bank defines financial inclusion in three levels: (i) as the ability to access financial services, (ii) the appropriateness of those services, measured through the level of usage, (iii) the quality of the financial services offered (Bruhn & Love, 2014). Financial inclusion prevalence is inhibited by many barriers, particularly in developing countries. These barriers, cited by more than 30% of those without bank accounts, include high costs; physical distance to the nearest infrastructure; and lack of proper documentation. However, significant differences in the prevalence of the barriers were noted across regions and demographical groups (Demirgüç-Kunt & Klapper, 2012b). Demirgüç-Kunt and Klapper (2012b) further observed that the level of education and age are important factors that may influence financial inclusion. Young adults specifically cited insufficient documentation, while adults living in rural areas cited distance from a bank. Country-specific variables are also noted as necessary for financial access (Honohan, 2007). For example, Allen et al. (2014) found that population density is considerably more critical for financial development in Africa than elsewhere. Another study used the same method when assessing the significance of various macroeconomic and country characteristics for financial access in developing economies. The results showed that “economic volatility, a weak rule of law, higher income inequality, social underdevelopment and regulatory constraints significantly lower financial inclusion levels” (Rojas-Suarez, 2010). In the World Bank global survey, over 80% of those without formal accounts cited the lack of money for using an account as their reason for not owning one. This finding indicates that financial exclusion, poverty and the lack of supply in financial services may be correlated. As a case in point, Burgess and Pande (2005) found evidence that opening bank branches in rural unbanked locations in India is associated with lower poverty in those areas. Allen et al. (2014) also use their study to illustrate that by servicing poor households, commercial banks can help improve the financial access of the poor in Kenya. While the research by Brune et al. (2011) shows that increased financial access through commitment savings accounts improves the well-being of poor households in rural Malawi. Park and Mercado (2018) later confirmed these earlier findings, showing that per capita income, the rule of law, and demographic characteristics are significantly positively correlated with financial inclusion. These findings prove that financial access is vital for eradicating poverty.

When modelled after M-Pesa, one of the successful pioneering innovations in the industry, digital financial services encompass the following components: a digital platform, retail agents, and a device to transact (Lyman & Lauer, 2015). Fintech innovations are viewed mainly as the solution to financial inclusion barriers (Agrawal, 2008). For instance, Mbiti and Weil (2011) argue that the distance to financial institutions becomes less critical when financial services and products are digitised. Secondly, identity verification technologies allow for simpler screening processes of people, a challenge currently faced by financial institutions in most developing economies. The expected increase in service providers through innovative banking solutions allows for increased competition in the market. This competition is expected to bring down prices, making financial products and services more affordable.

In developed economies, the definition of fintech and its products is more sophisticated and therefore entails more than just digital finance. Arneris, Barberis and Ross's (2016) study on the fintech landscape asserts that fintech is marked by the emergence of new start-up players alongside the traditional banking sector. Furthermore, innovations such as bitcoin have become significant in the financial world and have led to the development of different cryptocurrencies. Bartlett et al. (2018) highlight the role of fintech algorithms in cost reduction in the mortgage market. In the credit market,

To measure financial inclusion, various scholars have opted for the use of an index. Below is a summary of some of the literature on the creation of a financial inclusion index:

Sarma and Pais (2011) examined the relationship between financial inclusion and development. Using an index of financial inclusion (IFI) developed in Sarma (2008), they assessed the macro-level factors that can be associated with financial inclusion. The study involved carrying out three sets of regressions of the IFI on three different sets of variables: socio-economic variables such as income, employment, inequality, literacy etc.; the role of physical infrastructure and the effect of banking sector variables such as soundness indicators, ownership pattern and the prevailing rate of interest. They found that the level of human development and that of financial inclusion are strongly positively correlated, although few exceptions exist. Chakravarty and Pal (2013) used an axiomatic approach to calculate the percentage contributions of different dimensions to overall financial inclusion. The study looks at the outreach of banking services. The study found that the acceleration of geographic penetration of banking services and credit availability should get the policy priority to enhance financial inclusion across states in India. Kumar (2013) assesses the determinants of financial inclusion in India using panel fixed effects and dynamic panel generalized methods of moments (GMM). The results indicate that the branch network has unambiguous beneficial impact on financial inclusion. The proportion of factories and employee base are significant determinants of penetration indicators. The findings reveal the importance of a region's socio-economic and

environmental setup in shaping the banking habits of masses. Yorulmaz (2013) uses Sarma (2008)'s method of three dimensions of financial inclusion to measure the coverage of financial inclusion in Turkey. He found that high-income regions tend to show more level of financial inclusion and vice-versa. Ishmael et al. (2013) used the confirmatory factor analysis (CFA) to build a composite financial inclusion index for Egypt. The study looks at the access, barriers and usage indicators provided by the Global Findex. The results reveal that in 2017, the level of financial inclusion in Egypt improved due to improvements in accessibility. Accordingly, this led to a boost in the usage level of formal and informal banking services. Arora (2014) assesses three different dimensions: outreach, ease and cost of the transaction to measure financial inclusion across developing and developed countries. Further, it produces a new Socio-Economic Development Index, which incorporates financial access. It then compares socio-economic development of various countries as shown by Human Development Index (HDI) alone and by the new index combining financial access. The results reveal that adopting a more comprehensive approach to development, which includes finance as well as the indicators incorporated in the Human Development Index, provides a better picture of a country's development levels. Also, the ranking of countries in terms of HDI changes if financial access is considered. Ambarkhane et al. (2016) compute a financial inclusion index for 21 states. The study looks at three dimensions: supply, demand and infrastructure and then applies a drag factor. In this study, other financial services such as insurance, pension schemes, are considered in addition to banking. Based on the observed results, states under observation are then grouped into four categories: high, higher middle, lower-middle and low. Wang and Guan (2017) propose an improved IFI to measure the level of financial inclusion across countries. While the study is like Sarma (2008), the dimension and indicator weights are applied differently. The results reveal that European and North American countries have a higher level of financial inclusion than African and most Asian countries. Based on this distribution, the spatial econometric method is applied to analyse the inner mechanism. The study found simultaneous spill-over and aggregation of the development of financial inclusion in one country on its neighbour, and that neighbouring countries influence one another, which leads to aggregation in regions. Anarfo et al. (2019) use the PVAR approach to assess the link between monetary policy and financial inclusion. The study looks at macroeconomic variables (monetary policy rate, a log of consumer price index (CPI), real effective exchange rate, etc.). It creates a financial inclusion index (ATMS per hundred thousand adults, bank branches per hundred thousand adults, depositors with commercial banks per thousand adults, etc.). The study found that monetary policy has a significant impact on financial inclusion. Financial inclusion was observed to be a possible enhancer of macroeconomic stability since it significantly impacts macroeconomic variables such as the GDP growth rate, the inflation rate, and the real effective exchange rate. Ajide (2019) examines how financial inclusion impacts entrepreneurship in

13 selected African countries using the principal component analysis (PCA). For robustness check, an IFI was developed following the methodology of Sarma (2008) using six dimensions. The six dimensions include automated teller machines (ATM) per 100,000 adults, commercial bank branches per 1,000 adults, depositors with commercial banks per 1,000 adults, domestic credit to GDP ratio, banks' borrower per 1,000 adults and number of commercial bank accounts per 1,000 adults. The study results reveal that financial inclusion had a significant effect on entrepreneurship development in Africa. Remittances, financial crisis and growth did not have a significant effect on entrepreneurship while start-up procedures and time required to establish a business discouraged entrepreneurship development. Anarfo et al. (2020) studied the relationship between financial regulation and financial inclusion. In defining financial inclusion, the study employs the PCA to construct a composite index using access and usage factors. Results show that financial regulation has a negative effect on financial inclusion in Sub-Saharan Africa, suggesting that tight financial regulation does not enhance financial inclusion. This means that tightening prudential regulations could negatively impact access to finance and therefore conflict with the financial inclusion goals. More specifically, the capital adequacy requirement significantly reduces banks' capacity to provide financial services which may result in credit rationing.

