

Research Article

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Fintech: Innovating Financial Inclusion for African Small and Medium-sized Enterprises

Selma Haj Khelifa¹ , Nada Srifi^{2*} 

¹Professor Habilitation to conduct research (HDR), Doctor in Finance & Banking & Fintech, Groupe ISCAE, Morocco

²Internal Auditor, PhD Candidate in Finance, Groupe ISCAE, Morocco

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Correspondence:

nadasrifi@hotmail.com

ABSTRACT

Small and Medium-Sized Enterprises (SMEs) are the lifeblood of Africa's economy. However, one of their biggest challenges is access to Finance. This study assesses the potential of Financial Technologies (fintech), as an innovative force, in addressing the financial inclusion challenges faced by SMEs across African countries. By adopting an exploratory approach, meticulously reviewing relevant published materials and data from reputable sources such as the World Bank, this study analyzes the correlation between SMEs' financial inclusion and fintech implementation in Africa. Employing Principal Component Analysis (PCA) and regression modeling in R Studio, this study provides a rigorous analysis of this dynamic. The results indicate that increased usage of fintech significantly improves access to funding and enhances financial inclusion. However, while fintech is bridging the business gap, it cannot operate in isolation. A robust ecosystem, trust-building, and infrastructure are essential to fintech's success.

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Fintech is a blend of “financial” and “technology”. It refers to emerging technologies that enhance the delivery and utilization of financial services ([Financial Technology \(Fintech\), 2024](#)). It is a pivotal innovation in the financial industry, rapidly evolving due to factors like the sharing economy, favorable regulations, and advancements in information technology. Fintech aims to transform the financial landscape by reducing costs, enhancing the quality of services, and fostering greater diversity and stability ([The Fintech Revolution, 2015](#)). Fintech companies are known for their innovation. They leverage technological advancements to facilitate new business models, streamline operational processes, and enhance the delivery of goods and services ([Zhang et al., 2021](#)).

FinTech, according to consensus among many researchers, prioritizes customer-centric solutions ([Puschmann, 2017](#)). Therefore, its focus lies in enhancing services for consumers rather than solely benefiting financial institutions ([Thakor, 2020](#)). This disruptive innovation is viewed as an opportunity to enhance transparency, consumer friendliness, and cost-effectiveness in finance. Furthermore, it is poised to revolutionize the financial industry by challenging established service providers, such as banks, insurance companies, and existing investment firms ([Buchak et al., 2018](#)). As a result, Fintech is transforming the finance services sector by providing products that are more customized to consumers’ requirements while maintaining lower costs ([Arner et al., 2020](#); [Hoffmann et al., 2020](#); [Philippon, 2019](#); [Thakor, 2020](#)). Hence, experts believe that it has the potential to bridge gaps, empower marginalized communities, and foster financial inclusion ([Breza et al., 2020](#); [Demirguc-Kunt et al., 2018](#)).

Fintech is expected to address deficiencies in payment systems and lending, particularly where traditional financial services are less accessible ([Demirguc-Kunt et al., 2018](#); [Fuster et al., 2019](#)). In fact, Small and Medium-sized Enterprises (SMEs) are among the entities that receive inadequate attention from traditional banks ([Erdogan, 2019](#)). According to [Bowmaker-Falconer and Herrington \(2020\)](#) and [Omer \(2016\)](#), external funding remains a persistent challenge for the majority of SMEs. As reported in the World Economic Forum ([2021a, 2021b](#)), SMEs face difficulties in accessing funding as well as low levels of financial slack resources. The funding gap for these businesses was due to their high risk and low profitability perceived by the traditional lenders. These challenges within SMEs hinder their ability to generate employment, contribute to National Income (GDP) growth, and maintain long-term sustainability ([Mutoko et al., 2017](#)). Meanwhile, the SMEs are the major drivers of economic activity, as well as social and environmental progress around the world. According to the [Future Readiness of SMEs \(2021a, 2021b\)](#), SMEs represent around 90% of businesses globally and up to 70% of employment worldwide. The World Bank estimates SMEs contribute up to 40% of GDP in emerging markets and developing countries.

In emerging markets, SMEs encounter several challenges intrinsic to their nature when accessing loans, including a lack of collateral, a funding gap, and inadequate financial records. The same study estimates that 65 million firms, that represent 40% of formal Micro, Small and Medium Enterprises (MSMEs) in developing countries, have an outstanding financial need of \$5.2

trillion every year, which corresponds to 1.4 times the current level of the MSME lending worldwide ([Future Readiness of SMEs, 2021a, 2021b](#)). The unmet demand of the SMEs in developing countries has begun to raise the interest of fintech companies. For instance, investor funding for fintech startups in the Middle East, North Africa, and Pakistan (MENAP) has more than quadrupled from nearly \$200 million in 2020 to approximately \$885 million in 2022 ([Fintech in MENAP, 2023](#)).

In Africa, the number of tech startups tripled between 2020 and 2021 reaching approximately 5,200 companies. Nearly half of these startups operate in the fintech space, actively disrupting and enhancing conventional financial services. African fintech companies have already achieved substantial market presence, generating estimated revenues of \$4 billion to \$6 billion in 2020 ([Fintech in Africa, 2022](#)). In Morocco, fintech has been growing rapidly despite being in its early stages. According to the report '[Fintechs Across the Arab World](#)' (2020), Morocco stands as the 3rd largest hub of fintech in the Arab world as of 2020.

The growth of fintech has played an enormous role in democratizing financial services and accelerating financial inclusion for SMEs worldwide. Many fintech companies are making progress in promoting financial inclusion within their customer base ([Cambridge Centre of Alternative Finance, 2022](#)). A major part of their customer base consists of SMEs that face challenges in accessing financial services.

