

# The Effects of the Informal Sector on Financial Inclusion in Sub-Saharan Africa: Do ICTs and Economic Freedom Matter?

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**How to cite this paper:** Timbi, S., Nkot, S. C., & Kansea, P. E. (2025). The Effects of the Informal Sector on Financial Inclusion in Sub-Saharan Africa: Do ICTs and Economic Freedom Matter? *Theoretical Economics Letters*, 15, 517-550.

<https://doi.org/10.4236/tel.2025.152029>

**Received:** February 5, 2024

**Accepted:** March 30, 2025

**Published:** April 27, 2025

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## Abstract

The objective of this study is to examine the effect of shadow economy on financial inclusion. We identify the robust effects and channels through which the shadow economy affects financial inclusion using a sample of 25 Sub-Saharan African countries over the period 2010-2018. The empirical evidence is based on fixed effects (FE) and system-Generalized Method of Moments (Sys-GMM). Our results show that shadow economy negatively and significantly affects all the dimensions of financial inclusion measured by penetration, availability, and usage of financial services as well as the financial inclusion index. These effects are mediated by Information and Communication Technologies measured by internet, mobile phones and telephone and by the institutional environment captured by economic freedom. We suggest the strengthening of telecommunication infrastructures as well as the establishment of an incentive framework in order to reduce informality in the economy for a better financial inclusion.

## Keywords

Financial Inclusion, Shadow Economy, ICT, Institutions, Sub-Saharan Africa

## 1. Introduction

Over the past decade, although Sub-Saharan Africa (SSA) has made progress in financial inclusion, it is clear that it remains low compared to the rest of the world. For example, according to a recent Global Findex report, the rate of banking has increased in SSA. It rose from 23% in 2011 to 34% in 2014 and 43% in 2017 to reach 55% in 2021 against a global average of 51%, 62% and 68% and 76% respec-

tively in 2011, 2014, 2017 and 2021 (Demirgüç-kunt et al., 2022). Conversely, between 2017 and 2021, the proportion of adults with an account increased from 95% to 97% in OECD countries; East Asia and Pacific countries achieved an increase from 70% to 81% and developing countries experienced an 8-point increase from 61% to 69%. More specifically, these disparities persist between the sub-regions in SSA. Thus, Eastern Africa recorded 54%, Southern Africa 55%, Western Africa 35% and Central Africa recorded the lowest rate of 35%. Nevertheless, a thorough analysis suggests the beginning of a certain convergence in financial inclusion in SSA (Banque Européenne d'Investissement, 2018). This progress resulted mainly from the progress made in ICT penetration in SSA countries. The 2021 data reflect SSA's continued global leadership in mobile money account ownership, with 33% of adults in the region having a mobile money account, compared to 10% of adults globally (Demirgüç-kunt et al., 2022).

Financial inclusion still remains a major priority for policy makers and researchers. After the mixed result of achieving the goal of universal financial inclusion by 2020, this goal has been reported and included in the first United Nations Sustainable Development Goal (SDG) of “*Eradicating poverty in all its forms everywhere*”. Similarly, Africa's Agenda 2063 considers financial inclusion as one of its pillars by aspiring to “*Eradicate poverty in the coming decades by enhancing investment in productive capacities (skills and assets), improving incomes, creating jobs and meeting basic living needs*”.

The literature on endogenous growth has largely demonstrated the crucial role of a financial system (Aghion & Hewitt, 2006). In fact, a developed and inclusive financial system broadens access to funds and reduces the cost of access, thereby boosting production and economic activity. Contributions from theoretical and empirical studies have shown how the financial system allocates resources, mobilizes savings, diversifies risk and energizes the economic system (King & Levine, 1993; Calderón & Liu, 2003; Echchabi & Azouzi, 2015). Development economics suggests that a better supply of financial services contributes to the development of all levels of a society.

Previous work on financial inclusion has focused on its measurements (Sarma & Pais, 2011; Demirgüç-kunt et al., 2022; Ambarkhane et al., 2020; Tram et al., 2021), its effects on poverty, inequality and growth (Ghosh & Vinod, 2017; Makina & Walle, 2019), on financial stability (Saha & Dutta, 2020), monetary policy (Elsherif, 2019; Akanbi et al., 2020) and on its determinants such as supply factors, economic and non-economic determinants of demand and institutional context (Beck & De La Torre, 2007; Guérineau & Jacolin, 2014; Nkoa & Song, 2020). These determinants of financial inclusion do not always seem to be identical from one country to another. Thus, they must be understood within a coherent logical framework of an ideal market. Very recently, studies have attempted to link financial inclusion to the informal sector (Ajide, 2021).

Over the last three decades, Sub-Saharan Africa witnessed a downturn trend in the informal sector despite its high level. As an illustration, the size of the informal

sector has declined by six points from 40.81% to 34.74% of GDP between 2004 and 2015 (Medina & Schneider, 2018) and is continuing declining from 40.6% of GDP in 2010 to 39% of GDP in 2018 (Elgin et al., 2021). The notion of informal sector is a term created by Hart (1985) and empirically highlights the dimension of a phenomenon that has grown considerably in developed societies. Still called shadow economy, grey economy, undeclared economy or informal economy, it is defined as a market-based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of GDP (Smith, 1997). Thus, the migration of informal sector actors to the formal sector is a key objective for governments. Reducing informality is among the priorities of the Sustainable Development Goals. For example, SDG 8:3 aims to “*promote development-oriented policies that foster productive activities, decent work, entrepreneurship, creativity and innovation and stimulate the growth of micro, small and medium-sized enterprises and facilitate their integration into the formal sector, including through access to financial services*”.

The informal economy, which has long been overlooked, has recently been the subject of renewed interest, due to the precision of concepts and measurement techniques and the major political, social and economic issues it raises. The analysis of the effects of the informal sector is controversial. Some researchers conclude in a negative effect of the informal sector on the economy (Jacolin et al., 2019; Déléchat & Medina, 2020) while other authors find a positive effect (Calomiris & Nissim, 2014; Rozas & Gauthier, 2012).

On the one side, a large informal sector weighs on the mobilization of domestic resources, which is essential for financing basic public services (health, education) or infrastructure projects, which are nonetheless essential for economic diversification and integration into global value chains (Jacolin et al., 2019), moreover it is detrimental to the achievement Sustainable Development Goals (Déléchat & Medina, 2020). The informal system is found to be inefficient for financing important projects (Jacolin et al., 2019). Widespread “informality” is of particular concern today, as it may make it more difficult for countries to embark on the inclusive development path that is essential to repair the damage of the COVID-19 pandemic (Yu & Vorisek, 2021).

On the other side, these negative effects of the informal sector must be put into perspective. In fact, limited access to formal financial services in SSA has led to the development of informal finance which plays an important role in financing micro-projects, micro-entrepreneurship, women’s entrepreneurship, mainstream activities and even some formal sector activities. In this vein, Rozas and Gauthier (2012) find that tontines have a positive and significant effect on employment and sales growth within firms and Besley et al. (1993) conclude that it improves welfare.

The empirical literature on the informal sector reveals three main axes. The first axis highlights the construction of indicators and the measurement of the informal sector (Schneider et al., 2010; Medina & Schneider, 2018; Elgin et al., 2021;

Estevão et al., 2022). The second wave identifies the determinants of the informal sector. From this work, it emerges that economic variables such as poverty (Berdiev et al., 2020), financial inclusion (Ajide, 2021), psychological factors (Salahodjaev, 2015) or institutional (Buehn et al., 2013) explain the informal sector. And the third axis highlights the effects of the informal sector on economic variables such as economic growth (Goel et al., 2019), quality of life (Kireenko & Nevzorova, 2015) and on meso-economic variables such as energy (Canh et al., 2021), air pollution (Dada et al., 2021; Huynh, 2020). Referring to the African context, several studies have analyzed the relationship between the informal sector and financial inclusion. First, using parametric and non-parametric approaches and the propensity score matching approach, Jacolin et al. (2019) examine the effect of mobile financial services on the informal sector and find that mobile financial services significantly reduce the size of the informal sector. Second, Ishioro (2020) analyzes the relationship between financial market inclusion, the informal sector and the economic growth paradigm in the least developed economies. He finds that the informal sector has facilitated the growth process of financial market inclusion performance in Nigeria. Furthermore, the short-run results indicate that only the lagged value of the informal market explains financial market inclusion in Nigeria. Finally, Ajide (2021) analyzes the possible relationship between financial inclusion and the informal sector in selected African countries. He finds that financial inclusion reduces the size of the informal sector and that low corruption and high economic growth coupled with financial inclusion reduces the informal sector. Furthermore, he finds direct causality from financial inclusion to the informal sector.