2.5 Chapter Summary

In conclusion, the impact of digital finance on financial inclusion has been argued to be positive and significant by previous studies. Empirically quantifying the extent of this in Africa is a necessary addition to the body of knowledge.

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CHAPTER 3

Data and Methodology

3.1 Introduction

This chapter presents the methodology followed in conducting the study, the data used, as well as the sources thereof. The chapter further details the research design employed, model specification and estimation. It is organised into six distinct yet coherent sections. The second section describes the data used in the study and the method followed in choosing a sample size, as well as the periods under review. The third section elaborates on the variables selected, while the fourth outlines the analytical framework. The fifth and sixth sections detail the regression equation and the variables thereof.

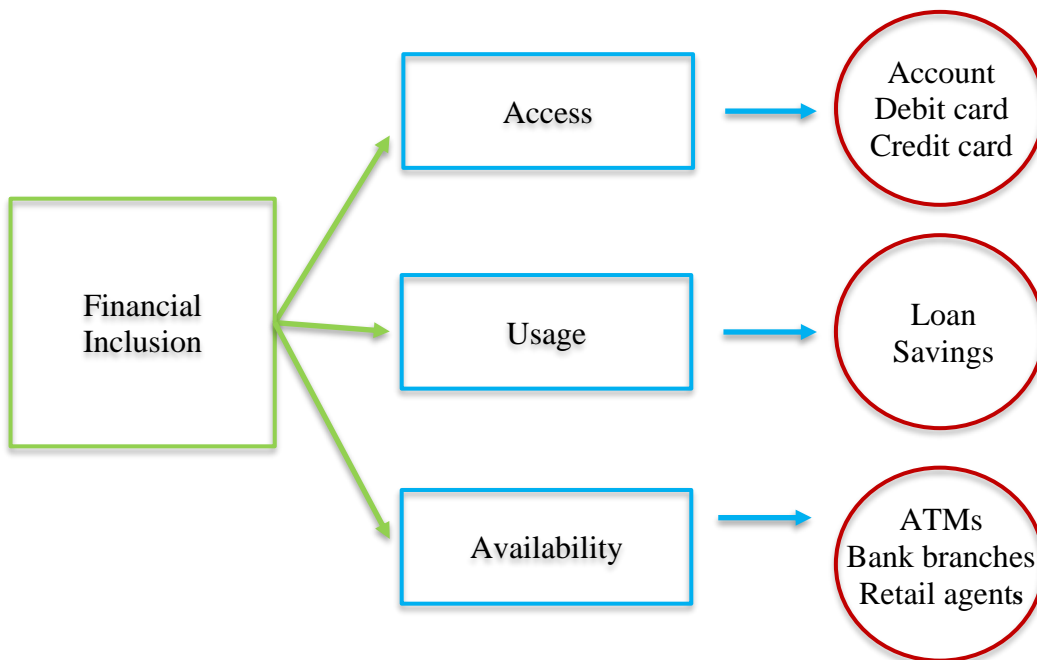
3.2 Sample size and period

A sample of 36 African countries is selected from the data collected by the Global Findex, over 3 periods to assess financial inclusion performance over time. The Global Financial Inclusion database (Global Findex) provides in-depth, demand-side data showing how people save, borrow, make payments, and manage risk at a country level. The indicators are based on interviews with about 150,000 nationally representative and randomly selected adults aged 15 and above. Supply-side data is collected by the IMF using the Financial Access Surveys (FAS) (Demirgüç-Kunt & Klapper, 2012b). The FAS database contains 152 time series resulting in 47 basic indicators, which are grouped by the geographic outreach and use of financial services (IMF, 2014). Due to economic and practical constraints, the feasibility of collecting information pertaining to the entire population of African countries was not possible. Taking these constraints into account, this paper follows the convenience sampling method in selecting the data from both data sources.

3.3 Financial Inclusion variables

This study considers financial inclusion to be a function of three sub-indices: access, usage and availability. Consistent with Sarma (2008), a financially inclusive system is defined as one that maximises all three of these sub-indices. The sub-indices are individually determined by specific indicators, detailed in the diagram below.

Diagram 2: Financial Inclusion Variables



Sources: Camara and Tuesta (2014); own computation

3.3.1 Access

Access to financial services is considered the most basic level of financial inclusion. The function of access is to allow people to make simple transactions such as storing money, making payments and receiving transfers. In our study, it is represented by either owning a formal financial account or having access to a debit or credit card. The inclusion of debit and credit card ownership is to account for people who may hold these cards but not own an account, as they constitute the financially included. The Global Findex considers formal account users as people who have a bank account; people who use mobile banking services but do not have an account; as well as individuals who do not have a bank account because someone else in the family already has one. Access is a useful measure for when financial inclusion levels are low, as is the case with most African countries, as it reflects the most basic needs when it comes to financial inclusion.

3.3.2 Usage

While access to financial services is imperative, financial inclusion is observed more truly through how people use financial services. In our study of usage, we attempt to look at the primary forms of usage that we can measure. This paper considers the percentage of the adult population that are

keeping savings or have a taken loan from a financial institution in the past 12 months, as key indicators of using financial services.

3.3.3 Availability

Availability reflects the infrastructure and human capital that is accessible to users of financial services to enable them to transact. It demonstrates the depth of outreach of financial inclusion. The choice of including this measure was influenced by a study done by Nyambariga (2013), where it was found that automated teller machines had a significant influence on financial inclusion. We consider the following indicators: automated teller machines (ATMs) per 100 000 adults, commercial bank branches per 100 000 adults, ATMs per 1000 km² and commercial bank branches per 1000 km². These account for the physical point of services offered by financial institutions (commercial banks, credit unions, rural banks, post office savings banks, etc.). This information is collected from financial services providers through the International Monetary Fund’s FAS.

Table 1: Summary of variables

Measure	Variable	Source
Access	Account	World Bank Global Findex
	Debit card	World Bank Global Findex
	Credit card	World Bank Global Findex
Usage	Loan	World Bank Global Findex
	Savings	World Bank Global Findex
Availability	ATMs per 1000 km ²	IMF FAS
	ATMs per 100 000 adults	IMF FAS
	Bank Branches per 1000 km ²	IMF FAS
	Bank Branches per 100 000 adults	IMF FAS

3.4 Analytical Framework: Measuring Financial Inclusion

The issue of how financial inclusion can be measured is one that is of concern to both researchers and policymakers. This study uses an index-building approach covering the three indicators of financial inclusion (access, usage and availability) to construct the Financial Inclusion Index (FII). There are two parametric analyses which can be used for this indexing: The Principal Component Analysis (PCA) and Common Factor Analysis (CFA). The CFA requires a selection of the underlying number of common factors for indexing, while the PCA does not require one to make assumptions on the raw data. This study will, therefore, use the PCA as an indexing strategy. The PCA index assigns weights to the variables using a two-stage approach. The first stage PCA is used to estimate the three sub-indices representing financial inclusion. The second stage PCA is used to determine the overall financial inclusion index, with the previously constructed sub-indices as causal variables. The general

approach in the construction of a composite index is to select and prepare the indicator variables to include in the composite index, assign weights and aggregate the indicator variables, then finally, to test the robustness of the composite index (Yorulmaz, 2018). The process for the construction of the index is outlined below.