Despite intensified endeavors to establish inclusive financial systems in both developed and emerging economies, research in this domain remains limited, largely due to the challenges associated with empirical measurement ([Sha'ban et al., 2020](#)). Indeed, additional empirical studies are crucial, especially in emerging countries ([Van et al., 2021](#)). The exploration of financial inclusion for SMEs and the analysis of Fintech's impact in this domain, especially in the African landscape, are still in their early stages, mainly focusing on income inequality, and neglecting the business gap faced by SMEs. Research in this area can illuminate the distinctive challenges and opportunities encountered by these economies, thereby providing valuable insights for the formulation of more effective policies and strategies.

Therefore, this paper aims to explore and comprehend the impact of fintech in African countries. Specifically, it focuses on how fintech influences the financial inclusion of SMEs, considering their challenges in accessing funding, and aims to identify key success drivers in the African landscape.

This study addresses the following key Research Question (RQ):

RQ: How can the financial services of fintech companies contribute to achieving financial inclusion for small and medium-sized enterprises in Africa?

To provide more concrete insights and actionable recommendations, this study will delve into a complementary question (CQ):

CQ: What are the main factors that influence financial inclusion of SMEs?

Based on these research questions, this study formulates the following hypotheses to structure the investigation and provide a framework for empirical analysis:

Hypothesis 1 (H1): The financial inclusion of SMEs in Africa is significantly influenced by key factors, amongst which are regulation, digital infrastructure, and banking ecosystem.

Hypothesis 2 (H2): A supportive regulatory framework and a well-developed fintech ecosystem positively impact the accessibility of financial services for African SMEs?

To address these inquiries and assess the impact of fintech on financial inclusion, this study relies on data from credible sources, including the World Bank. Using an exploratory approach of analyzing data from different African countries, looking at the impact of Fintech services as well as macroeconomic variables, financial sector indicators, and digital infrastructure. Our primary contribution to the existing literature lies in identifying the critical priorities related to Fintech within the African context, with the aim of bridging the financial inclusion gap for SMEs.

Literature Review

SMEs Role and Difficulties

In today's interconnected economies, small and medium-sized enterprises (SMEs) play a pivotal role. They serve as the main drivers of income generation, job creation, and reduction of unemployment. However, SMEs face significant challenges in their development, particularly when it comes to accessing financial resources. The aftermath of the global crisis has exacerbated this issue, making it even more challenging for businesses to secure funding. Several factors contribute to this difficulty, including the business environment, market risks, the prevalence of informality (Voordeckers & Steijvers, 2008), a rise in non-performing loans, heightened demands for collateral, and the absence of a diversified portfolio (Wilson et al., 2007). These combined hurdles make it more challenging for businesses to secure the necessary funding for their operations and growth.

According to the pecking order theory, SMEs leaders tend to prioritize internal sources of financing over external ones (Myers & Majluf, 1984). This preference is driven by several factors:

Bankruptcy Costs: SMEs perceive external debt as having higher bankruptcy costs compared to using their own internal funds. In other words, they believe that taking on external debt may increase the risk of financial distress and potential bankruptcy.

Control and governance: By relying on internal financing (such as retained earnings), SMEs maintain greater governance over their operations and decision-making. External financing often comes with conditions and covenants that could limit their autonomy.

Fiscal Disparities: SMEs recognize that the cost of equity (raising funds through issuing shares) is generally higher than the cost of debt (borrowing). Since interest payments on debt are tax-deductible, debt financing is often more attractive from a tax perspective.

Furthermore, according to agency theory (Jensen & Meckling, 1976) and research by Gasse and D'Amours (2000), the inadequacy of resources for assessing risks faced by SMEs influences the decisions made by banks. This situation arises due to the significant information asymmetry

and the inability of these enterprises to generate shareable and transparent information. Consequently, this risk assessment process leads to conflicting interests between banks and SMEs. While SMEs aim to manage profitability while maintaining a fixed risk level, banks prioritize risk control by emphasizing profitability. Both parties remain committed to achieving their goals and attaining the desired level of profitability (Sarasvathy et al., 1998).

In developing countries, it is widely acknowledged that SMEs encounter substantial obstacles when attempting to access formal credit. As a consequence, these firms exhibit (Beck et al., 2007) significantly lower rates of credit availability, thereby reducing financial inclusion compared to their counterparts in advanced economies (Beck & DemirgüçKunt, 2006; Beck et al., 2007; Epstein & Finkelstein Shapiro, 2021). The challenge is exacerbated by a multitude of internal and external obstacles. These include corruption, technological limitations, and inadequate infrastructure, all of which impede the process of financial inclusion. Furthermore, barriers on both the supply and demand sides significantly affect the financial inclusion of SMEs (Blancher et al., 2019).

SMEs in Africa constitute over 90 percent of all enterprises. Among these, approximately 70 to 80 percent fall into the category of micro and very small enterprises (Wamba, 2013). However, the funding of SMEs activities has consistently been a significant issue for business leaders and political authorities, regardless of whether they are in developing or developed nations (Founanou & Ratsimalahelo, 2011; Levratto et al., 2001). The World Bank Group revealed in its study 'Small Businesses Adapting to Rapidly Changing Economic Landscape' (2021) that 35.7% of small enterprises and medium-sized enterprises perceive access to finance as a significant hindrance to their business development.

Only 22% of firms in Africa have a loan or line of credit, compared to 43% in other developing economies, as sourced from the World Bank's Enterprise Surveys. This information is detailed in the World Bank Policy Research Working Paper titled What Have We Learned from the Enterprise Surveys Regarding Access to Credit by SMEs?¹. Additionally, the African Development Bank's Economic Report on Africa 2020 provides insights into the challenges faced by small firms in Africa regarding access to external credit. The report notes that only 13% of small companies in Africa have a line of credit or loan from a financial institution, underscoring the relative disadvantage they face compared to larger firms. These sources collectively shed light on the financial constraints encountered by small and medium-sized enterprises in Africa, emphasizing the need for policies that enhance access to credit for these firms.