From the above, it appears, to the best limit of our knowledge, that only the direct causality from financial inclusion to the informal sector has been studied. Hence, the objectives of this paper are twofold and constitute its originality. First, it investigates the effect of the informal sector on financial inclusion in SSA. Specifically, it analyzes the direct effect of the informal economy on financial inclusion. Second, it examines the channels through which the informal sector affects financial inclusion. For a more detailed analysis, we focus on the channels of Information and Communication Technologies (ICT) and economic freedom. Indeed, ICTs have been growing rapidly in recent years in SSA and are playing an increasingly important role in the development of all segments of economic activity, and economic freedom is an important pillar for the formalization of economies. Economic freedom is one of the foundations on which financial contracts are built and reflects the quality of doing business in an economy. Through its dimensions, economic freedom strengthens trust between economic agents by protecting property rights and promoting financial freedom, all of which can affect the informal sector and enhance financial inclusion.

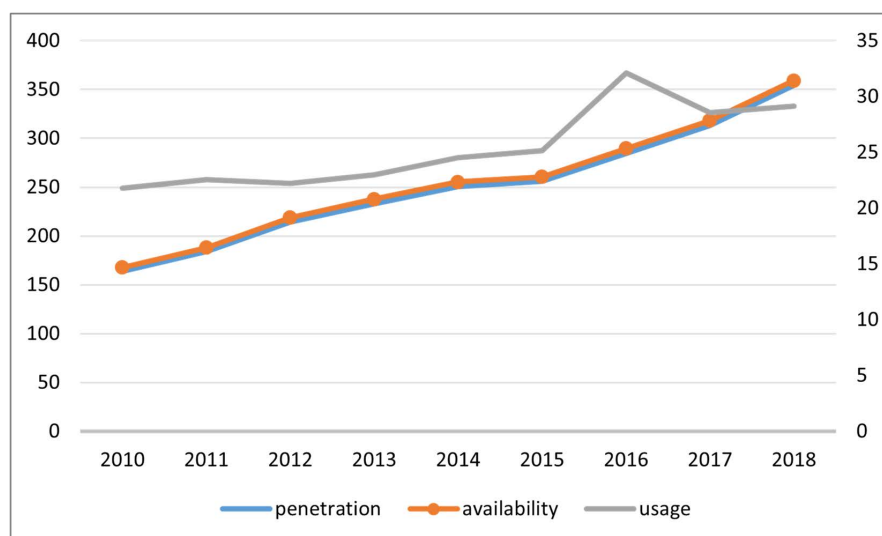
The rest of the paper is structured as follows. Section 2 displays some stylized facts, including the trend in financial inclusion, the informal sector and the correlation between the two phenomena in SSA. Section 3 reviews the related theo-

retical and empirical literature. Section 4 describes the econometric strategy. Section 5 discusses the results; and section 6 concludes this study.

## 2. Stylized Facts

This section focuses on analyzing the stylized facts about financial inclusion, the informal sector and the correlation between financial inclusion and the informal sector in SSA.

### 2.1. Increasing of Financial Inclusion in Sub-Saharan Africa



Source: Authors from IMF financial Access Survey database (2022).

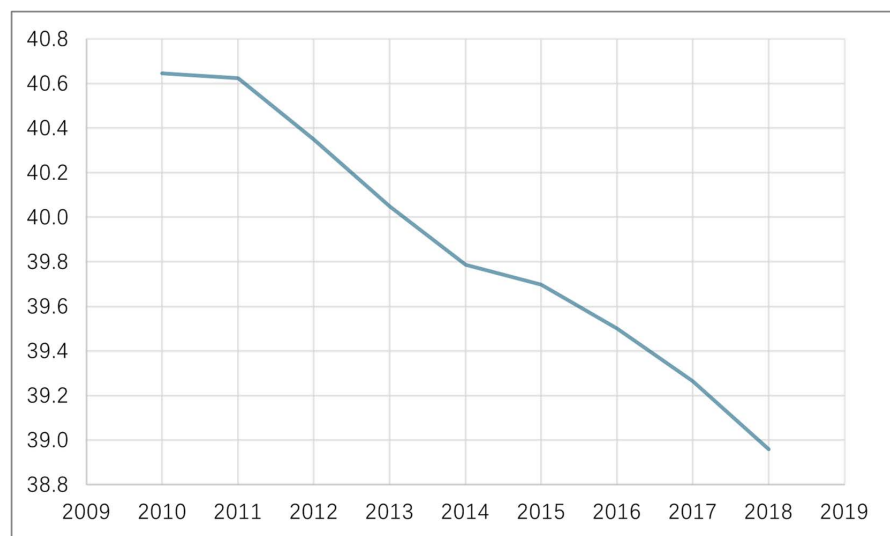
**Figure 1.** Evolution of financial inclusion.

**Figure 1** shows the evolution of the dimensions of financial inclusion in Sub-Saharan Africa between 2010 and 2018. In terms of financial service penetration, the number of commercial bank account holders per 1000 adults increased from an average of 164 adults in 2010 to 354 in 2018. Regarding the availability of financial services, the number of commercial bank branches per 100,000 adults increased on average from about 3.87 in 2010 to 4.89 in 2018. Finally, with respect to the use of financial services, the outstanding deposit with commercial banks increased on average from 21.80% of GDP in 2010 to 29.11% of GDP in 2018. The low level of financial inclusion in SSA compared to other regions can be explained by individual factors such as age, gender, level of education, wealth, GDP growth rate and presence of financial institutions or quality of institutions. However, the performance recorded in terms of financial inclusion seems to be the result of the introduction of ICTs and especially of financial technologies. In this vein, the share of the adult population in SSA that has used the internet to pay for something in the last year has increased from 6% in 2017 to 17% in 2021. The number of credit and debit card holders increased from 7% in 2017 to 12% in 2021. However, disparities persist among SSA countries. For example, some countries have very high (Kenya,

73%; Uganda, 50%), high (Botswana, 22%; Burkina Faso, 31%; Ethiopia, 36%; Ghana, 35%, Mali, 21%; Namibia, 39%; Rwanda, 30%; Senegal, 28%, Tanzania, 38%), low (Cameroon, 11%; Guinea, 10%; Madagascar, 10%), and very low (Sierra Leone, 8%; Niger, 7%; Republic of the Congo, 8%; Burundi, 1%) mobile account penetration rates.

## 2.2. Downtrend of the Informal Economy in SSA

**Figure 2** displays the evolution of the informal sector in SSA and shows that this rate has declined slightly between 2010 and 2018. The average annual rate of the informal sector as a percentage of GDP fell from 40.6% in 2010 to 39% in 2018. However, disparities can be noted between countries. For example, Nigeria and Gabon have the highest informality rates at 56.84%, while Namibia has the lowest rate in SSA at 28.97% (Elgin et al., 2021). The preponderance of the informal sector in SSA is generally due to the economic environment, regulatory, legal and policy frameworks and some micro-factors, such as low education, discrimination, poverty, lack of access to economic resources, property, financial and other business services, and markets.



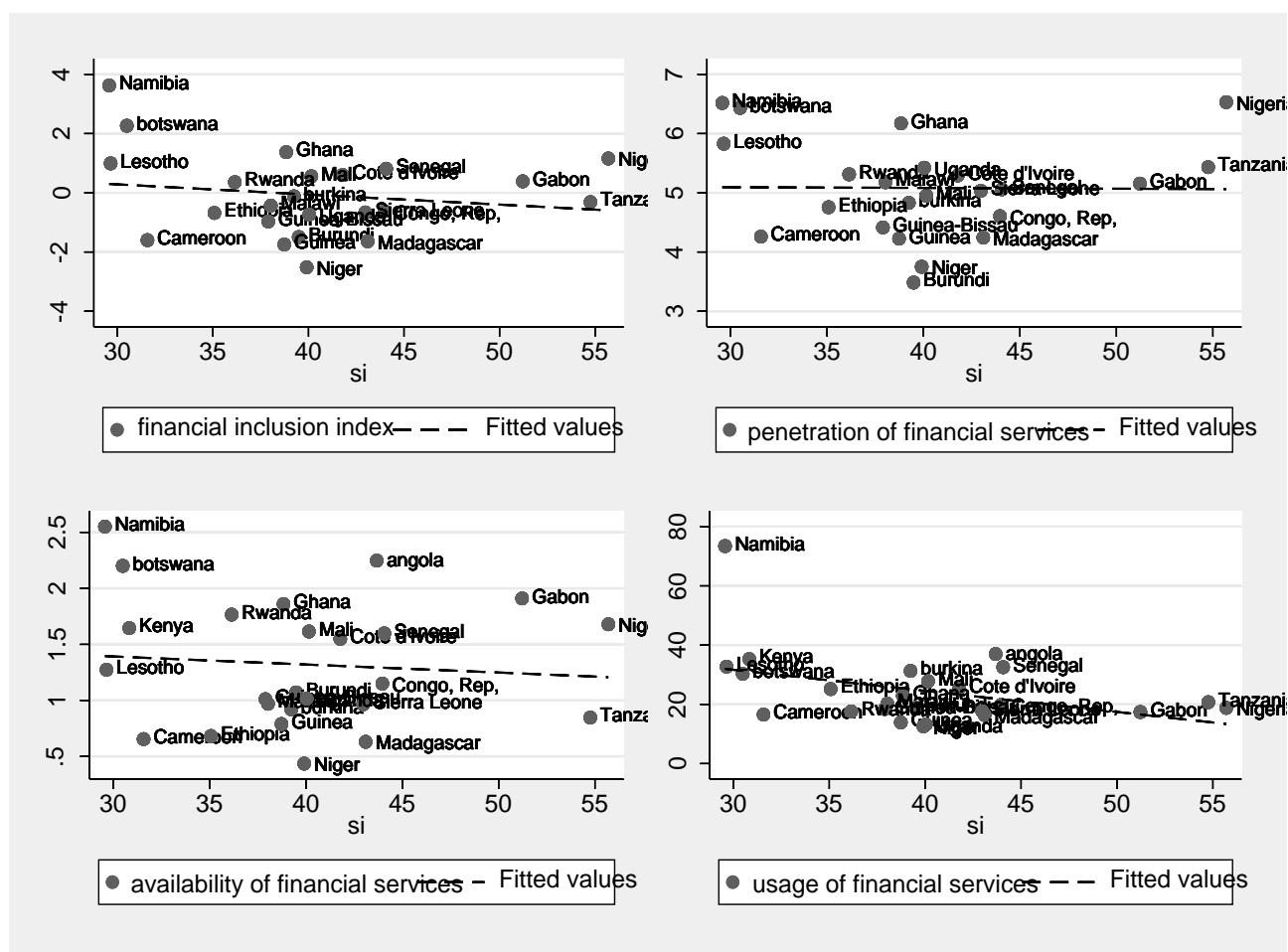
Source: Authors from Elgin et al. (2021).