3.4.1 Data normalisation

The values are normalised before combining the variables into three sub-indices that determine financial inclusion. Normalisation is necessary when comparing indicators with differing scales. Normalisation is conducted using the following formula:

$$X_{normalised} = \frac{x_i - \min(x)}{\max(x) - \min(x)}$$

3.4.2 Missing Data

In dealing with missing data, we follow the process in the OECD handbook on constructing composite indices. It outlines the basic missingness mechanisms as: missing completely at random (MCAR), missing at random (MAR), not missing at random (NMAR). According to the handbook, there are three general methods for dealing with missing data: (i) case deletion, (ii) single imputation or (iii) multiple imputation (Yorulmaz, 2018). In the first case, we simply omit all the countries with missing values from the analysis. The biggest drawback in this approach is that it results in larger standard errors, given the reduced sample. According to Lebovic (2015), “as a rule of thumb, if a variable has more than 5% missing observations, then cases should not be deleted”. Therefore, to ensure that we analyse a more robust dataset, the missing data values are imputed in our analysis. The single imputation method is used, where a regional mean for the countries with missing values per variable is imputed. The logic behind this choice of imputation, is that countries in the same region are more likely to have similar factors that affect their economic standing and are therefore more comparable.

3.4.3 Principal Component Analysis as an indexing strategy

Using Cámara and Tuesta's (2014) approach, we postulate that the latent variable financial inclusion is linearly determined as follows:

$$FII_i = \varpi_1 a_i + \varpi_2 u_i + \varpi_3 av_i + \varepsilon_i \quad (1)$$

Where subscript i denotes the country, and $\varpi_1 a_i$, $\varpi_2 u_i$, $\varpi_3 av_i$, capture the access, usage, and availability dimensions, respectively. The total variation in financial inclusion is represented by two parts: variation due to causal variables and variation due to error \mathcal{E}_i . In the case of a good model, including an adequate number of explanatory variables ensures that the variance of the error term is relatively small compared to the variance of the latent variable, financial inclusion. Given the above, the analysis will need to prove that the variation in the causal variables can largely explain the total variation in financial inclusion.

These causal variables are unknown endogenous variables that are estimated with the β , θ and γ parameters. The dimension estimators are formulated as follows:

$$Y_i^a = \frac{\sum_{j,k=1}^p \lambda_j^a P_{ki}^a}{\sum_{j=1}^p \lambda_j^a} \quad (2)$$

$$Y_i^u = \frac{\sum_{j,k=1}^p \lambda_j^u P_{ki}^u}{\sum_{j=1}^p \lambda_j^u} \quad (3)$$

$$Y_i^{av} = \frac{\sum_{j,k=1}^p \lambda_j^{av} P_{ki}^{av}}{\sum_{j=1}^p \lambda_j^{av}} \quad (4)$$

Subscript j refers to the number of principal components that also coincide with the number of sub-indices, p where $P_k = X \lambda_j \lambda_j$ represents the variance of the k -th principal component (weights) and X is the indicators matrix. The weights given to each component are decreasing, so that the larger proportion of the variation in each dimension is explained by the first principal component, and so on. Following this order, the p -th principal component is a linear combination of the indicators that accounts for the smallest variance (Cámara & Tuesta, 2017).

The second stage of the PCA computes the overall financial inclusion index by replacing Y_i access, Y_i usage and Y_i availability in the first equation. This results in the following index estimator:

$$FII_i = \frac{\sum_{j=1}^p \lambda_j P_{ki}}{\sum_{j=1}^p \lambda_j} \quad (5)$$

The highest weight, λ_1 , is attached to the first principal component because it accounts for the largest proportion of the total variation in all causal variables. Similarly, the second-highest weight, λ_2 , is attached to the second principal component etc.

The relative weights of each dimension for Access, Usage and Availability measures are computed as:

$$\omega_k = \frac{\sum_{j=1}^3 \phi_{\lambda_j} \phi_{jk}}{\sum_{j=1}^3 \phi_{\lambda_j}}, k = 1,2,3 \quad (6)$$

After the weights are assigned, the final FII is computed from the three dimensions.

3.5 Fintech regression analysis

Following the computation of financial inclusion indices, this study examines the relationship between fintech and financial inclusion using a regression analysis.

The general form of the regression equation is:

$$Y_i = a_0 + a_1X1 + a_2X2 \dots a_nXn + \varepsilon_i \quad (7)$$

Where $X1, X2, \dots, Xn$ are regressor variables and a_1, a_2, \dots, a_n are the parameters to be estimated, and ε_i is the error term. The dependent variable, Y_i denotes the FII computed earlier. The independent variables, X_i are the estimated components that make up financial technology.

The equation to examine the effect of financial technology and macroeconomic factors on financial inclusion index is presented in equation 2 below:

$$FII_{i,t} = a_0 + a_1FINTECH_{i,t} + a_2BDEV_{i,t} + a_3GDPG_{i,t} + a_4GFC_{i,t} + \varepsilon_{i,t} \quad (8)$$

Where FINTECH denotes financial technology, BDEV is banking sector development, GDPG represents GDP growth, and GFC is gross fixed capital formation. These variables are explained below.

3.6 Description of Variable

3.6.1 Fintech

The first variable, fintech, is represented by people who use the internet or mobile phones to access and manage their financial accounts. We look at the percentage of the population aged 15+, who use their mobile phone to i) send money, ii) receive money, iii) pay bills. This variable is denoted as MINTACCACCESS. We also look at the variable of people who use the internet to manage their financials. This variable is denoted as DIGPAYUSE in the analysis. Using these variables, we regress financial inclusion against mobile internet access and digital payments usage.

3.6.2 Banking Sector development

This variable denotes the banking sector credit to GDP in the countries under study. The relationship between banking sector development and financial inclusion is an important one to study given that financial inclusion has been found to have a relationship with macroeconomic factors as well. In a study, Ravikumar (2014) attempted to assess the role of the banking sector in financial inclusion from different viewpoints in India. This study revealed that the banking sector is a crucial driver for financial inclusion/inclusive growth. Still, large proportions of the population excluded from the formal financial system also show higher poverty ratios and higher inequality.

3.6.3 GDP growth

Another important macroeconomic factor to study is the role of GDP growth in financial inclusion. Economic growth has been found to have a significant positive impact across all specifications. This means that countries with higher economic growth have more inclusive financial systems. Looking specifically at GDP per capita, the following studies found that income is an important factor in explaining the level of financial inclusion in a country (Sarma & Pais, 2011); (Fungáčová & Weill, 2015). However, several studies suggest that financial inclusion is a precondition for economic growth, implying the possibility of bi-directional causality between these two variables (Mohan, 2006); (Chibba, 2009); (Olaniyi, 2016).

3.6.4 Gross Fixed capital formation

Finally, we look at gross fixed capital formation for the macroeconomic factors that may affect financial inclusion. A study by Uneze (2013), found that the relationship between gross fixed capital formation and economic growth has bi-directional causality. This means that higher economic growth leads to higher capital formation and that in turn, increases in capital formation results in higher economic growth. The increased economic growth (proxied by GDP growth) as stated above, is said to have a positive and significant impact on financial inclusion. It is therefore appropriate to study any direct impact of gross fixed capital formation on financial inclusion levels to determine the direct relationship between these two variables.