Despite the challenges faced by developing economies, governments, financial institutions, and relevant national and international bodies remain dedicated to promoting financial inclusion for underserved individuals and businesses. This commitment aims to strengthen the overall economy. Several obstacles lie on the way; however, developing nations are actively addressing their limitations by embracing modern financing methods for both individuals and firms. In the age of

¹ Source: World Bank. The paper analyzes firm-level data across 116 countries, highlighting the disparities in access to finance between African firms and those in other developing regions.

technology-driven global competition, digital transformation is crucial for achieving rapid economic growth (Bansal, 2014).

Fintech and Financial Inclusion of SMEs

The emergence and widespread adoption of financial technologies (fintech) gained significant momentum globally after the onset of the 2008 global financial crisis (Fintech Was Born out of the 2008 Crisis, 2022). Fintech, or financial technologies, serves as a contemporary tool aimed at promoting financial inclusion. Scholars have provided diverse definitions of fintech from various perspectives. According to Schueffel (2016), fintech is an independent industry that leverages technology to improve financial services. Fintech represents a collection of novel technologies intentionally designed and implemented to challenge the conventional methods through which financial services are provided (Ogbuji et al., 2020). Fintech represents technology-driven innovations that give rise to novel business processes, products, and models. These innovations significantly influence how financial services are provided to individuals, households, and businesses (Khera et al., 2022).

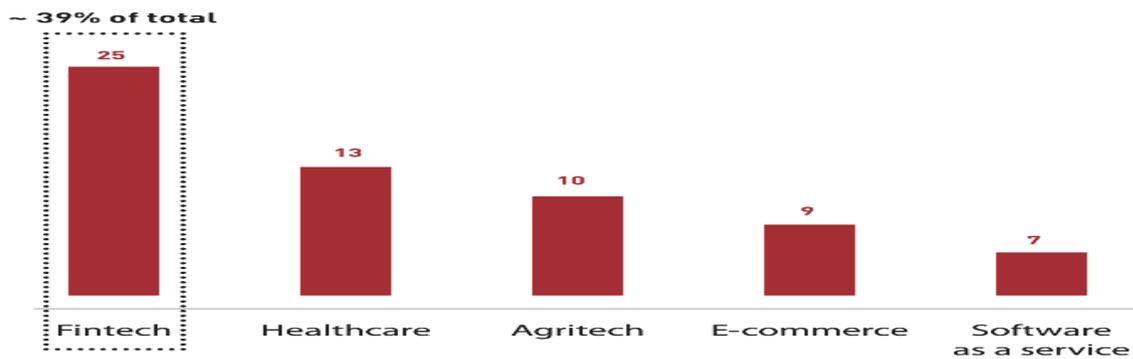
Fintech has experienced rapid growth, driven in part by several factors. These include the regulatory challenges faced by traditional banks, substantial investments from venture capitalists, an influx of technologically skilled talent, and the emergence of collaborative opportunities with established financial institutions (Kavuri & Milne, 2019). The impact of fintech is primarily driven by the utilization of big data, the internet, artificial intelligence, blockchain, cloud computing, and machine learning. These technologies have played a pivotal role in advancing peer-to-peer lending, peer-to-peer payment services, and crowdfunding activities. As a result, they have significantly improved the financial prospects of vulnerable groups and economically disadvantaged individuals (Chang et al., 2019; Kurmanova et al., 2020; Wayne et al., 2020).

Fintech companies have consistently drawn substantial investments, especially in markets with significant growth prospects, particularly in emerging economies. For instance, between 2017 and 2020, the African continent, home to at least 33 of the 47 weakest economies globally, attracted over \$2.8 billion in seed investments (The State of Fintech in Emerging Markets Report, 2021). Moreover, the sector of Fintech was the most funded sector in Africa in 2017, by fostering the biggest number of deals, surpassing healthcare, Agritech, E-commerce and Software service and reaching over 300 by end of 2017 and totaling to 39% of the total of deals funded between January and June 2017² (Finnovating for Africa, 2017), as presented in Figure 1.

² Source: Finnovating for Africa: Exploring the African Fintech Ecosystem Report 2017 by Disrupt Africa. This report includes data on fintech startups launched and tracks funding and acquisitions.

Figure 1

Number of Deals Funded by Sector in Africa from January to June 2017



Source: Finnovating for Africa: Exploring the African Fintech Ecosystem Report, [Disrupt Africa, 2017](#)

Fintech has been revolutionizing the market by offering digitalized financial solutions to both vulnerable groups and businesses to address their financial requirements ([Karsh & Abufara, 2020](#)). Digital financial inclusion encompasses the utilization of formal financial services via mobile phones and computers ([Sahay et al., 2020](#)). Between 2014 and 2017, digital financial inclusion expanded across many countries, even in cases where traditional financial inclusion faced challenges. Fintech plays a crucial role in bridging gaps in both payments and lending, particularly where conventional financial services are less accessible ([Demirguc-Kunt et al., 2018](#)). Fintech also has a complementary role alongside traditional banking services ([Fuster et al., 2019](#)). In fact, fintech, and big tech lenders specifically, cater to borrowers who have historically been underserved by banks. Fintech, or digital finance, can lead to greater financial inclusion, expansion of financial services to non-financial sectors, and the extension of basic services to individuals ([Agarwal et al., 2019](#); [Frost et al., 2019](#); [Hau et al., 2021](#)). This is especially true in developing and underdeveloped countries, where mobile phone penetration rates are very high.

Fintech has significantly impacted both MSMEs and SMEs. The advent of digital transformation and the integration of innovative technologies in financial markets have resulted in improved credit options for these companies ([Gupta, 2022](#)). According to the same study, Fintech firms have successfully reduced transaction costs and enhanced access to credit for smaller businesses by leveraging novel technologies. This improved access is facilitated by expedited creditworthiness assessments of borrowers, made possible through the application of artificial intelligence and big data analysis by fintech companies.