**Figure 2.** Evolution of shadow economy.

## 2.3. The Informal Economy Is Negatively Correlated with Financial Inclusion in SSA

**Figure 3** shows that the informal sector is negatively correlated with different dimensions of financial inclusion in SSA. Indeed, the larger the informal sector of an economy, the less likely it is that governments will be able to mobilize the revenues to build the necessary infrastructure in terms of improving education, health, physical infrastructure (roads, ICT, etc.) that would boost financial inclusion. Moreover, the less informal an economy is, the easier it is for banks to collect funds from depositors and thus increase the accessibility, availability and use of

financial services. An informal economy characterized by informal finance is sometimes too expensive for users with the practice of usury rates. Thus, migration to the formal sector is likely to increase the demand for financial services.



Source: authors from Stata 16.0.

**Figure 3.** Correlation between financial inclusion dimensions and shadow economy.

### 3. Literature Review and Theoretical Positioning

Far from providing a complete picture, the literature identifies four groups of theories that make it possible to analyze financial inclusion. First, the so-called traditional theories include the theory of financial intermediation (Diamond, 1984), the theory of credit rationing and exclusion from financial markets (Keynes, 1930; Jaffee & Modigliani 1969; Stiglitz & Weiss, 1981), the theory of transaction costs (Coase, 1937), the theory of economic development (Boyd & Smith, 1998) and the theory of capabilities (Sen, 2000). The second group highlights the so-called modern theories that incorporate the possibility theory of access boundaries and theories of access barriers (Beck & de la Torre, 2007). The third group can be attributed to the seminal and synthetic work of Ozili (2020) which highlights three other modern theories such as the beneficiary theory of financial inclusion, the

financing theory of financial inclusion and the supply theory of financial inclusion. Finally, the fourth group relates to the work of [Ahmad Malik and Yadav \(2022\)](#). Indeed, [Ahmad and Yadav \(2022\)](#) develop four groups of theories related to financial inclusion. First, theories that provide an in-depth understanding of income, savings and other determinants. Second, theories that deal with individual perspectives and their relevance to financial inclusion. The third group deals with the sociological perspective and the fourth highlights institutional factors. Furthermore, the view of financial dualism, which assumes that in the long run informal finance tends to disappear, giving way to formal finance, has opened up the debate on the relationship that can exist between the informal and financial sectors ([Ghate, 1992](#)).

The theoretical anchoring of the effects of the informal sector on financial inclusion goes back at least to the cost-benefit theory of crime or the economics of crime ([Becker, 1968](#)), the interest rate hypothesis ([Williamson, 2004](#)) or the information asymmetry ([Di Giannatale et al., 2013](#)) due to the fact that economies operate in formal or informal markets. The cost-benefit theory of crime posits that rational economic agents evaluate the benefits and costs of involvement in underground economic activities and the resulting detection and punishment. Thus, rational economic agents would weigh the perceived benefits (avoiding obnoxious/heavy taxes, rigid government regulations, and impoverishing controls) against the immoderate/opportunity costs of operating informally (financial costs associated with detection and apprehension, foregoing access to official sector tax refunds). According to [De Soto \(1989\)](#), informality generally leads to two kinds of costs; first, penalties when the informal activity is detected, and the inability to take full advantage of government provided goods. The second cost of informality is the inability to take full advantage of government provided goods, in particular the legal and judicial system and the police. These theories have given rise to three streams.

Firstly, the dualist approach, which follows on from the work of [Lewis \(1954\)](#) and [Harris & Todaro \(1970\)](#). This approach is based on a dual labor market model, in which the informal sector is considered as a residual component of this market that is not linked to the formal economy; it is a subsistence economy that exists only because the formal economy is unable to provide sufficient jobs. Secondly, unlike the previous approach, the structuralist approach emphasizes the interdependence between the informal and formal sectors; according to this Marxist-inspired approach, the informal sector is integrated into the capitalist system in a subordinate relationship; by providing cheap labor and products to formal enterprises, the informal sector increases the flexibility and competitiveness of the economy. Finally, the legalist approach considers that the informal sector is made up of micro-entrepreneurs who prefer to operate informally in order to escape from public regulations that are considered as suffocating; this liberal approach contrasts with the two previous ones, insofar as the choice of informality is voluntary and linked to the excessive legalization costs associated with formal status and registration.

### 3.1. Informal Economy and Financial Inclusion: An Empirical Synthesis

There are at least three main directions for analyzing the effects of the informal economy on financial inclusion. The first wave sheds light on direct effects by addressing either unidirectional or bidirectional causality. [Ajide \(2021\)](#) investigates the possible relationship between financial inclusion and the informal economy in selected African countries. The study uses panel data estimation technique and Toda and Yamamoto causal approach on data from selected African countries over the period 2005 to 2015. The results show that financial inclusion reduces the size of the informal sector. The causality results show that there is a unidirectional causality from financial inclusion to the informal sector. Thus, a country with a low level of corruption and a high level of growth may benefit more from reducing the size of the informal sector through financial inclusion.

[Gobbi and Zizza \(2012\)](#) studied the relationship between the informal economy and the development of the financial sector in the Italian debt market during the period 1997-2003 and found that the informal economy prevented the development of the financial sector, but that the development of the financial sector had no statistical impact on the informal economy.

[Bose et al. \(2012\)](#) studied the interaction between the informal economy and improvements in the banking sector in 137 countries over the period 1995-2007 using panel regression and found a negative relationship between the informal sector and banking sector development.

[Berdiev and Saunoris \(2016\)](#) examine the dynamic relationship between financial development and the informal economy using data for 161 countries over the period 1960-2009. Specifically, they use a panel vector autoregressive model to construct impulse response functions that illustrate the time path of one variable (e.g., the informal economy) following an orthogonal shock to another variable (e.g., financial development). They find that financial development reduces the size of the informal economy. Moreover, there is evidence of reverse causality between these variables; namely, a shock to the informal economy inhibits financial development.

The second wave focuses on the non-linear relationship. In this vein, [Affandi and Malik \(2020\)](#) studied the influence of the informal sector and the reach of financial institutions in six Balkan countries on financial inclusion from 2006 to 2017. The authors used the non-linear ARDL model, a non-linear cointegration approach, to identify asymmetric effects by investigating how the informal economy and the reach of financial institutions influence financial inclusion. The results suggest that the informal economy has a significant negative impact on financial inclusion, while the outreach of financial institutions has a significant effect on financial inclusion.

[Hajilee et al. \(2017\)](#) examine the impact of the informal economy on financial market inclusion by looking at both short-run and long-run effects simultaneously. They use the recent non-linear cointegration approach (i.e. NARDL), which

introduces non-linearity in the model specification, to look for asymmetric effects of the informal economy on financial market inclusion. Using annual data from 1980 to 2013 for 18 selected emerging economies, they find that the informal economy has significant short-run asymmetric effects on financial market inclusion for a majority of the sampled emerging economies.