Table 2:

Variable	Definition	Measurement	Expectation
<i>MINTACCESS ACC</i>	Mobile internet to access account	<i>Used a mobile phone or the internet to access an account (% age 15+)</i>	Positive
DIGPAYUSE	Digital payments usage	<i>Made or received digital payments in the past year (% age 15+)</i>	Positive
BANKDEV	Banking sector development	<i>Banking sector credit to GDP</i>	Positive
GDPGR	Economic growth	<i>GDP growth rate</i>	Bi-directional
GFC	Gross fixed capital formation	<i>Gross fixed capital formation (% of GDP)</i>	Bi-directional

3.7 Estimation Approach

In the estimation of the regression model in Equation 8, we need to decide on the approach to employ when analysing the panel data set used in the study. Panel data combines at least two dimensions: a cross-sectional and a time series dimension. We consider three main types of widely used analytical models: the OLS, fixed effects and random effects. The OLS technique is not suitable for panel data as it may result in biased estimates due to unobserved heterogeneity (Arellano, 2009). We therefore only consider the fixed and random effects techniques, as they control for unobserved heterogeneity. Fixed effects are independent variables whose levels are determined or set by the experimenter. Random effects are classification effects where the levels of the effects are assumed to be randomly selected from an infinite population of possible levels (Pawel & Hill, 2006). In the choice between fixed and random effects, Bell, Fairbrother & Jones (2019) argue that “in most research scenarios, a well-specified random effect model provides everything that fixed-effect models provide and more, making it the superior method for most practitioners”. This is because, with panel data, fixed effects only explain deviations from the mean over time and therefore do not explain anything about relationships with independent variables that do not change over time. This results in the discarding of important and useful information between the explanatory and explained variables in the panel (Nerlove, 2005). However, a more statistically robust manner of choosing between the two fixed and random effects is to perform a Hausman test to detect any endogenous regressors.

CHAPTER 4

DISCUSSION OF RESULTS

4.1 Introduction

In this section, the results of the estimated financial inclusion indices are presented. The chapter is broken down into four more sections. The second section looks at the results of the PCA analysis performed, while the third section gives the FII results. The fourth section reviews the regression results, and the last section concludes the chapter.

4.2 Results of the PCA for FII

To understand how the study arrived at the sub-indices, we review the PCA analysis below. In the first stage of the PCA, the weights for the variables in each sub-index are computed, and then the variables: *access, usage and availability* are estimated. These are the dimensions used in the second stage to calculate the financial inclusion index. The weights are derived using equations 2 - 4 outlined in chapter 3, then normalized to sum to 1. Given that weights are endogenously obtained from the principal components, it is imperative to understand how the study arrived at these to understand the estimated sub-indices better. The analysis of the weights is summarised below.

When looking at all the indicators in each sub-index, we note that while the variables are not equal, no variable weight is dominant in any sub-index for all periods. Cámara and Tuesta (2017) state that this is a desirable condition for a composite index, as it indicates that all variables are necessary for the computation of the financial inclusion index. In assessing the access sub-index results, in 2011, credit card ownership had the highest weight, with account ownership having the lowest. This may indicate that credit card ownership is a better indicator of financial access, given that it considers people with access to financial services regardless of them owning a bank account or not. The increase in the account ownership weights in 2014 & 2017 can be explained by the inclusion of mobile money accounts in the data for these periods. The usage weights are evenly split between savings and loans into all three periods. This might mean that having savings or having a loan holds the same value in explaining the usage of financial services. When looking at availability, the ratio of ATMs and bank branches per 1000 km² have relatively equal weights, which are higher than those observed per adult population. We conclude that indicators pertaining to location have more information than those pertaining to population when it comes to the availability of financial infrastructure.

Table 3: Stage 1 PCA weights

		Weights (sum to 1)		
		2011	2014	2017
Access	Account	0,225	0,433	0,448
	Debit card	0,334	0,256	0,081
	Credit card	0,442	0,311	0,471
Usage	Savings	0,500	0,500	0,500
	Loan	0,500	0,500	0,500
Availability	ATMs per 1000 km2	0,354	0,348	0,350
	ATMs per 100 000 adults	0,240	0,215	0,228
	Bank Branches per 1000 km2	0,365	0,353	0,353
	Bank Branches per 100 000 adults	0,041	0,084	0,068

Using the estimated sub-indices above, the weights for the composite financial inclusion index are computed. The results show that the PCA assigns the highest weights to usage and availability (~0.8 combined) for all three periods. This indicates that while access to financial services and having available infrastructure improve financial inclusion, the usage of these services contributes the most in explaining the level of financial inclusion achieved.

The descriptive statistic in Table 4 below shows an increase in the mean for access from 0.2098 in 2011 to 0.2678 in 2017. The minimum value for access also increases from 0.0116 to 0.0362. This means that the level of access for countries increases over time. The usage mean marginally decreases from 0.3173 in 2011 to 0.3139 in 2017. The minimum value increases from 0.0146 to 0.0182; the maximum values decreased from 1 to 0.8824 in 2017. The availability sub-index mean increases from 0.0690 in 2011 to 0.0858 in 2017 while both the minimum and maximum values decrease from 0.0005 and 0.9409 in 2011 to 0 and 0.9160 respectively in 2017. Overall, the FII mean increases from 0.1957 in 2011 to 0.2012 in 2014 and then 0.2117 in 2017. This increase in the FII average for all three periods is driven largely by the increase in access to financial services. This makes sense given that access to financial services increases in both East and Central Africa during this period due to the introduction and prevalence of mobile money. The usage and availability measures may require further investigation and study to understand the drivers of their performance during this period.

Table 4: Descriptive of Financial Inclusion Index

		ACCESS	USAGE	AVAILABILITY	FII
2011	Mean	0.2098	0.3173	0.0690	0.1957
	Median	0.1826	0.2869	0.0275	0.1753
	Std Dev.	0.2079	0.2198	0.1599	0.1758
	Min	0.0116	0.0146	0.0005	0.0095
	Max	1.0000	1.0000	0.9409	0.9754
2014	Mean	0.2362	0.3018	0.0840	0.2012
	Median	0.1807	0.2167	0.0382	0.1343
	Std Dev.	0.2165	0.2549	0.1576	0.1919
	Min	0.0064	0.0000	0.0007	0.0042
	Max	1.0000	1.0000	0.9315	0.9705
2017	Mean	0.2678	0.3139	0.0858	0.2117
	Median	0.2167	0.3051	0.0443	0.1893
	Std Dev.	0.2001	0.2073	0.1541	0.1541
	Min	0.0362	0.0182	0.0000	0.0213
	Max	1.0000	0.8824	0.9160	0.8089