The financial inclusion of Small and Medium-Sized Enterprises (SMEs) is shaped by diverse factors spanning technological, infrastructural, financial, and macroeconomic dimensions. Key enablers include the adoption of financial technologies (fintech) and mobile money solutions, which enhance access to credit and improve transactional efficiency, alongside investments in digital and physical infrastructure that broaden connectivity and market access ([Fouejieu et al., 2020](#)). The efficiency and competitiveness of the banking sector significantly influence SME credit availability, further supported by credit information systems and tailored financial products. Effective regulatory frameworks, particularly those ensuring supervision and contract enforcement, reduce informational asymmetries and mitigate risks, thereby bolstering financial

inclusion. Macroeconomic indicators such as GDP per capita, investment levels, and inflation are also critical determinants, with stable conditions fostering greater confidence and resource allocation toward SMEs. These findings underscore the importance of a holistic, context-sensitive approach to narrowing the financial inclusion gap, particularly in developing economies such as sub-Saharan Africa, where financial inclusion remains limited.

Success Factors of Fintech as a Booster of SMEs Financing

The financial services industry has long been resistant to technological disruptions, resulting in a defensive economic stance. The dot-com boom, which occurred in the past, further showed the resilience of incumbent players ([Cutting Through the FinTech Noise, 2015](#)). Indeed, fintech emerged, disrupting the market and capturing attention. Fintech startups are increasingly directing their attention from the USA to Asia. While the USA has historically been the preferred destination for scaling up, Europe and Southeast Asia now offer comparable advantages, including a substantial market, an abundant talent pool, access to capital, and political stability. Notably, the average age of fintech startups reaching exit in Southeast Asia tends to be lower than that in Europe and the USA ([The future of fintech in Southeast Asia, 2020](#)).

Numerous fintech startups are exploring novel avenues to develop successful business models, enhance customer experiences, and drive transformative changes in financial services ([Gomber et al., 2018](#)). Several factors are likely to impact the success of startups in the fintech industry. These factors encompass:

Government support: Government policies play a significant role in shaping the rise and growth of fintech startups ([Haddad & Hornuf, 2019](#)). This refers to the policies and the regulatory framework, which can ensure that cutting-edge technology and a skilled hi-tech workforce are readily available to fintech ventures. Globally, governments can further support startups by providing initial capital and other financial resources, such as low-interest rates and tax incentives. Additionally, governments can foster collaboration by partnering with fintech startups on various initiatives. A notable example of such a partnership is the collaboration between the Monetary Authority of Singapore (MAS) and fintech firm Auquan for the blockchain-based Project Ubin ([The Future Is Here Project Ubin, 2017](#)).

Capital: Fintech startups rely on various funding sources to support their establishment and ongoing growth. These alternative financing channels encompass friends and family, loans, crowdfunding, angel investors, accelerators, venture capital, initial public offerings (IPOs) in public markets, and initial coin offerings (ICOs) ([Hill, 2018](#)). However, many fintech startups and small businesses face significant credit constraints due to limited access to traditional banking services, particularly in regions where financial institutions are risk-averse or lack the infrastructure to extend credit effectively. To tackle global sustainability challenges, substantial investments and a well-developed banking system are necessary for sustainable businesses that yield successful outcomes. However, these efforts often hinge on overcoming barriers to accessing affordable and sufficient credit ([Bocken, 2015](#)).

Technology adoption: Prominent big tech companies operate via technological platforms that heavily rely on robust digital infrastructure, extensive data utilization, and cutting-edge

technologies. These companies leverage their substantial resources to create seamless user interactions, often built around smartphone-based consumption that surpasses traditional business models. Notably, key players in this domain include GAFAM (Google, Apple, Facebook, Amazon, and Microsoft) and BAT (Baidu, Alibaba, and Tencent) (UPF Barcelona School of Management, 2021). Similarly, fintech companies depend on advanced digital infrastructure to support their operations and drive innovation. Critical technologies such as machine learning (ML), Internet of Things (IoT), artificial intelligence (AI), blockchain, and cloud computing are integral to their success (Drivers of Fintech Industry, 2020). Access to reliable digital infrastructure, including high-speed internet, secure data centers, and scalable cloud solutions, is a prerequisite for the growth and competitiveness of fintech firms, particularly in emerging markets.

In addition to the factors mentioned earlier, the primary drivers of fintech adoption include unmet demand, the competitive landscape, and shifting demographics (King & Nesbitt, 2020). In developing countries, including the African region, fintech is prospering and has had an enormous impact on the growth and on the development of SMEs. In this regard, and since Africa has distinct features from the rest of the world, digital payment and Mobile Money platforms have been the business models that have achieved great success in the region. Mobile payment services are increasingly replacing traditional development initiatives, enabling African countries to fund local industrial and agricultural projects. Notably, the mobile payment revolution has gained momentum in the region, with fintech solutions like M-Pesa playing a crucial role in enhancing financial inclusion (Ashenafi & Dong, 2022).

Macroeconomic variables such as GDP, inflation, and country-specific factors play a crucial role in shaping the financial ecosystem and determining the level of financial inclusion and business performance. GDP serves as a key indicator of economic activity, influencing consumer demand and investment flows, while inflation affects the cost of borrowing and saving, directly impacting access to credit and financial stability (Demirguc-Kunt et al., 2018). Additionally, country-specific factors, including governance quality, regulatory frameworks, and market infrastructure, significantly affect the adoption of financial innovations and the development of inclusive financial systems (Beck et al., 2016).

The adoption of fintech varies across different regions. Adoption refers to the widespread use of new applications, processes, or products. Fintech has emerged in every part of the world, including both advanced and developing countries. However, the pace of its adoption varies significantly. Understanding the forces of fintech and its strength in impacting SMEs financing not only sheds light on current developments of fintech but also allows us to anticipate the future growth trajectory.

Method

Model Framework

Our research unfolds in two distinct phases leveraging the RStudio application to drive the mathematical analysis. First, we meticulously construct the Financial Inclusion Index, which is a crucial prerequisite for quantifying the impact of various factors. This index serves as a compass, guiding us through the intricate landscape of financial inclusion among SMEs. To create the index,

we employ Principal Component Analysis³ (PCA). This statistical technique allows us to distill the richness of diverse indicators into a single composite measure.