The third wave highlights the relationship between the informal sector and financial inclusion, assuming that this relationship is moderated by macroeconomic variables. [Elgin and Uras \(2013\)](#) examine the relationship between financial development and the size of the informal economy. They construct a model in which an exogenous change in the size of the informal sector creates two effects on financial development. Specifically, the informal sector harms financial development by increasing financial repression due to tax evasion. However, on the other hand, increasing the size of the informal sector facilitates financial development by alleviating the capacity constraint on the financial sector. Using an international panel dataset of 152 countries over the period 1999-2007, they find a relationship in the form of an inverted U between the size of the informal sector and financial development. The relationship was shown to occur through two operational channels. The first was financial repression from which a rise in the informal sector undermines financial development. The second was financial efficiency through which the size of the informal sector has a beneficial impact on financial development. In short, the growth of the informal economy increases the prevalence of tax evasion, which hinders financial sector development. Assuming that the informal sector exhibits a downward trend in SSA, we test the following hypothesis:

**Hypothesis 1.** *The informal sector negatively affects financial inclusion in SSA.*

### 3.2. Indirect Effects of the Informal Sector on Financial Inclusion

In the literature, we identify ICT, and economic freedom as channels through which the informal sector can stimulate or hinder financial inclusion.

The first channel is ICT. ICTs represent an increase in public service delivery as well as a channel through which the size of informal economic activity could be reduced ([Haruna & Alhassan, 2022](#)). Indeed, by facilitating the mobilization of resources from informal finance, ICTs stimulate access to and use of financial services. For [Garcia-Murillo and Velez-Ospina \(2017\)](#), as ICTs are general-purpose technologies, they can provide people with information on education, employment opportunities and government services that can potentially enable them to migrate to the formal sector. The empowerment that comes from the use of ICTs means wider and deeper access to information and resources and helps to reduce the informal sector and potentially improve the lives of users. [Lewin and Sweet \(2005\)](#) argue that indirect social returns come from ICT use. The use of ICTs improves the functioning of the market and increases trade. Investments in ICT reduce costs because better communication systems reduce transaction costs ([Datta & Agarwal, 2004](#); [Waverman et al., 2005](#)). ICT enables markets to function better

and supply and demand to be regulated. Consequently, it increases information about prices, job opportunities and markets (Sridhar & Sridhar, 2004). In addition, good communication networks replace costly physical transport and thus expand networks (of buyers and suppliers) and markets. Ajide et al. (2022) find that the informal sector can have an effect on ICT development. Coupled with social protection and wage payments, ICT improves women financial inclusion (Kankaria & Dutta, 2021).

The second channel is economic freedom: the indirect effect of the informal economy on financial inclusion is the result of an economically free environment. The choice of this channel is based on the fact that the establishment of a truly free market economy in terms of financial freedom, business freedom, government spending, protection of property rights, efficiency of justice, tax burden, public expenditure, fiscal health, monetary freedom, trade freedom and investment freedom reduce the negative effect of the informal sector on financial inclusion. For example, Loayza (1997) shows that an increase in the size of the informal sector negatively affects growth by, first, reducing the availability of public services for everyone in the economy, and, second, increasing the number of activities that use some of the existing public service less efficiently or not at all. Furthermore, the expansion of the informal economy reduces tax revenues (Kodila-Tedika & Mutascu, 2013) and lower tax revenues reduce government revenues, which reduces the ability to provide high quality public goods (Broms, 2011). Fugazza and Jacques (2004) conclude that labor market regulations and tax burden are the reasons for informal activities. Moreover, corruption not only increases the informal economy, but also reduces the impact of fiscal policy on the underground economy (Huynh & Nguyen, 2020). Schneider (2005) estimates the level of the informal economy in 110 countries, including developing, transition, and developed OECD economies and finds that an increase in the size of the informal sector can lead to a reduction in state resources, which in turn reduces the quality and quantity of goods and services provided by the public sector. Assuming a sustained increase in ICT in SSA and given the role of economic freedom in the development of financial services markets, we test the following hypothesis:

**Hypothesis 2.** *ICT and economic freedom reinforce the negative effects of informal sector on financial inclusion*

## 4. Research Methodology

### 4.1. Empirical Model

The empirical model results from the work of Hajilee et al. (2017) who adopted specifications considering the informal sector from Hajilee and Al Nasser (2014). Its choice is justified by the fact that the financial inclusion model predicts that a decline in the informal sector should increase the level of financial inclusion. The empirical specification is thus illustrated by Equation (1):

$$IF_{it} = \alpha + \beta SI_{it} + \lambda X_{it} + v_i + \mu_i + \varepsilon_{it} \quad (1)$$

where  $IF_{it}$  is the dependent variable that describes the penetration, availability,

usage of financial services and the financial inclusion index in SSA. Following [Camara and Tuesta \(2018\)](#), we use a one stage Principal Component Analysis to construct financial inclusion index.  $SI_{it}$  represents the informal sector of the country  $i$  at the period  $t$ . This independent variable is the informal economy as a percentage of GDP, derived from [Elgin et al. \(2021\)](#). The data cover 158 countries from 1993 to 2018. The informal sector index is estimated using the Multiple Indicators Multiple Causes (MIMIC) model, which is considered the best method to assess the size of the informal sector in relation to foreign exchange demand, electricity consumption and other methods.

$X_{it}$  is the vector of control variables consisting of: i) unemployment measured by total unemployment as a percentage of the population. Employment is a factor associated with financial inclusion ([Goodwin et al., 2000](#)). The unemployed or those with irregular and insecure employment are less likely to participate in the financial system ([Sarma & Pais, 2011](#)). ii) education measured by the adult literacy rate as a percentage of people aged 15 and above. Education is positively associated with formal account ownership ([Fungáčová & Weill, 2015](#)). GDP per capita captures the standard of living of the population and is measured by GDP per capita in constant dollars. [Demirgüç-Kunt et al. \(2013\)](#) and [Kabakova and Plaksenkov \(2018\)](#) argue that GDP per capita plays a major role in explaining cross-country differences in the use of formal accounts. Population is measured by population density i.e. the number of people per kilometre of land area. [Allen et al. \(2014\)](#) points out that population density is important for financial inclusion. Gov-index is the index of institutional quality. It is calculated from the six World Governance Indicator (WGI) governance indicators namely political stability/absence of terrorism, control of corruption, regulatory quality, government effectiveness, voice and accountability and rule of law using Principal Component Analysis (PCA). We use this index in order to obtain overall information and thus avoid arbitrary selection or scattered information. In addition, the use of this index allows us to solve potential endogeneity problems caused by institutional variables and probably avoid multi-collinearity. Institutional quality has a positive impact on financial inclusion in terms of penetration, accessibility and use of financial services ([Nkoa & Song, 2020](#)). Inflation is measured by the GDP deflator as an annual percentage. [Kendall et al. \(2010\)](#) argue that inflation has a negative and significant effect on deposit penetration. [Andrianaivo and Kpodar \(2011\)](#), on the other hand, find that inflation has no effect on financial inclusion. Trade openness is proxied by the flows of exports and imports of goods and services as a percentage of GDP. Greater openness negatively affects financial inclusion ([Do & Levchenko, 2007](#)).  $\mu_i$  captures unobserved country-specific effects.  $\nu_t$  captures the time-specific effect common to all countries and  $\varepsilon_{it}$  is the error term. Thus,  $\alpha$ ,  $\beta$  and  $\lambda$  are the parameters to be estimated.

The model to be estimated is specified by the following Equation (2):

$$IF_{it} = \alpha + \beta SI_{it} + \lambda_1 Unemp_{it} + \lambda_2 Edu_{it} + \lambda_3 gdp_{it} + \lambda_4 Dens_{it} + \lambda_5 Gov\_index_{it} + \lambda_6 Inf_{it} + \lambda_7 Trade_{it} + \nu_t + \mu_i + \varepsilon_{it} \quad (2)$$

The influence of interactive variables is considered in model (3) below:

$$IF_{it} = \alpha + \beta SI_{it} + \lambda X_{it} + \gamma I_{it} + v_t + \mu_i + \varepsilon_{it} \quad (3)$$

where  $I$  considers interactions illustrating the transmission channels through which the informal sector acts on financial inclusion. We consider Information and Communication Technology (ICT) and economic freedom as transmission channels (Huynh & Nguyen, 2020).

$$\begin{aligned} IF_{it} = & \alpha + \beta SI_{it} + \lambda_1 Unemp_{it} + \lambda_2 Edu_{it} + \lambda_3 gdp_{it} + \lambda_4 Dens_{it} + \lambda_5 Gov\_index_{it} \\ & + \lambda_6 Inf_{it} + \lambda_7 Trade_{it} + \lambda_8 Internet_{it} + \lambda_9 Mobile_{it} + \lambda_{10} Tel_{it} + \lambda_{11} Freedom_{it} \\ & + \gamma_1 (SI * Internet)_{it} + \gamma_2 (SI * Mobile)_{it} + \gamma_3 (SI * Tel)_{it} \\ & + \gamma_4 (SI * Freedom)_{it} + v_t + \mu_i + \varepsilon_{it} \end{aligned} \quad (4)$$

## 4.2. Estimation Technique

Drawing on the work of Kumar (2013) and Huynh (2020), the relationship between the informal sector and financial inclusion is studied based on Equation (1). The coefficients in Equation (1) are estimated using two different estimation techniques: indicator variable least squares and system GMM.