4.3 Sub-regional Analysis of FII

A summary of the FII regional results is presented in Table 5. As expected, the top-ranking countries are those in South and East Africa. The introduction and proper facilitation of mobile money services in Kenya and other East, Central and West African countries is evident in the increased access and overall FII scores. An open and friendly regulatory environment, along with no legacy financial services to convert from are some of the reasons most cited for this observation (GSMA, 2009); (Bishko & Chan, 2013). Looking at West Africa, while Nigeria, the biggest economy in the region, increases between 2011 and 2014, we note that the FII score decreased to below 2011 levels in 2017. This may be because mobile financial services are not too prevalent in the country, and while the adult population is growing, traditional financial services are not increasingly accessible to the new joining adult population. The restrictive regulatory environment and cultural nuances are some of the reasons cited for mobile financial services not taking off in the country (GSMA, 2019b). In 2011, the top 5 highest ranked countries in providing access to financial services were Mauritius, South Africa, Botswana, Kenya and Zimbabwe. While the other countries stay in relatively the same rankings, Zimbabwe dropped to 10th ranking in 2017. The economic downfall and political instability are some of the factors that may have contributed to this decline in financial access in Zimbabwe. We note that countries with the highest access levels seem to be concentrated in the SADC region, with growth in East African countries. This is expected given the financial development of the SADC region and the East African development. We further note that the top 5 lowest-ranked countries are Niger, Madagascar, Benin, Burundi and Central African Republic. Of these, only Benin shows an improvement in access levels over time. It is also worth noting that access levels in North Africa do

not increase during the three periods under review. For a more thorough analysis, using a larger sample of countries, further research on the financial inclusion levels in this region could be performed. For usage, the top 5 ranking countries are Mauritius, South Africa, Kenya, Rwanda and Uganda in 2011, with little change over time. This means that most financial usage is in the East African region. Here as well, we note that the lowest ranking countries are mostly in the Central region. The availability measure has the highest-ranking countries as Botswana, Mauritius, Namibia, Nigeria and South Africa. The absence of East African countries makes sense, given the prevalence of mobile banking initiatives in the region, which do not require extensive physical banking infrastructure. The Southern African domination can be explained by the fact that the region has the most developed financial services sector and therefore, would be ahead of other regions in the provision of financial infrastructure. The improvement of financial inclusion in Ghana and Namibia over time is worth noting and may warrant further study to understand the key drivers of the increase in both the sub-indices and the overall FII. The FII averages show that there is a need for further innovation and development in the Central part of Africa when it comes to financial inclusion. Overall, we notice that development pertaining to new means of financial access are what have propelled financial inclusion levels ahead.

Table 5: Sub-regional analysis of Financial Inclusion Index

	ACCESS	USAGE	AVAILABILITY	FII
2011				
Southern Africa	0.4186	0.4342	0.1926	0.3309
West Africa	0.1044	0.2483	0.0295	0.1330
Central Africa	0.1052	0.1453	0.0158	0.0846
East Africa	0.1971	0.4088	0.0383	0.2188
North Africa	0.2145	0.3207	0.0117	0.1741
2014				
Southern Africa	0.4245	0.4478	0.2175	0.3462
West Africa	0.1408	0.1970	0.0410	0.1240
Central Africa	0.1500	0.1847	0.0322	0.1155
East Africa	0.2441	0.3949	0.0468	0.2294
North Africa	0.1405	0.2000	0.0234	0.1178
2017				
Southern Africa	0.4317	0.3582	0.2122	0.3114
West Africa	0.2100	0.2411	0.0391	0.1524
Central Africa	0.2127	0.2101	0.0555	0.1469
East Africa	0.2391	0.4805	0.0505	0.2599
North Africa	0.1279	0.1603	0.0058	0.0909
2011-2017				
Southern Africa	0.4249	0.4134	0.2074	0.3295
West Africa	0.1517	0.2288	0.0365	0.1365
Central Africa	0.1560	0.1800	0.0345	0.1157

East Africa	0.2267	0.4280	0.0452	0.2361
North Africa	0.1610	0.2270	0.0136	0.1276

4.4 Descriptive and Correlation Analysis

The results in Tables 6 and 7 below show the descriptive statistics and the correlation results of the variables in the regression equation on the relationship between FII and fintech.

Table 6: Regression descriptive statistic

Stats	Mean	Median	Min	Max	N
FII	0.2029	0.1669	0.0042	0.9754	108
ACCESS	0.2379	0.1924	0.0064	1.0000	108
USAGE	0.3110	0.2770	0.0000	1.0000	108
AVAILABILITY	0.0796	0.0368	0.0000	0.9409	108
MINTACCESSACC	0.1733	0.1443	0.0003	0.7180	67
DIGPAYUSAGE	0.2926	0.2805	0.0409	0.7896	68
BANKDEV	22.2610	14.5291	0.0000	151.1179	108
GDPGR	4.7116	4.6999	-4.3873	14.1939	108
GFC	23.4799	22.8945	0.0000	74.6082	108

Note: MINTACCESSACC= Used a mobile phone or the internet to access an account (% age 15+); DIGPAYUSAGE= Made or received digital payments in the past year (% age 15+); BANKDEV= banking sector credit to GDP; GDPGR= GDP Growth rate; GFC= Gross fixed capital formation (% of GDP)

Before conducting the regression analysis, we examine the independence of the explanatory variables by estimating the correlation coefficients. The results of the correlation coefficients, presented in Table 7, generally suggests weaker associations among the explanatory variables, except for MINTACCESSACC and DIGPAYUSAGE. This indicates the usage of the two variables in the same regression analysis is likely to produce bias coefficients due to multicollinearity. These potential biases were considered in the regression analysis.

Table 7: Correlation Matrix

	1	2	3	4	5	6	7	8	9
1.FII	1.000								
2.ACCESS	0.927 (0.000)	1.000							
3.USAGE	0.917 (0.000)	0.800 (0.000)	1.000						
4.AVAILABILITY	0.834 (0.000)	0.775 (0.000)	0.557 (0.000)	1.000					
5.MINTACCESSAC C	0.288 (0.018)	0.419 (0.000)	0.397 (0.001)	-0.046 (0.713)	1.000				
6.DIGPAYUSAG	0.711 (0.000)	0.814 (0.000)	0.684 (0.000)	0.450 (0.000)	0.795 (0.000)	1.000			
7.BANKDEV	0.683 (0.000)	0.690 (0.000)	0.515 (0.000)	0.700 (0.000)	0.075 (0.548)	0.520 (0.000)	1.000		
8.GDPGR	0.008 (0.936)	-0.051 (0.599)	0.107 (0.271)	-0.108 (0.267)	-0.115 (0.353)	-0.268 (0.028)	-0.176 (0.068)	1.000	
9.GFC	-0.050 (0.610)	-0.084 (0.386)	0.005 (0.963)	-0.097 (0.318)	-0.230 (0.061)	-0.245 (0.044)	-0.141 (0.146)	0.343 (0.000)	1.000

Note: MINTACCESSACC= Used a mobile phone or the internet to access an account (% age 15+); DIGPAYUSAGE= Made or received digital payments in the past year (% age 15+);

BANKDEV= banking sector credit to GDP; GDPGR= GDP Growth rate; GFC= Gross fixed capital formation (% of GDP). Values in parentheses denote p-values.

4.5 Regression Results: FII and Fintech

The regression analysis below looks at the relationship between multiple explanatory variables and the FII, along with its sub-indices. The explanatory variables under analysis are: the use of a mobile phone to access an account (MINTACCESSACC); using a mobile phone to i) send money, ii) receive money, iii) pay bills, made in the past year (DIGPAYUSAGE) along with macroeconomic, financial variables of banking sector credit to GDP (BANKDEV), GDP growth rate (GDPGR) and gross fixed capital formation (GFC). Table 8 below presents the results of the regression model. We perform two stepwise regression analyses to address the potential multicollinearity bias observed in the correlation analysis. Model 1 includes MINTACCESSACC variable without the DIGPAYUSAGE variable, while Model 2 includes the DIGPAYUSAGE variable without the MINTACCESSACC variable. The estimated coefficients of determination (R^2) of 0.5332 for Model 1 and 0.6438 for Model 2, indicate that 53.32% and 64.38% variations in FII are collectively explained by the independent variables in both models. This also suggests that the inclusion of DIGPAYUSAGE provides higher explanatory power compared with MINTACCESSACC. This makes sense since DIGPAYUSAGE considers people who may not have internet access but have a mobile account that allows them to transact, versus MINTACCESSACC, which is only applicable to the currently banked population. This is consistent with the findings by Ishegoma (2011) that most of the people registered with mobile banking systems did not have bank accounts, meaning that mobile banking systems offer financial services more widely than digital financial services, which only cater to people who are already financially included. We observe a positive and significant effect of both MINTACCESSACC and DIGPAYUSAGE on the FII at the 1% level of significance. This indicates that financial technology improves financial inclusion. As people have access to mobile phones, they are now able to access financial service and therefore participate in the financial system. Furthermore, access to internet services also allows for people who already have bank accounts to deepen their financial inclusion levels beyond merely accessing services, but to them having greater usage of those financial services. Ozili (2018) found the same thing in his study, that “provided the excluded population have a mobile phone, and affordable internet connectivity, a greater supply of mobile and digital finance is often predicted to have positive effects on financial inclusion, all other things being equal”. The magnitude of the estimated coefficients suggests that digital payments have a greater effect in enhancing financial inclusion compared to usage of mobile phones and the internet to access account.