Initially, we standardize the various indicators by normalizing them. This ensures that each indicator contributes equally to the subsequent analysis. Normalization facilitates fair comparisons across different scales and units, making the data more amenable to aggregation. Next, we employ PCA employing R Studio⁴. This technique extracts the most influential patterns from the normalized variables. By identifying the principal components, we capture the dominant variation across the indicators. These components act as a representative sub-index. Finally, we aggregate the sub-indices derived from PCA into a comprehensive final index or multiple indexes. This composite indexes succinctly summarizes the multidimensional aspects of financial inclusion, providing a holistic view of SMEs' economic participation.

In our research, we draw upon data from the World Bank's Enterprise Surveys Database. This comprehensive resource provides updated indicators on formal and informal financial services and digital payments. The most relevant to our analysis of SMEs Financial Inclusion is in the list below:

- Percent of firms using banks to finance investments
- Proportion of investment financed by banks
- Percent of firms using banks to finance working capital
- Proportion of working capital financed by banks
- Percent of firms with a checking or savings account
- Percent of firms with a bank loan/line of credit

In our process of constructing the Financial Inclusion Index, we take several crucial steps to ensure robustness and comparability. To mitigate the impact of extreme values, we apply winsorization to each series of variables. This technique trims extreme values, preventing them from disproportionately influencing the subsequent calculations. We normalize the winsorized indicators to a common scale between 0 and 1.

Subsequently, we construct the SME Financial Inclusion Index using PCA. This approach ensures impartiality and captures the multidimensional aspects of financial inclusion. The resulting subindices, weighted by squared factor loadings, form a comprehensive representation of SMEs' economic participation. The final index is formed by summing the underlying series, with weights derived from PCA. These weights precisely capture each series' impact on the specific sub-index's variation.

³ PCA is a statistical technique used to reduce the dimensionality of datasets while preserving as much variability as possible by transforming correlated variables into a smaller number of uncorrelated components (Jolliffe & Cadima, 2016).

⁴ R Studio is an integrated development environment (IDE) for R, designed for statistical computing, data analysis, and visualization, with tools for debugging and integration with data science packages.

$$SMEs_FI_{it} = \sum_{j=1}^n wI_{it} \quad (1)$$

Where SMEs_FI represents the SMEs Financial Inclusion index, w is the weight related to each feature and is the result of PCA, where I indicates one of the six features assimilated into financial inclusion, and *i* and *t* are the country and the time, respectively.

The sub-indices are then aggregated into a higher-level SME Financial Inclusion index, capturing the first explicative components.

Finally, after finding the SMEs_FI index, we proceeded with Regression. This model is well-suited to our research because it helps us get the full picture of how the different indicators impact and participate in the SMEs financial inclusion, and also because of the nature of our data, which is not fully balanced. We also apply PCA to the data extracted from reputable sources to eliminate multicollinearity issues, add dummy variables for Country and Year, and then proceed with the regression analysis.

$$SMEs_{FI_{it}} = \beta_0 + \beta_1 \text{Mobile Money} + \beta_2 \text{Digital Infrastructure} + \beta_3 \text{Banking System} + \beta_4 \text{Credit Constraints} + \beta_5 \text{Regulation} + \beta_6 \text{GDP per Capita} + \beta_7 \text{Investment} + \beta_8 \text{Inflation} + \lambda \text{Country Dummy} + \varepsilon_{it} \quad (2)$$

Where SMEs_FI represents the SMEs Financial Inclusion index for country *i* in time period *t* and Mobile_Money, Digital_Infrastructure, Banking_System, Credit_Constraints, Regulation, GDP_per_Capita, Investment and Inflation are the independent variables for country *i* in time period *t*. Country Dummy are the dummy variables for the different countries. β_0 is the intercept term, $\beta_1, \beta_2, \dots, \beta_9$ are the coefficients for the independent variables, and ε_{it} is the error term.

Data

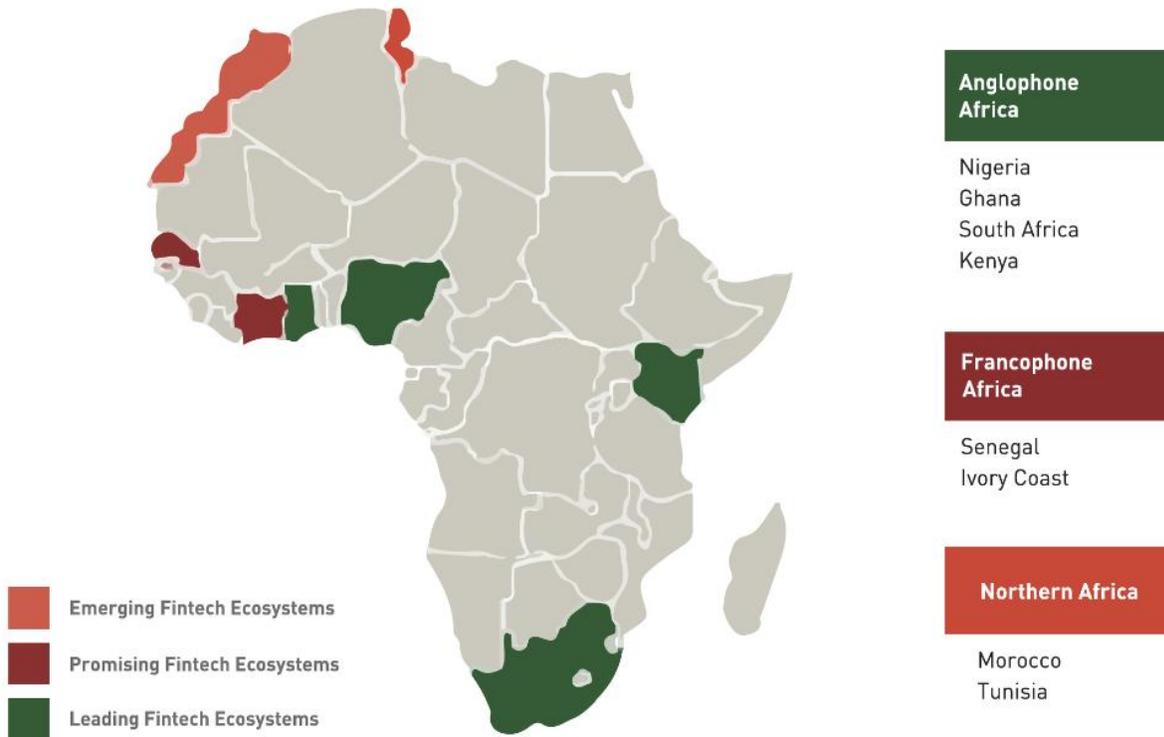
This research primarily relied on reliable data from various sources for the period 2011-2021. Our primary sources of data are the World Bank Enterprise Surveys (WBES), the Global Findex Database (Findex), and the International Monetary Fund (IMF). We also leveraged data from Netcraft for the digital infrastructure data. These databases were the most tailored to our analysis for multiple reasons. WBES data enables us to contextualize Fintech adoption within the broader business landscape, whereas Findex provides insights into access to financial services, digital adoption, and behaviors across diverse populations and IMF data encompasses macroeconomic indicators, exchange rates, and policy frameworks. It contextualizes Fintech within broader economic dynamics.