The first estimation technique was used to estimate the static version of the model, while the GMM system is used to estimate the dynamic version of Equation (1). While fixed effects estimation addresses the issue of heterogeneity, this estimation approach does not address the issue of endogeneity, especially when Equation (1) includes the reflected dependent variable. Results based on the fixed-effects model should therefore be interpreted with caution because it is weakened by endogeneity.

Tests are performed to justify the choice of the fixed-effects model that provides the most appropriate coefficient estimates. The Lagrange test was performed to test the validity of the random model estimate against the OLS model and the Hausman test was performed to see the appropriateness of the fixed or random effect estimation approaches. When the Hausman test does not admit of a fit or when the probability of the test is less than 10%, the fixed effect model is preferred. When  $p\text{-value} > 10\%$ , the test does not permit to choose. The choice of the best model depends on the author's conviction (Kpodar, 2007). Hence, based on the comparison between the R2-Within and the R2-between ( $R2\text{-Within} > R2\text{-between}$ ), we choose the fixed effects. For all estimation approaches, we used robust estimators to deal with the existence of possible heteroscedasticity and autocorrelation problems using the so-called "clustering" technique.

There are several reasons for using the GMM approach in this study. The GMM method has the advantage of controlling and solving the problem of endogeneity. In this study, several sources of endogeneity can be noted. First, the problem of bi-directional causality. The informal sector can affect financial inclusion and vice versa (Ajide, 2021); secondly, the calculation of financial inclusion and governance indexes, although objective, does not exclude the risk of errors measurement (Nkoa & Song, 2022); finally, the use of dynamic panels ( $N > T$ ) can also be a

source of endogeneity. Indeed, it is assumed that the first-order lag of the dependent variable is an independent variable, but this lagged variable is correlated with the error term. The absence of autocorrelation of the residuals guarantees that unbiased estimators are obtained. Moreover, two conditions have been satisfied and allow the use of the GMM technique in a system. First, the dependent variable of financial inclusion is persistent, given that the correlation between its current value and its lagged value is higher than the rule of thumb threshold of 0.800 (**Table 1**) and the number of time series ( $T = 9$ ) is lower than the number of cross-sections ( $N = 25$ ). Therefore,  $N > T$ .

**Table 1.** Persistence of financial inclusion dimensions.

	FII	Penetration	Availability	usage
FII (-1)	0.8012			
Penetration (-1)		0.8290		
Available (-1)			0.8403	
Usage (-1)				0.8271

To deal with these sources of endogeneity, especially the latter, GMMs are appropriate. And for small samples as in this case, the literature recommends system GMMs. The system GMM addresses the shortcomings of the standard GMM estimator. In the end, **Blundell and Bond (1998)** developed the system GMM estimator to solve the problems of multicollinearity, endogeneity bias and omitted variables. Further details on the system GMM approach can be found in **Arellano and Bover (1995)** and **Blundell and Bond (1998)**.

Four post-estimation diagnostic tests are used to assess the validity of GMM models in systems (**Asongu & De Moor, 2017**). Based on these criteria, two aspects deserve to be developed. On the one hand, Arellano and Bond's second-order autocorrelation test (AR (2)) is preferred over the first-order test (AR (1)) because studies in the literature rely exclusively on the second-order test (**Narayan et al., 2011**). On the other hand, Hansen's test is preferred over Sargan's test and such preference is justified by the rule of thumb that the number of instruments is less than the corresponding number of effective sections in each specification. While the Sargan test requires homoscedastic errors, which is too strong an assumption and sometimes unrealistic, the Hansen test is robust even in the presence of heteroscedasticity but is unreliable in the case of instrument proliferation. Therefore, this robust test can be adopted and the rule of thumb to avoid instrument proliferation followed (**Tchamyu et al., 2019**).

### 4.3. The Data

The data for this study are from the World Development Indicators (2022), **Elgin et al. (2021)** the International Monetary Fund's Financial Access Survey (2022) and the World Governance Indicators (2022). The sample includes 25 countries in Sub-Saharan Africa (**Table 2**). The study covers the period 2010-2018. The de-

scriptive statistics (**Table 2**) show small variations. It is generally accepted that small fluctuations in data lead to unbiased results (Nkoa & Song, 2022). The correlation matrix (**Table 3**) shows a weak interdependence between financial inclusion and the informal sector. Moreover, the negative correlation assumes a negative effect of the informal sector on financial inclusion. Overall, the correlations are not high enough to cause serious problems of multicollinearity.

**Table 2.** Descriptives statistics.

variables	N	mean	sd	min	max
shadow	225	39.88	6.917	28.97	56.84
mobile	223	75.67	34.76	7.821	163.9
tel	222	195,749	243,456	0	1.181e+06
freedom	225	55.64	6.051	38.90	72
internet	212	14.22	12.56	0.580	59.60
trade	215	65.33	28.48	20.72	150.2
inf	225	7.244	8.711	-17.59	60.99
unemp	225	7.461	0.228	7.194	7.983
edu	225	60.28	3.506	54.26	67.26
gdp	225	7.052	0.845	5.642	8.907
dens	225	3.910	1.279	0.945	6.212
gov	225	8.20e-10	2.158	-4.573	5.743
FII	182	8.17e-10	1.516	-3.262	5.514

Source: Authors.

**Table 3.** Matrix of correlation.

	FII	unemp	edu	gdp	dens	Gov-index	inf	trade	shadow	mobile	internet	tel	freedom
FII	1												
unemp	-0.179**	1											
edu	0.055	-0.116	1										
gdp	0.513***	-0.069	0.007	1									
dens	-0.380***	-0.039	0.029	-0.545***	1								
Gov-index	0.671***	-0.065	0.017	0.426***	-0.287***	1							
inf	0.027	0.249***	0.046	-0.034	0.155**	0.044	1						
trade	0.334***	0.025	0.026	0.432***	-0.476***	0.280***	0.026	1					
shadow	-0.253***	0.129	-0.061	-0.078	0.283***	-0.429***	0.084	-0.421***	1				
mobile	0.635***	-0.387***	0.003	0.774***	-0.464***	0.464***	-0.167**	0.451***	-0.212***	1			
internet	0.598***	-0.491***	0.200**	0.603***	-0.124	0.446***	-0.137*	0.189**	-0.234***	0.697***	1		
tel	0.013	0.009	0.024	0.150*	0.068	-0.040	0.037	-0.304***	-0.049	-0.021	0.132*	1	
freedom	0.487***	-0.137*	0.039	0.320***	-0.148*	0.744***	-0.001	-0.126	-0.153*	0.374***	0.399***	0.033	1

Source: Authors.

## 5. Empirical Results and Discussion

This section presents and discusses the results of the baseline model, as well as the

robustness results.

## 5.1. The Baseline Results

### 5.1.1. Direct Effects of the Informal Sector on Financial Inclusion in SSA

The results of the linear model show that the informal sector has negative and significant effects on financial inclusion in SSA (Table 4). All else being equal, decreases in the level of the informal sector by 1% lead to an increase in the financial inclusion index of 0.000939 points. Specifically, the penetration, availability and use of financial services increase by 6.291, 0.124 and 0.216 points. There are at least two reasons for this result. First, a low level of informality is associated with high productivity, which favors capital gains and thus may increase the demand for financial services. Second, a less informal economy is correlated with fewer developmental challenges such as poverty, inequality, and disease, which may increase access to and use of financial services and thus financial inclusion.

**Table 4.** Direct effects of shadow economy on financial inclusion in SSA.

	FII	Penetration	Availability	Usage
Estimation technique: Fixed effects				
unemp	-0.0475 (0.294)	-0.262** (0.111)	-1.191* (0.719)	-3.171 (6.215)
edu	-0.00492 (0.0118)	0.00456 (0.00447)	-0.0243 (0.0403)	0.0350 (0.348)
gdp	0.831 (1.174)	0.971** (0.445)	2.451*** (0.285)	2.959 (2.463)
trade	0.000518 (0.00478)	-0.00230 (0.00181)	-0.0133** (0.00567)	-0.0359 (0.0490)
dens	3.191** (1.223)	2.038*** (0.463)	-0.151 (0.142)	2.940** (1.225)
Gov-index	-0.0666 (0.0964)	0.0646* (0.0365)	0.339*** (0.0694)	1.117* (0.600)
inf	-0.00563 (0.00709)	-0.000264 (0.00268)	0.0371** (0.0174)	0.126 (0.151)
internet	0.0126* (0.00757)	0.00326 (0.00287)	-0.00592 (0.0191)	0.180*** (0.0517)
shadow	-0.0250 (0.0829)	-0.0605* (0.0314)	-0.0408* (0.0224)	-0.457** (0.193)
Constant	-4.548 (13.57)	8.559* (5.140)	0.555 (5.945)	54.71 (51.36)
Lagrangian test	0.0000	0.0000	0.0000	0.0000
Hausman test	0.1090	0.1090	0.1108	0.9670
Observations	161	161	180	180
R-squared	0.298	0.594	0.667	0.278
Number of countries	21	21	21	21

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

This result corroborates those found by [Hajilee et al. \(2017\)](#) and [Affandi and Malik \(2020\)](#) who find that the informal sector negatively affects financial inclusion. This result is justified by the fact that services (especially financial) offered in the informal sector are generally very expensive. Borrowers usually pay back the loans they take out one hundred percent. This phenomenon is therefore likely to limit the demand for financial services. Migration to the formal sector offers cost benefits to financial service seekers, all of which increase the demand for formal financial services and thus the level of financial inclusion.