The coefficient for banking sector development (BANKDEV) is significant at the 1% level in Model 1 and at the 5% level in Model 2 on FII. This indicates that banking sector development improves

financial inclusion levels. The magnitude of the estimated coefficients suggests that banking sector development only improves financial inclusion marginally. These findings are consistent with the findings by the GSMA that explain how “mobile money expansion is associated with growth in the commercial banking sector, and that mobile money is complementary to commercial banking services and therefore can enable its diversification and expansion – or at the very least, it has no discernible impact” (GSMA, 2019a).

GDP growth rate is observed to be significant at the 10% level in Model 2 and not significant in Model 1. This means that for mobile phone access to an existing bank account, GDP growth has no relationship with financial inclusion. For digital payments, GDP growth has a marginally positive relationship with financial inclusion. As stated in the previous section, several studies suggest the possibility of a bi-directional causality relationship between these two variables. Evans (2016) found that African countries with higher economic growth have more inclusive financial systems and that GDP per capita has a significant positive impact on financial inclusion. On the other hand, Hamdan (2019) shows that mobile money adoption causes significant business growth and benefits macroeconomic development by analysing firm-level data on urban businesses in Kenya. It is worth noting that the definition of financial inclusion in both these studies is heavily skewed towards focusing only on access to financial services. Therefore, the observed weak but positive relationship between financial inclusion and economic growth might require further investigations to understand the intricacies of the bi-directional relationship observed in other studies, using the definition of financial inclusion used in this paper.

Finally, we observe that gross fixed capital formation is not significant in the analysis. This may indicate that fixed capital formation has no relationship with financial inclusion. While it has been found to have a positive and strongly significant relationship with economic growth (Ongo & Vukekeng, 2014), any impact on financial inclusion is likely to be passively passed through the increase in economic growth, which has a positive relationship with financial inclusion as seen in GDP growth above.

Table 8: Financial Technology and Financial Inclusion in Africa

Dependent Variable: Financial Inclusion Index				
	REM		REM	
	Model 1		Model 2	
	Coef.	z	Coef.	z
Constant	0.046 (0.041)	1.11	0.006 (0.023)	0.25
MINTACCESSACC	0.235*** (0.083)	2.84		
DIGPAYUSAGE			0.334*** (0.059)	5.7
BANKDEV	0.004*** (0.001)	6.01	0.003** (0.001)	2.39
GDPGR	0.004 (0.004)	0.86	0.005* (0.003)	1.88
GFC	0.000 (0.001)	0.4	0.000 (0.001)	0.61
Wald $\chi^2(4)$	44.52		84.92	
Prob > χ^2	0.000		0.000	
R-squared	0.5332		0.6438	
Hausman χ	1.51		6.49	
Prob > χ^2	0.8253		0.1656	
Countries	36		36	
Observations	67		68	

*Note: MINTACCESSACC= Used a mobile phone or the internet to access an account (% age 15+); DIGPAYUSAGE= Made or received digital payments in the past year (% age 15+); BANKDEV= banking sector credit to GDP; GDPGR= GDP Growth rate; GFC= Gross fixed capital formation (% of GDP). Robust standard errors in parentheses. ***, ** and * denotes significance at 1%, 5% and 10%.*

Table 9 below outlines the results of the two stepwise regression analyses on the dimensions of financial inclusion (access, usage, availability) and Fintech. Consistent with Table 8 above, Model 1 includes the MINTACCESSACC variable without the DIGPAYUSAGE variable, while Model 2 includes the DIGPAYUSAGE variable without the MINTACCESSACC variable. Looking at the access Model, the estimated coefficients of determination (R^2) of 0.6217 for Model 1 and 0.5702 for Model 2, indicate that 62.17% and 57.02% variations in access are collectively explained by the independent variables in both models. This suggests that for access, the inclusion of MINTACCESSACC provides higher explanatory power compared than DIGPAYUSAGE. This is an expected observation given that MINTACCESSACC includes the population that would not usually have access to traditional financial services, while DIGPAYUSAGE only looks at the population with existing accounts. For both MINTACCESSACC and DIGPAYUSAGE, we observe a positive relationship with the access variable at 1% level of significance, an observation that is consistent with findings by Hamdan (2019). Banking sector development is significant at the 1% level for Model 1

and at the 5% level for Model 2 as we had observed in the aggregated FII results. GDPGR is also significant at the 5% level for Model 2, meaning that the growth of GDP has a positive effect on access to financial inclusion when looking at people who use their mobile phones to make or receive digital payments, and GFC has no observably significant impact, an observation consistent with that made at the overall FII level.

For the usage variable, Model 1 has an R^2 of 0.4111, while Model 2 is 0.5288, meaning 41.11% and 52.88% of the variation is explained in the two models. This means that DIGPAYUSAGE explains the usage of financial services more than MINTACCESSACC, an unexpected scenario given that DIGPAYUSAGE is not the only way that people with bank accounts can access or use these services, while MINTACCESSAC is the only manner that people with mobile accounts can access and use their accounts. At the 1% significance level, both MINTACCESSAC and DIGPAYUSAGE have a positive relationship with the usage of financial inclusion. This observation confirms the importance of usage for improving financial inclusion. Banking sector development is also significant for Model 1 at the 1% significance level and at the 5% for Model 2 as observed with access and FII. GFC has no observably significant impact, an observation consistent with that made at the overall FII level.

Finally, the availability measure shows an R^2 of 0.0513 (5.13%) and 0.0625 (6.25%) for Model 1 and Model 2, respectively. The low R^2 levels indicate that the variables under analysis are not appropriately suited to explaining the availability of financial infrastructure. As such, this creates an opportunity for future research in understanding the variables that affect the availability of financial infrastructure and its impact on financial inclusion.