In our study, focused on the African context, we selected ten countries for our analysis. These specific nations were chosen based on benchmarking against analyses conducted by reputable

agencies such as McKinsey and PwC. Our aim was to capture the most developed African countries in terms of Fintech prosperity to ensure a rich study and availability of data. In [Figure 2](#), we showcase the African Fintech ecosystem map, which categorizes countries based on their Fintech Ecosystems.

Figure 2

African Fintech Ecosystem Categorization of Country Development Stages in Fintech



Source: Digitalizing Africa, CFC and PWC, 2021

The selected African countries included in the analysis are Côte d'Ivoire (Ivory Coast), Egypt, Ghana, Kenya, Morocco, Nigeria, Senegal, South Africa, Tunisia, and Uganda. In the African context, Fintech companies operate within an environment characterized by limited technological infrastructure, and they predominantly rely on straightforward technologies. Hence, African Fintechs focus primarily on pragmatic solutions related to payments and transfers ([Casablanca Finance City and PWC, 2018](#)).

In the light of the above, we focus our analysis on data related to payment systems and mobile money services, tailoring it to the specificities of Fintech firms and SMEs in the African context. Our main indicators are Financial Inclusion, which is the result of PCA analysis combining a complex, multidimensional set of eight features, fintech-related data, and macroeconomic data gathered from the sources listed in [Table 1](#).

Table 1
Independent Variables Description

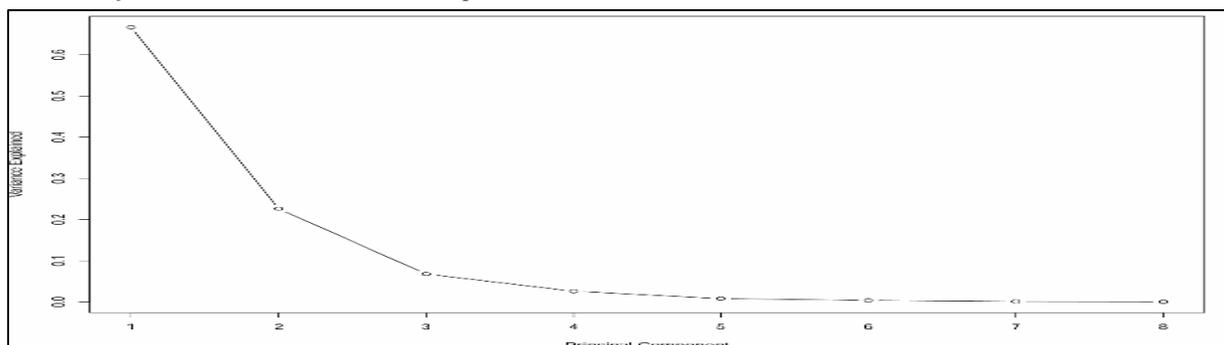
	Variable Definition	Source
Financial Inclusion	PC1 + PC2	Principle Component Analysis (PCA)
Mobile Money Services	Number of registered mobile money accounts	Global Findex Database (Findex)
Digital Infrastructure	Secure Internet servers	Netcraft
	Saved at a financial institution (% age 15+)	Global Findex Database (Findex)
Banking System	SMEs with an outstanding loan or line of credit (%)	Global Findex Database (Findex)
	SMEs with an account at a formal financial institution (%)	Global Findex Database (Findex)
Credit Constraints	Percent of firms identifying access to finance as a major constraint	World Bank Enterprise Surveys (WBES)
Regulation	Mobile Money regulatory index (0-100)	Global Findex Database (Findex)
GDP per Capita	Gross domestic product per capita, current prices	International Monetary Fund (IMF)
Investment	Total investment	International Monetary Fund (IMF)
Inflation	Inflation, end of period consumer prices	International Monetary Fund (IMF)

The challenge that we could face in the data collection phase is identifying a homogenous and consecutive set of data. In African countries, most data are recent, as there haven't been historical surveys taking place and unbalanced between the different countries.

Results and Discussion

The outputs from Equation 1 of the Principal Components Analysis (PCA) constitute the Financial Inclusion Indexes, offering valuable insights into the fintech landscapes across African nations and their impact on the financial well-being of SMEs. The cumulative variance of the components was analyzed to identify the most significant indexes and determine the number of components included in the model. The analysis revealed that the Financial Inclusion Index is effectively represented by the first two principal components (PC1 and PC2), which account for 89% of the variance in the SME financial inclusion metric, as illustrated in [Figure 3](#).