With regard to the control variables, two trends can be identified. On the one hand, unemployment and inflation have a negative and significant effect on financial inclusion. Indeed, the more an individual has a job that provides him with a regular income, the more he tends to be financially included. For example, the payment of salaries through formal financial institutions allows the worker to have a bank account and to use it more through credit applications, overdrafts, transfers for third parties or to receive money. This result is in line with those of [Carbó et al. \(2005\)](#) and [Devlin \(2005\)](#) who found that employment has a beneficial effect on financial inclusion. On the other hand, inflation, which reflects rising prices and microeconomic instability, is likely to limit financial inclusion. This result is similar to [Allen et al. \(2014\)](#), [Rojas-Suarez and Amado \(2014\)](#) and [Omar and Inaba \(2020\)](#), but contradicts [Evans \(2016\)](#) who find insignificant impact of inflation on the level of financial inclusion.

On the other hand, education, GDP per capita, population density, governance, and trade openness have a positive and significant effect on financial inclusion in SSA. This result is similar to [Robinson \(2014\)](#) who argues that there is a strong relationship between literacy and financial inclusion in that the ability to read and write is a prerequisite for opening and maintaining a bank account. Moreover, many other empirical studies so far show that having financial knowledge and skills is significantly related to people saving more and borrowing money, along with an increase in the chances of starting a new business ([Acemoglu et al., 2014](#)). The coefficients of GDP per capita are positive and significant suggesting that countries with high GDP per capita also experience a high level of financial inclusion. This result is consistent with [Kumar \(2013\)](#) who finds that GDP has a positive and significant effect on financial inclusion. Economies with high population are expected to have better access to financial services due to convenient network effects. This result is positive and significant and thus corroborates with the findings of [Chithra and Selvam \(2013\)](#), [Allen et al. \(2014\)](#), and [Park and Mercado \(2015\)](#). With respect to governance, good governance and high institutional quality through strengthening the rule of law, good regulatory quality are more likely to foster voluntary financial inclusion. This result joins those of [Avom and Bobbo \(2018\)](#), [Nkoa and Song \(2020\)](#). Trade openness has a positive and significant effect on financial inclusion. This result is consistent with [Kim et al. \(2018\)](#) who show that in the long run trade openness has an effect on financial inclusion (Financial Development). This result is also similar to that of [Rajan and Zingales \(2003\)](#) who

argue that trade openness, especially when combined with openness to capital flows, weakens the incentives of incumbent commercial firms or financial intermediaries to block financial development in order to reduce entry and competition.

### 5.1.2. Indirect Effects of the Informal Sector on Financial Inclusion

The results reported in **Table 5** and **Table 6** show that the informal sector has significant negative effects on transmission channels. A decrease in the informal sector coupled with ICT including internet, mobile and fixed phone on the one hand and economic freedom on the other hand significantly increases several dimensions of financial inclusion. This result joins the work of **Garcia-Murillo and Velez-Ospina (2017)** and **Chacaltana et al. (2018)** who show that the combination of ICT and the informal sector promotes migration to the formal sector. This result also joins that of **Jacolin et al. (2019)** who find that mobile financial services reduce the size of the informal sector. Similarly, **Nguimkeu & Okou (2021)** who opine that instead of focusing on formalization as an imperative policy goal, more realistic short to medium term policies should leverage low-skill-biased digital technologies to upgrade the skills of workers and enhance the productivity of firms in the informal sector.

**Table 5.** Transmission channel of shadow economy on financial inclusion in SSA.

	Dependent variable: financial inclusion index				Dependent variable: penetration of financial services			
	Estimation technique: Fixed effects				Estimation technique: Fixed effects			
unempl	0.0252 (0.289)	0.00989 (0.142)	-0.129 (0.135)	-0.537*** (0.195)	-0.246** (0.111)	-0.193* (0.112)	-0.225** (0.108)	-0.632*** (0.158)
edu	-0.00497 (0.0115)	0.00122 (0.00242)	-0.000399 (0.00329)	0.00391 (0.0109)	0.00455 (0.00445)	0.00699 (0.00425)	0.00599 (0.00423)	0.0119 (0.0101)
gdp	-0.933 (1.149)	-0.794 (0.800)	-0.421 (0.829)	1.109*** (0.280)	0.993** (0.443)	1.058** (0.442)	0.724* (0.417)	0.760*** (0.0617)
trade	-0.000534 (0.00470)	-0.00189 (0.00566)	-0.00346 (0.00580)	-0.00195 (0.00408)	-0.00253 (0.00181)	-0.00309* (0.00170)	-0.00276 (0.00177)	0.00329* (0.00175)
dens	4.392*** (1.282)	3.498*** (1.218)	3.695*** (0.938)	0.151 (0.182)	2.292*** (0.494)	2.250*** (0.417)	2.215*** (0.403)	0.201*** (0.0351)
Gov-index	0.0121 (0.0990)	-0.0560 (0.0534)	-0.0508 (0.0589)	0.106 (0.0749)	-0.0479 (0.0382)	-0.0518 (0.0360)	-0.0569 (0.0364)	0.155*** (0.0281)
inf	-0.00760 (0.00698)	-0.00697 (0.00468)	-0.00737 (0.00526)	-0.00747 (0.00685)	-0.000680 (0.00269)	-0.000820 (0.00265)	-0.000602 (0.00265)	0.0122** (0.00497)
shadow	-0.0244 (0.0811)	-0.0185 (0.0543)	-0.0520 (0.0350)	0.141 (0.175)	-0.0603* (0.0313)	-0.0412 (0.0316)	-0.0537* (0.0304)	-0.115* (0.0652)
internet	0.0788*** (0.0264)				0.0173* (0.0102)			
Internet*shadow	-0.00204*** (0.000781)				-0.00433** (0.00164)			

## Continued

mobile		0.0204 (0.0218)				0.0120* (0.00615)		
Mobile*shadow		-0.000437 (0.000622)				-0.0267* (0.0157)		
Tel			0.0114** (0.00545)				4.62e-07 (6.92e-07)	
Tel*shadow			-0.00393** (0.00165)				-8.23e-09 (1.42e-08)	
freedom				0.117 (0.118)				0.0812* (0.0432)
Freedom*shadow				-0.00309 (0.00308)				-0.00237** (0.00114)
Constant	-8.671 (13.37)	-7.276 (9.535)	-7.914 (8.499)	-9.740 (7.370)	7.685 (5.155)	6.727 (4.751)	5.361 (4.738)	6.491** (2.784)
Lagrangian test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hausman test	0.0449	0.0853	0.0126	0.1657	0.0000	0.0000	0.0000	0.0000
Observations	161	172	172	173	161	172	172	173
R-squared	0.333	0.290	0.301	0.211	0.601	0.598	0.587	0.768
Number of countries	21	22	22	22	21	22	22	22

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

**Table 6.** Transmission channel of shadow economy on financial inclusion in SSA.

	Dependent variable: availability of financial services				Dependent variable: Usage of financial services			
	Estimation technique: Fixed effects				Estimation technique: Fixed effects			
unemp	-0.304** (0.144)	-0.106* (0.0590)	-0.197*** (0.0624)	-0.302*** (0.113)	7.070 (7.135)	2.830 (2.848)	3.346 (3.393)	4.173 (3.606)
edu	-0.00404 (0.00804)	0.00661*** (0.00158)	0.00744*** (0.00114)	-0.00639 (0.00724)	-0.0644 (0.284)	0.00698 (0.0531)	0.0410 (0.0843)	0.0215 (0.0702)
gdp	0.528*** (0.0600)	0.428** (0.197)	-0.263 (0.234)	0.496*** (0.0433)	-13.63 (26.92)	7.718 (19.74)	4.502 (16.05)	6.730 (16.54)
trade	-0.000765 (0.00116)	0.00333** (0.00148)	0.00282*** (0.000995)	-0.00122 (0.00121)	-0.0573 (0.111)	-0.0658 (0.122)	-0.0873 (0.139)	-0.0907 (0.150)
dens	0.0692** (0.0296)	0.815*** (0.285)	1.045*** (0.294)	0.101*** (0.0261)	64.57** (30.91)	46.80 (27.91)	41.67* (21.29)	39.68* (19.56)
Gov-index	0.0731*** (0.0141)	-0.0113 (0.0325)	-0.00614 (0.0324)	0.0895*** (0.0208)	2.370 (2.498)	0.0333 (1.238)	0.0330 (1.350)	0.407 (1.158)
inf	0.00573 (0.00349)	-0.00372** (0.00153)	-0.00414** (0.00151)	0.00484 (0.00333)	-0.0629 (0.155)	-0.0429 (0.0693)	-0.0221 (0.0902)	-0.0309 (0.0864)
shadow	-0.0138* (0.00700)	-0.0180 (0.0182)	-0.0203 (0.0192)	-0.175*** (0.0479)	0.743 (2.032)	0.669 (1.200)	-0.0561 (0.742)	5.123 (5.635)