Table 9: Financial Technology and Dimensions of Financial Inclusion in Africa

Dep. variables	ACCESS		USAGE		AVAILABILITY	
	REM	FEM	REM	REM	FEM	FEM
	MODE	MODEL	MODEL	MODEL 2	MODEL 1	MODEL 2
	L 1	2	1	MODEL 2	MODEL 1	2
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Constant	0.0112 (0.0348)	-0.0710 (0.0833)	0.0672 (0.0702)	0.0029 (0.0664)	0.1164*** (0.0314)	0.1111*** (0.0327)
MINTACCESSACC	0.5076* ** (0.0617)		0.4837** * (0.1498)		-0.0199 (0.0354)	
DIGPAYUSAGE		0.4682*** (0.0813)		0.6192*** (0.1278)		0.0176 (0.0319)
BANKDEV	0.0051* ** (0.0017)	0.0065** (0.0027)	0.0042** * (0.0010)	0.0024** (0.0010)	-0.0010 (0.0011)	-0.0012 (0.0011)
GDPGR	0.0040 (0.0034)	0.0097** (0.0046)	0.0063 (0.0080)	0.0091 (0.0075)	0.0002 (0.0018)	-0.0002 (0.0018)
GFC	0.0007 (0.0008)	-0.0004 (0.0014)	0.0016 (0.0022)	0.0014 (0.0020)	-0.0002 (0.0005)	0.0000 (0.0005)
Wald χ^2 (4)/F	134.59	9.29	29.19	47.5	0.37	0.47
Prob > χ^2 /F	0.000	0.0001	0.000	0.000	0.8311	0.7594
R-squared	0.6217	0.5702	0.4111	0.5288	0.0513	0.0625
Hausman	1.27	18.27	2.51	6.39	16.39	17.28
Prob > χ^2	0.8667	0.0011	0.6437	0.172	0.0025	0.0017
Countries	36	36	36	36	36	36
Observations	67	68	67	68	67	68

Note: MINTACCESSACC= Used a mobile phone or the internet to access an account (% age 15+); DIGPAYUSAGE= Made or received digital payments in the past year (% age 15+); BANKDEV= banking sector credit to GDP; GDPGR= GDP Growth rate; GFC= Gross fixed capital formation (% of GDP). Robust standard errors in parentheses. ***, ** and * denotes significance at 1%, 5% and 10%.

CHAPTER 5 CONCLUSION

5.1 Introduction

The objective of this research was to study financial inclusion evolution over time in Africa and the relationship between financial inclusion and financial technology. To perform this analysis, we constructed financial inclusion indices for the periods 2011, 2014 and 2017 using the PCA analysis. We further performed a regression analysis to study the relationship between the sub-indices, composite index, macroeconomic factors and financial technology.

5.2 Summary of the study and conclusion

The study performed was a cross country study on the latent factors that explain financial inclusion. Using the financial inclusion index, we first computed comparable financial inclusion country indices for three periods for all the countries under observation. We found that countries with more developed banking sectors (Mauritius, Namibia, South Africa, Ghana, etc.) have higher levels of financial inclusion, owing to traditional financial services for all the countries. For countries with high indices but little or no traditional financial services, mobile money has been the key driver. The inclusion of mobile money accounts has been instrumental in increasing financial inclusion levels in East Africa (Kenya in particular). Our empirical analysis shows that increasing individual sub-indices (access, usage, availability) increases the levels of financial inclusion in a country. This means that for countries to increase their financial inclusion levels, focus must be given to the individual sub-indices. The regression analysis confirms this assessment, showing that overall, the use of mobile accounts has a positive and significant relationship with financial inclusion while the use of digital payments for existing accounts also improves financial inclusion but to a lesser extent. This is an important distinction given that ownership of mobile money accounts increases the number of people with access to financial services while using digital payments merely deepens and enhances the usage of existing account holders. The analysis also shows that the macroeconomic factors of economic growth and banking sector development also are important for financial inclusion, though to a lesser degree. For countries with low index scores, focusing on improving access first should be the primary objective. Countries with more established banking sectors should focus on depth, measured through usage and availability. While this paper recognises that an improved definition of availability with more suited variables is needed going forward, the inclusion of the variable is still considered relevant and necessary when studying financial inclusion.

5.3 Policy Recommendations

This paper recommends the development of a uniform taxonomy on financial inclusion and its measurements. The fragmented nature of the language in both fintech and financial inclusion industries creates room for the existence of superficial measurements. The role of policymakers would be to propel forward the development of this taxonomy, working with all the relevant stakeholders. Furthermore, based on the findings in this study that access is merely the starting point which does not consider the depth of financial inclusion, a greater focus on understanding usage and measuring its impact, led by policymakers would mature the conversation around financial inclusion.

5.4 Avenues for future research

For future studies, this paper recommends a further study of the sub-indices that explain financial inclusion, particularly availability. It is further recommended that other variables which explain fintech are explored to see the other factors that may have a relationship with financial inclusion. For application purposes, this paper recommends the study of what impacts (positively or negatively) the sub-indices and how countries can maximise each sub-index. This is especially relevant to policymakers and innovators, who have a vested interest in the ways in which they can increase financial inclusion levels in their respective countries.

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APPENDIX

Table 10: Countries under analysis by region

North	Central	East	South	West
Chad	Burkina Faso	Burundi	Angola	Benin
Mauritania	Cameroon	Ethiopia	Botswana	Cote d'Ivoire
	Central African Republic	Kenya	Lesotho	Ghana
	Congo, Dem. Rep.	Malawi	Madagascar	Guinea
	Congo, Rep.	Rwanda	Mauritius	Liberia
	Gabon	Sudan	Namibia	Mali
		Tanzania	South Africa	Niger
		Uganda	Zambia	Nigeria
			Zimbabwe	Senegal
				Sierra Leone
				Togo

Table 11: Missing data

Factor	2011	2014	2017
Access	Cote d'Ivoire Ethiopia Namibia	Central African Republic Lesotho Liberia	Angola Burundi Sudan
Usage	Cote d'Ivoire Ethiopia Namibia	Central African Republic Lesotho Liberia	Angola Burundi Sudan
Availability	Cote d'Ivoire Ethiopia Namibia	Central African Republic Cote d'Ivoire Ethiopia Gabon Lesotho Liberia Sierra Leone Togo	Angola Benin Burundi Cameroon Central African Republic Congo, Dem. Rep. Congo, Rep. Cote d'Ivoire Ethiopia Gabon Kenya Lesotho Liberia Malawi Mali Mauritania Namibia Niger Nigeria Senegal Sierra Leone Tanzania

Table 12: Stage 2 PCA weights

	Weights (sum to 1)		
	2011	2014	2017
Access	0,168	0,103	0,181
Usage	0,415	0,466	0,408
Availability	0,417	0,431	0,411

Table 13, 14 & 15: Sub-Indices by country

	ACCESS					
	2011	RANK	2014	RANK	2017	RANK
Angola	0,357	6	0,292	10	0,096	32
Benin	0,038	32	0,100	26	0,286	12
Botswana	0,515	3	0,580	5	0,396	6
Burkina Faso	0,065	25	0,105	23	0,279	13
Burundi	0,034	33	0,006	36	0,154	23
Cameroon	0,104	24	0,059	31	0,214	19
Central African Republic	0,024	34	0,174	20	0,072	34
Chad	0,216	12	0,059	32	0,106	31
Congo, Dem. Rep.	0,063	26	0,105	24	0,109	30
Congo, Rep.	0,189	17	0,131	22	0,187	22
Cote d'Ivoire	0,179	19	0,196	17	0,211	21
Ethiopia	0,246	8	0,092	27	0,129	28
Gabon	0,186	18	0,325	8	0,414	5
Ghana	0,218	11	0,250	12	0,385	7
Guinea	0,055	28	0,047	33	0,129	29
Kenya	0,499	4	0,617	3	0,543	4
Lesotho	0,215	13	0,185	18	0,307	11
Liberia	0,151	21	0,176	19	0,148	27
Madagascar	0,012	35	0,016	35	0,095	33
Malawi	0,144	22	0,136	21	0,151	25
Mali	0,043	30	0,100	25	0,278	14
Mauritania	0,213	15	0,222	16	0,149	26
Mauritius	1,000	1	1,000	1	1,000	1
Namibia	0,214	14	0,646	2	0,775	2
Niger	0,012	36	0,024	34	0,036	36
Nigeria	0,224	10	0,408	6	0,257	16
Rwanda	0,207	16	0,239	14	0,219	18
Senegal	0,043	31	0,086	28	0,243	17
Sierra Leone	0,127	23	0,081	30	0,058	35
South Africa	0,689	2	0,599	4	0,574	3
Sudan	0,049	29	0,329	7	0,154	23
Tanzania	0,233	9	0,241	13	0,213	20
Togo	0,059	27	0,082	29	0,278	15
Uganda	0,166	20	0,293	9	0,350	8
Zambia	0,271	7	0,271	11	0,328	9
Zimbabwe	0,495	5	0,232	15	0,313	10