Figure 3
Variance of Financial Inclusion Index Components

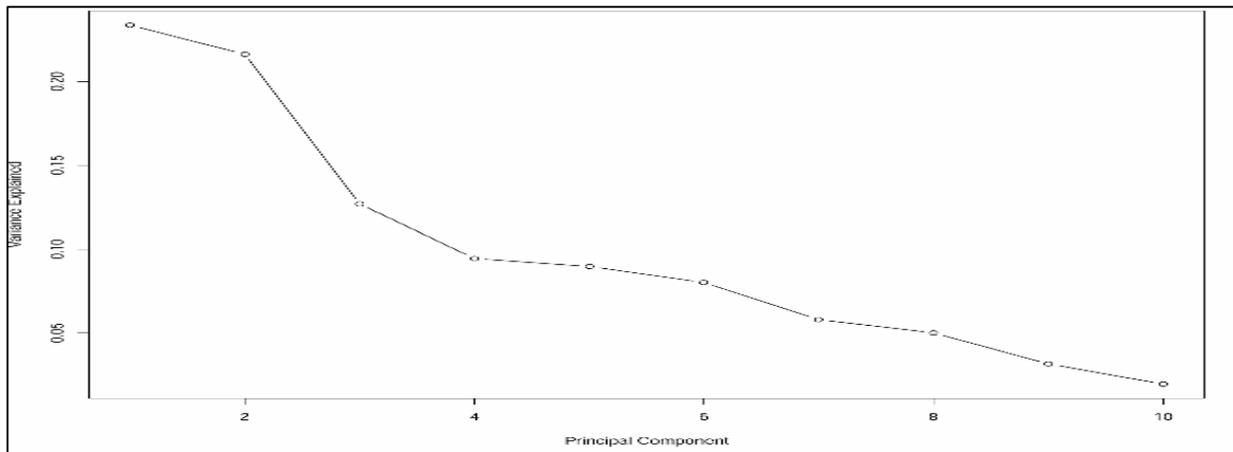


Source: author, via R studio

The data was subsequently prepared for regression analysis by applying Principal Components Analysis (PCA) to the variables presented in the preceding table. PCA addressed multicollinearity among predictors by transforming correlated variables into a set of uncorrelated principal components while retaining the interpretative value and meaning of the original indicators. Additionally, it reduced the dataset's dimensionality while preserving the majority of its variance. For this study, six principal components were selected, collectively capturing 76% of the variance. A visual representation of these components is provided in [Figure 4](#).

Figure 4

Variance of Independent Variables Components from PCA



Source: author, via R studio

Equation 2 represents the regression model, which incorporates a range of indicators addressing various dimensions of financial inclusion. The two dependent variables are derived from the initial PCA model and represent composite indexes encapsulating the level of financial inclusion for SMEs. These indexes include metrics such as access to credit and the utilization of banking services. The independent variables, also extracted through PCA, along with their corresponding coefficients, serve as explanatory indicators for the dependent variables, offering insights into the determinants of SME financial inclusion.

The regression analysis provided valuable insights into the determinants of SME financial inclusion by linking synthesized factors and country-specific effects to the financial inclusion index. [Figure 5](#) illustrates the estimated coefficients resulting from the regression model. The detailed regression results are presented in the [Appendix](#) through three tables.

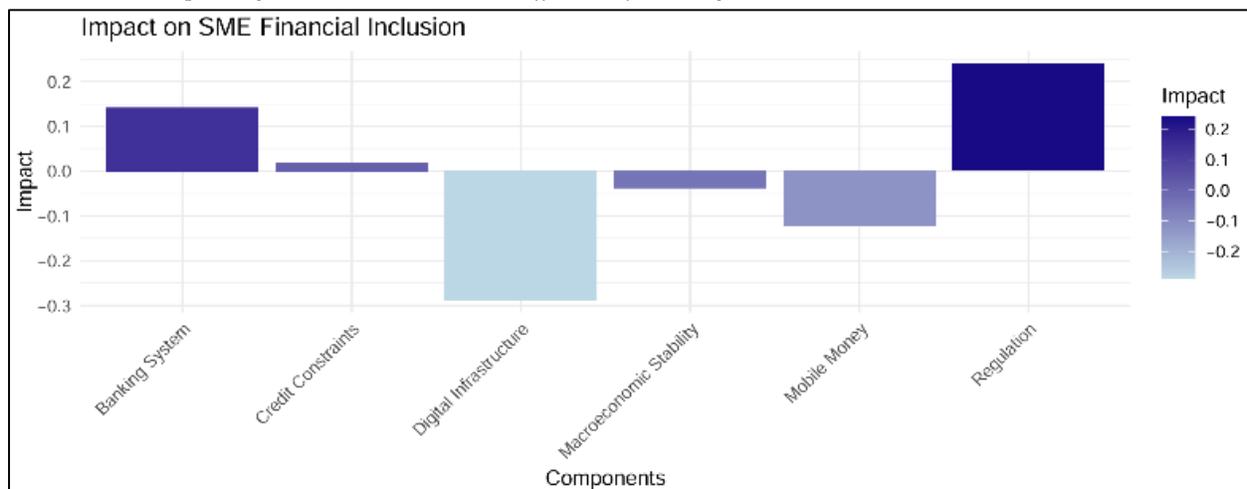
The analysis revealed that deficiencies in economic and digital infrastructure, including poor connectivity, low GDP per capita, and insufficient investment levels, significantly hinder financial access for SMEs by limiting the adoption of financial technologies and restricting integration into formal financial systems. Macroeconomic instability, particularly inflation, further undermined the potential benefits of mobile financial services, reducing their overall impact on financial participation. Access to formal banking services, such as bank accounts and credit lines, emerged as a vital contributor, with SMEs enjoying significantly higher levels of financial inclusion when these resources were available. Additionally, targeted investments addressing structural barriers,

such as inadequate credit access and regulatory challenges, positively influenced SME financial inclusion. These findings underscore the critical need to address structural deficiencies, foster macroeconomic stability, and invest in accessible financial and digital infrastructure to enhance the participation of SMEs in formal financial systems.