**Continued**

internet	0.0251*				2.291***			
	(0.0141)				(0.645)			
Internet*shadow	-0.000651*				-0.0599***			
	(0.000371)				(0.0184)			
mobile		0.00324				0.224		
		(0.00929)				(0.266)		
mobile*shadow		-1.73e-05				-0.00722		
		(0.000250)				(0.00858)		
Tel			0.00759**				0.000118	
			(0.00294)				(0.000083)	
Tel*shadow			-0.0255***				-0.00417**	
			(0.00556)				(0.00176)	
freedom				0.110***				3.312
				(0.0319)				(3.460)
Freedom*shadow				-0.00316***				-0.0900
				(0.000844)				(0.0930)
Constant	0.437	2.797	1.747	-5.997***	-194.4	-248.3	-186.9	-390.4
	(1.223)	(2.688)	(3.259)	(2.040)	(329.7)	(269.8)	(207.5)	(392.0)
Lagrangian test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hausman test	0.0000	0.0003	0.0000	0.0014	0.6118	0.8245	0.7839	0.7455
Observations	180	191	191	192	180	191	191	192
R-squared	0.667	0.544	0.617	0.684	0.129	0.056	0.056	0.056
Number of countries	24	24	24	24	23	24	24	24

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

Information and communication technologies (ICTs) can influence the effect of the informal economy on financial inclusion in several ways: namely: Access to digital financial services (ICTs can enable individuals and businesses in the informal economy to access digital financial services, such as mobile payments, online bank accounts and online loans); Reduced transaction costs (ICTs can reduce transaction costs for individuals and businesses in the informal economy, by enabling online transactions and reducing the need for cash); access to information and training (ICTs can provide individuals and businesses in the informal economy with access to information and training on financial services and management practices, which can help them improve their financial inclusion).

The informal sector indirectly affects financial inclusion through economic freedom. Indeed, the informal economy is generally stronger the weaker the capacity of the state. The preponderance of the informal sector is accompanied by significantly lower levels of revenue and expenditure, less efficient public institutions, significant regulatory and fiscal burdens and weaker governance. In this

vein, in a recent study, [Awasthi and Engelschalk \(2018\)](#) show that cash transactions involving goods and services for which no receipts are issued significantly increase the risk of tax evasion. They show the existence of an apparent strong negative correlation between the use of formal electronic payments and the size of the underground economy. The non-participation of the informal economy in tax revenues reduces the ability of public authorities to intervene effectively. And the consequences are not only financial, but can also be social or economic, and in terms of governance.

## 5.2. Robustness Analysis

This study adopts the System Generalized Method of Moments as an empirical strategy to check the robustness of the results. The specified model only considers the financial inclusion index as the dependent variable. The specification is [Roodman's \(2009a, 2009b\)](#) extension of [Arellano and Bover \(1995\)](#) which has been documented to limit instrument proliferation and control for cross-sectional dependence ([Love & Zicchino, 2006; Baltagi, 2008](#)).

The following equations in level (5) and difference (6) summarize the procedure for estimating the direct effects of the informal sector on financial inclusion, namely:

$$IF_{i,t} = \sigma_0 + \sigma_1 IF_{i,t-\tau} + \gamma SI_{i,t-\tau} + \sum_{h=1}^k \varphi_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (5)$$

$$IF_{i,t} - IF_{i,t-\tau} = \sigma_0 + \sigma_1 (IF_{i,t-\tau} - IF_{i,t-2\tau}) + \gamma (SI_{i,t-\tau} - SI_{i,t-2\tau}) + \sum_{h=1}^k \varphi_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + \varepsilon_{i,t-\tau} \quad (6)$$

The level (7a) and (7b) and difference (8a) and (8b) equations summarize the ICT and economic freedom channels through which the informal sector affects financial inclusion.

$$IF_{i,t} = \sigma_0 + \sigma_1 IF_{i,t-\tau} + \gamma SI_{i,t-\tau} + \sum_{g=1}^3 \phi_g ICT_{i,t-\tau} + \sum_{h=1}^k \varphi_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (7a)$$

$$IF_{i,t} = \sigma_0 + \sigma_1 IF_{i,t-\tau} + \gamma SI_{i,t-\tau} + \delta Freedom_{i,t-\tau} + \sum_{h=1}^k \varphi_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (7b)$$

$$IF_{i,t} - IF_{i,t-\tau} = \sigma_0 + \sigma_1 (IF_{i,t-\tau} - IF_{i,t-2\tau}) + \gamma (SI_{i,t-\tau} - SI_{i,t-2\tau}) + \sum_{g=1}^3 \phi_g ICT_{i,t-2\tau} + \quad (8a)$$

$$\sum_{k=1}^3 \beta_k (SI_{k,i,t-\tau} * ICT_{i,t-\tau} - SI_{k,i,t-2\tau} * ICT_{i,t-2\tau}) + \sum_{h=1}^k \varphi_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + \varepsilon_{i,t-\tau}$$

$$IF_{i,t} - IF_{i,t-\tau} = \sigma_0 + \sigma_1 (IF_{i,t-\tau} - IF_{i,t-2\tau}) + \gamma (SI_{i,t-\tau} - SI_{i,t-2\tau}) + \delta (Freedom_{i,t-\tau} - Freedom_{i,t-2\tau}) + \quad (8b)$$

$$\psi (SI_{i,t-\tau} * Freedom_{i,t-\tau} - SI_{i,t-2\tau} * Freedom_{i,t-2\tau}) + \sum_{h=1}^k \varphi_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + \varepsilon_{i,t-\tau}$$

where  $IF_{i,t}$  measures the country's financial inclusion  $i$  at year  $t$ ;  $SI_{i,t}$  measures the informal sector,  $W_{i,t}$  is the vector of control variables (Unemployment, education, GDP/capita, population density, governance index, inflation, trade openness),  $\sigma$ ,  $\gamma$ ,  $\psi$ ,  $\delta$  and  $\varphi$  are parameters to be estimated,  $\tau$  represents tau.

$\eta_i$  is the country specific effect,  $\xi_t$  is the time specific constant and  $\varepsilon_{i,t}$  the error term.

In this specification, two-stage estimation is preferred over one-stage estimation because it addresses the heteroskedasticity problem. In addition, the problems of identification (Tchamyou & Asongu, 2017), simultaneity (Asongu & de Moore, 2017) and exclusion restrictions (Beck et al., 2003) are also addressed.

The results presented in Table 7 show that accessibility, availability and usage of financial services in the previous year positively and significantly affect financial inclusion. The diagnostic tests are also validated. Table 8 and Table 9 display the results of the transmission channels. First, the null hypothesis of no second-order autocorrelation of Arellano and Bond residuals (AR (2)) cannot be rejected for all specifications. Second, the Hansen OIR test, which is more robust than the Sargan OIR test, cannot be rejected because it is more robust and low in instruments.