	USAGE					
	2011	RANK	2014	RANK	2017	RANK
Angola	0,512	6	0,238	16	0,191	25
Benin	0,221	22	0,277	14	0,368	13
Botswana	0,433	9	0,739	4	0,350	14
Burkina Faso	0,196	23	0,216	19	0,392	12
Burundi	0,065	32	0,034	34	0,400	10
Cameroon	0,280	19	0,104	29	0,286	20
Central African Republic	0,022	35	0,170	24	0,101	31
Chad	0,293	18	0,071	31	0,029	35
Congo, Dem. Rep.	0,028	34	0,073	30	0,070	34
Congo, Rep.	0,165	26	0,212	21	0,134	28
Cote d'Ivoire	0,277	20	0,131	28	0,070	33
Ethiopia	0,494	7	0,365	10	0,662	3
Gabon	0,180	25	0,333	11	0,277	21
Ghana	0,434	8	0,462	9	0,495	7
Guinea	0,072	30	0,032	35	0,145	27
Kenya	0,703	2	0,852	2	0,882	1
Lesotho	0,193	24	0,208	22	0,198	24
Liberia	0,423	11	0,213	20	0,321	17
Madagascar	0,055	33	0,039	33	0,078	32
Malawi	0,429	10	0,224	17	0,319	18
Mali	0,159	27	0,057	32	0,202	23
Mauritania	0,348	17	0,329	13	0,291	19
Mauritius	1,000	1	1,000	1	0,616	4
Namibia	0,271	21	0,543	7	0,723	2
Niger	0,015	36	0,000	36	0,018	36
Nigeria	0,421	12	0,499	8	0,347	15
Rwanda	0,561	4	0,568	6	0,449	8
Senegal	0,140	29	0,137	26	0,232	22
Sierra Leone	0,420	13	0,217	18	0,121	29
South Africa	0,650	3	0,800	3	0,552	6
Sudan	0,070	31	0,172	23	0,400	10
Tanzania	0,394	15	0,268	15	0,170	26
Togo	0,148	28	0,143	25	0,333	16
Uganda	0,553	5	0,677	5	0,561	5
Zambia	0,374	16	0,331	12	0,404	9
Zimbabwe	0,420	14	0,133	27	0,112	30

	AVAILABILITY					
	2011	RANK	2014	RANK	2017	RANK
Angola	0,073	7	0,100	8	0,150	3
Benin	0,023	22	0,031	26	0,032	29
Botswana	0,127	4	0,122	5	0,135	6
Burkina Faso	0,014	27	0,020	30	0,022	31
Burundi	0,024	20	0,037	23	0,044	16
Cameroon	0,013	28	0,017	31	0,062	9
Central African Republic	0,003	34	0,063	11	0,062	9
Chad	0,001	36	0,001	36	0,000	36
Congo, Dem. Rep.	0,001	35	0,001	35	0,062	9
Congo, Rep.	0,013	29	0,030	27	0,062	9
Cote d'Ivoire	0,038	13	0,037	20	0,036	22
Ethiopia	0,047	11	0,044	17	0,044	16
Gabon	0,051	9	0,063	11	0,062	9
Ghana	0,042	12	0,067	10	0,103	8
Guinea	0,005	32	0,011	32	0,012	34
Kenya	0,059	8	0,063	13	0,044	16
Lesotho	0,048	10	0,148	4	0,150	3
Liberia	0,014	26	0,037	20	0,036	22
Madagascar	0,008	31	0,010	33	0,012	33
Malawi	0,024	21	0,039	18	0,044	16
Mali	0,020	24	0,031	25	0,033	27
Mauritania	0,023	23	0,046	15	0,012	35
Mauritius	0,941	1	0,932	1	0,916	1
Namibia	0,171	3	0,228	3	0,150	3
Niger	0,003	33	0,004	34	0,018	32
Nigeria	0,102	5	0,115	6	0,036	22
Rwanda	0,078	6	0,108	7	0,126	7
Senegal	0,034	15	0,037	19	0,043	21
Sierra Leone	0,009	30	0,037	20	0,036	22
South Africa	0,299	2	0,297	2	0,313	2
Sudan	0,020	25	0,022	29	0,024	30
Tanzania	0,025	19	0,027	28	0,044	16
Togo	0,033	16	0,044	16	0,048	15
Uganda	0,030	18	0,035	24	0,032	28
Zambia	0,036	14	0,049	14	0,051	14
Zimbabwe	0,030	17	0,072	9	0,034	26

Table 16: Financial Inclusion Indices by country

Country	2011		2014		2017	
	Country Index	Rank	Country Index	Rank	Country Index	Rank
Angola	0,303	5	0,184	14	0,157	22
Benin	0,108	24	0,153	17	0,215	12
Botswana	0,320	4	0,457	4	0,270	9
Burkina Faso	0,098	26	0,120	24	0,219	11
Burundi	0,043	31	0,032	33	0,209	14
Cameroon	0,139	21	0,062	29	0,181	19
Central African Republic	0,014	35	0,124	22	0,080	31
Chad	0,158	20	0,039	32	0,031	35
Congo, Dem. Rep.	0,023	34	0,046	31	0,074	33
Congo, Rep.	0,106	25	0,125	21	0,114	28
Cote d'Ivoire	0,161	19	0,097	26	0,081	30
Ethiopia	0,266	9	0,198	12	0,311	6
Gabon	0,127	23	0,216	10	0,213	13
Ghana	0,234	11	0,270	9	0,314	5
Guinea	0,042	32	0,024	34	0,087	29
Kenya	0,400	3	0,488	3	0,476	3
Lesotho	0,136	22	0,180	15	0,198	18
Liberia	0,207	16	0,133	19	0,172	21
Madagascar	0,029	33	0,024	35	0,054	34
Malawi	0,212	15	0,135	18	0,176	20
Mali	0,082	28	0,050	30	0,146	25
Mauritania	0,190	18	0,196	13	0,151	24
Mauritius	0,975	1	0,970	1	0,809	1
Namibia	0,220	12	0,418	5	0,497	2
Niger	0,009	36	0,004	36	0,021	36
Nigeria	0,255	10	0,324	8	0,203	16
Rwanda	0,300	6	0,336	7	0,275	8
Senegal	0,080	29	0,089	28	0,156	23
Sierra Leone	0,200	17	0,126	20	0,074	32
South Africa	0,510	2	0,562	2	0,458	4
Sudan	0,046	30	0,123	23	0,201	17
Tanzania	0,213	14	0,162	16	0,126	26
Togo	0,085	27	0,094	27	0,206	15
Uganda	0,270	7	0,361	6	0,305	7
Zambia	0,216	13	0,203	11	0,245	10
Zimbabwe	0,270	8	0,117	25	0,117	27

Table 17: Missing data in regression

Used a mobile phone or the internet to access an account (% age 15+)	Made or received digital payments in the past year (% age 15+)	Mobile money account (% age 15+)	Has a national identity card (% age 15+)
Burundi Sudan Angola	Burundi Angola	Burundi Sudan Angola Central African Republic	Burundi Sudan Angola Mauritius Ghana Liberia Nigeria Sierra Leone Central African Republic Congo, Dem. Rep.