Significant cross-country variations in SME financial inclusion were observed, with some nations benefiting from favorable financial ecosystems and supportive regulatory frameworks that facilitated high levels of inclusion. In contrast, countries with structural deficiencies or underdeveloped financial systems faced substantial barriers to integrating SMEs into formal financial channels. These findings highlight the critical need for context-specific policy interventions that address the unique needs and constraints of individual countries to effectively promote financial inclusion.

Figure 5

Main Factors Impacting Financial Inclusion, Coefficients from Regression via R Studio



Source: author, via R studio

This study offers a comprehensive analysis of the factors influencing SME financial inclusion by combining advanced statistical methodologies with a context-sensitive approach. The findings reveal critical challenges, including inadequate digital and economic infrastructure, suboptimal utilization of mobile financial services, and macroeconomic instability. Simultaneously, the study underscores the significant contributions of formal financial services, strategic investments, and conducive policy frameworks in advancing SME financial inclusion.

The findings of this study carry important implications for policymakers and stakeholders. Promoting SME financial inclusion necessitates a multifaceted strategy that reinforces both traditional and digital financial systems, mitigates the effects of macroeconomic instability, and implements targeted interventions to overcome country-specific challenges. This research provides a strong foundation for designing tailored policies that foster SME growth and integration into financial systems. Future studies can expand upon this framework by exploring additional variables and refining the understanding of the factors that influence SME financial inclusion.

Conclusion

This study employed a comprehensive analytical framework to evaluate the factors influencing SME financial inclusion, with a particular focus on African enterprises. The analysis revealed significant barriers stemming from inadequate economic, digital, and financial infrastructure. Deficiencies such as poor internet connectivity, low GDP per capita, and insufficient investment hinder the ability of African SMEs to adopt financial technologies and access formal financial systems. Addressing these structural challenges is essential for fostering a more inclusive financial ecosystem in the region, underscoring the critical need for targeted improvements in economic and digital infrastructure.

Mobile financial services have significant potential to enhance financial inclusion; however, their impact is often diminished by economic instability, particularly inflation, which undermines their advantages and reduces financial participation. Ensuring macroeconomic stability is, therefore, crucial to fully realizing the benefits of mobile financial solutions. Access to traditional banking services, such as bank accounts and credit lines, also plays a critical role in financial inclusion, with African SMEs that utilize these services demonstrating greater integration into the financial system. These findings underscore the importance of establishing a reliable banking infrastructure. Additionally, targeted investments aimed at addressing financial barriers, such as restricted credit access and regulatory obstacles, are essential for promoting greater SME engagement with the formal financial system.

The analysis revealed significant disparities in SME financial inclusion across African countries. Nations with well-developed financial ecosystems and supportive regulatory frameworks exhibit higher levels of SME inclusion, whereas those with structural challenges and underdeveloped financial systems encounter greater barriers to SME inclusion. These findings underscore the importance of tailoring policies to address the specific economic and institutional needs of individual countries, ensuring that interventions effectively target the unique obstacles they face.

Advancing SME financial inclusion in Africa necessitates a multifaceted strategy. Key priorities include enhancing digital and economic infrastructure, ensuring macroeconomic stability, and expanding access to traditional banking services. Through targeted investments and tailored policy measures, African countries can address existing barriers and foster an environment conducive to SME financial inclusion, ultimately driving broader economic growth and development.

However, the study's robustness and precision can be further strengthened. Expanding the dataset to encompass a wider range of countries and additional years would provide a more comprehensive understanding of diverse economic conditions and trends. Incorporating additional explanatory variables, such as industry-specific dynamics or regional economic indicators, could yield deeper insights into the determinants of SME financial inclusion. Furthermore, introducing interaction terms and exploring nonlinear relationships among predictors can enhance the model's capacity to capture complex, multifaceted dynamics. These advancements would contribute to a more nuanced and accurate understanding of the factors shaping SME financial inclusion in Africa.

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Appendix

Table 1

SME Financial Inclusion PCA Variances

PC1	PC2*	PC3	PC4	PC5	PC6	PC7	PC8
.66	.22	.06	.02	.00	.00	.00	.00

* Cumulative variance at 89.31% for PC2

Table 2

Independent Variables PCA Variances

PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
.23	.21	.12	.09	.08	.08	.05	.05	.03	.01

Cumulative variance at 76.08% for PC6

Table 3

SME Financial Inclusion Regression Model

	Estimate Coefficient	Std. Error	t value	Pr(> t)
(Intercept)	-.73	.03	-19.48	< 2e-16 ***
Mobile Money	-.12	.01	-8.52	2.29e-13 ***
Digital Infrastructure	-.28	.01	-25.63	< 2e-16 ***
Credit Constraints	.01	.01	1.27	.204
Banking System	.14	.01	9.00	2.23e-14 ***
Macroeconomic Stability	-.03	.02	-1.47	.144
Regulation	.24	.02	8.89	3.76e-14 ***
Egypt	2.21	.05	38.25	< 2e-16 ***
Ghana	-0.45	.06	-7.40	5.23e-11 ***
Kenya	-2.08	.08	-23.44	< 2e-16 ***
Morocco	3.90	.06	59.07	< 2e-16 ***
Nigeria	4.46	.06	72.11	< 2e-16 ***
Senegal	2.93	.06	45.95	< 2e-16 ***
South Africa	0.68	.05	12.14	< 2e-16 ***
Tunisia	-4.28	.09	-43.75	< 2e-16 ***

Residual standard error: .1339 on 95 degrees of freedom

Multiple R-squared: .9976, Adjusted R-squared: .9972

F-statistic: 2810 on 14 and 95 DF, p-value: < 2.2e-16

Robust standard error.

The significance of each variable is following the Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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Conflict of Interests

No, there are no conflicting interests of the output of this research.

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