**Table 7.** Table Robustness tests.

	FII	Penetration	Availability	usage
Estimation technique: system GMM				
L.FII	0.834*** (0.121)			
L.penetrate		0.990*** (0.0984)		
L.available			0.962*** (0.0978)	
L.use				0.775*** (0.195)
unemp	-0.204** (0.0816)	-0.0305* (0.016)	-0.0617*** (0.0097)	-0.131 (0.230)
edu	0.00883 (0.00568)	0.00915 (0.00570)	0.00126 (0.00379)	0.00190 (0.00281)
gdp	0.418* (0.216)	0.0925 (0.139)	0.0137* (0.0075)	0.0412 (0.117)
trade	-0.00430 (0.00666)	-0.000971 (0.00147)	-0.000223** (0.00016)	-0.00162 (0.00469)
dens	0.0845*** (0.00704)	0.0203* (0.0117)	-0.0105 (0.0300)	-0.0926 (0.0946)
Gov-index	0.0436*** (0.0094)	0.000141 (0.0279)	0.0179** (0.00713)	0.00675 (0.0473)
inf	-0.0157 (0.0122)	-0.00267 (0.00410)	-0.00296 (0.00862)	-0.00817 (0.00696)
internet	0.0123* (0.0069)	0.00353 (0.00478)	0.00349** (0.00140)	0.00275 (0.00528)

## Continued

shadow	-0.0200*** (0.00277)	-0.00525* (0.00272)	0.00295 (0.0110)	-0.0162* (0.00914)
Constant	-0.761 (3.406)	-1.024 (1.854)	-0.528 (1.025)	2.527* (1.475)
AR(1)	0.005	0.002	0.049	0.025
AR(2)	0.341	0.302	0.249	0.322
Hansen test	0.622	0.281	0.353	0.841
Number of countries	21	21	23	23
Instruments	18	17	17	18
Observations	120	120	135	135

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

**Table 8.** Robustness of transmission channel using system GMM.

	Dependent variable: Financial inclusion index				Dependent variable: availability of financial services			
	Estimation technique: system GMM				Estimation technique: system GMM			
L.FII	0.785*** (0.174)	0.820*** (0.136)	0.733*** (0.225)	0.704*** (0.215)				
L.penetrate					0.902*** (0.0571)	0.992*** (0.108)	0.931*** (0.177)	0.937*** (0.0858)
unemp	-0.266 (0.410)	0.247 (0.324)	0.0527 (0.493)	-0.0521*** (0.006)	-0.0299 (0.160)	0.0591 (0.210)	0.0727 (0.236)	-0.0422 (0.250)
edu	0.00604 (0.00730)	0.00718 (0.00575)	0.00474 (0.00459)	0.00641 (0.00768)	0.00998** (0.00457)	0.00648 (0.00556)	0.00865 (0.00576)	0.00541 (0.00640)
gdp	0.194 (0.251)	0.355 (0.355)	0.422 (0.517)	0.547* (0.319)	0.0608** (0.025)	0.0771* (0.043)	0.0577*** (0.007)	0.0811*** (0.024)
dens	0.221*** (0.012)	0.000260 (0.104)	0.144*** (0.026)	-0.0408 (0.238)	0.0637*** (0.012)	0.0936*** (0.032)	0.104* (0.060)	0.0800*** (0.0283)
Gov-index	0.0195 (0.107)	0.0735 (0.0576)	0.0872 (0.0733)	0.127 (0.0990)	0.00674 (0.0217)	0.0692 (0.0525)	0.0549** (0.026)	0.00523 (0.0742)
trade	0.00347 (0.00817)	0.00406 (0.00397)	0.00501 (0.00396)	0.000888 (0.00663)	-0.000662 (0.00259)	-0.00127 (0.00273)	-0.00181 (0.00513)	0.00151 (0.00290)
inf	-0.00126 (0.0236)	-0.00477 (0.00965)	-0.0101 (0.00951)	-0.0193 (0.0302)	-0.000677 (0.00328)	-0.00459 (0.00391)	-0.00283 (0.00752)	0.00335 (0.00636)
shadow	-0.00921 (0.0188)	-0.170** (0.0786)	0.0318 (0.0495)	-0.178 (0.499)	-0.0109 (0.0110)	-0.0317 (0.0267)	-3.00e-05 (0.0243)	0.00689 (0.112)
internet	0.0149** (0.0063)				0.0977*** (0.034)			
internet*shadow	-0.000474** *				-0.0187* (0.0101)			

**Continued**

mobile		0.0690**						-0.0174
		(0.0315)						(0.0119)
mobile*shadow		-0.00168**						0.00040
		(0.000717)						(0.00030)
Tel			0.0053					-0.00105
			(0.00687)					(0.00427)
Tel*shadow			-0.00102					0.00206
			(0.00179)					(0.0105)
freedom				-0.141				0.0184
				(0.363)				(0.0834)
Freedom*shadow				0.00334				-0.000176
				(0.00967)				(0.00202)
Constant	1.516	2.099	-5.844	3.978	0.524	1.695	0.361	-0.116
	(4.005)	(3.652)	(4.317)	(18.01)	(1.513)	(2.921)	(3.206)	(4.976)
AR(1)	0.047	0.045	0.048	0.035	0.002	0.005	0.006	0.035
AR(2)	0.373	0.444	0.312	0.363	0.229	0.191	0.179	0.200
Hansen test	0.885	0.509	0.579	0.391	0.739	0.243	0.080	0.181
Number of countries	21	22	22	22	21	22	22	22
Instruments	20	19	18	21	17	18	19	20
Observations	120	129	129	130	120	129	129	130

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

**Table 9.** Transmission channels using system GMM.

	Dependent variable: availability of financial services				Dependent variable: usage of financial services			
	Estimation technique: system GMM				Estimation technique: system GMM			
L.available	0.980***	0.908***	0.906***	0.931***				
	(0.0950)	(0.0785)	(0.146)	(0.136)				
L.usage					0.920***	0.845***	0.973***	0.800***
					(0.134)	(0.283)	(0.177)	(0.252)
unemp	-0.0489***	-0.0891***	-0.0594*	-0.132**	-0.292	-0.142	-0.00138	-0.0649
	(0.0165)	(0.0181)	(0.0319)	(0.053)	(0.277)	(0.224)	(0.186)	(0.189)
edu	0.00678**	0.0131***	-0.000585	0.00121	0.00113	0.00157	0.000593	0.00405
	(0.00316)	(0.00356)	(0.00380)	(0.00430)	(0.00439)	(0.00542)	(0.00397)	(0.00468)
gdp	0.0504***	0.740***	0.0366***	0.0808	0.0500	0.0568	0.0161	0.0219
	(0.0129)	(0.109)	(0.0119)	(0.121)	(0.150)	(0.221)	(0.115)	(0.277)
dens	0.00891**	0.0243***	0.0167***	0.00775***	0.0108***	-0.0396	0.0151**	0.00357**
	(0.0040)	(0.0311)	(0.0032)	(0.0011)	(0.0012)	(0.124)	(0.0075)	(0.0014)
Gov-index	0.0144**	0.0300	0.0305	0.00545**	0.0203	-0.000651	0.0326	0.0823
	(0.0063)	(0.0284)	(0.0367)	(0.0024)	(0.0456)	(0.0660)	(0.0309)	(0.0675)

## Continued

trade	-0.000505 (0.00108)	0.000645 (0.00104)	0.00196* (0.00114)	0.00218 (0.00138)	-0.000979 (0.00477)	0.00210 (0.00317)	0.000541 (0.00165)	2.39e-06 (0.00548)
inf	-0.00357* (0.0019)	-0.00430 (0.00626)	-0.0837** (0.039)	0.00319 (0.00650)	-0.0104 (0.0122)	-0.00816 (0.0112)	-0.00591 (0.00625)	-0.0180 (0.0155)
shadow	0.00708 (0.0115)	-0.0271 (0.0209)	0.0161 (0.0105)	-0.0724 (0.111)	-0.00893 (0.0272)	-0.0563 (0.0807)	0.0134 (0.0137)	-0.122 (0.333)
internet	0.00757*** (0.0026)				0.00789** (0.0032)			
internet*shadow	-0.00291*** (0.00057)				-0.00125* (0.0007)			
mobile		0.0153* (0.00801)				0.0221 (0.0236)		
mobile*shadow		-0.0322** (0.0126)				-0.000513 (0.000591)		
Tel			0.00963 (0.000167)				-0.000159 (0.00193)	
Tel*shadow			-0.000147 (0.000412)				0.000333 (0.00462)	
freedom				-0.0588 (0.0784)				0.117*** (0.0224)
Freedom*shadow				0.00161 (0.00195)				-0.00219*** (0.0006)
Constant	-0.510 (1.120)	0.436 (0.957)	-1.393 (1.073)	0.948 (4.336)	2.632 (3.235)	3.512 (5.124)	-0.636 (1.749)	7.400 (10.46)
AR(1)	0.045	0.045	0.043	0.044	0.023	0.029	0.034	0.022
AR(2)	0.195	0.418	0.264	0.570	0.259	0.254	0.266	0.603
Hansen test	0.352	0.147	0.260	0.188	0.949	0.658	0.879	0.500
Number of countries	23	24	24	24	23	24	24	24
Instruments	22	22	22	22	22	22	22	22
Observations	135	144	144	145	135	144	144	145

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

A reduction in the informal sector significantly increases financial inclusion. There are at least two explanations for this result. First, a decline in the informal sector or a formalization of the economy increases the profitability of banks, which can offer more services through the opening of new bank branches and ATMs, thus increasing access to financial services. Secondly, the decline in the informal sector allows the establishment of formal financial services in banks, which increases the demand of economic agents in terms of demand for savings products, credit, support, etc. These results are consistent with those obtained by [Ghate \(1992\)](#), [Úbeda et al. \(2022\)](#).

Taking the control variables shows that they have for the most part the signs predicted by the literature. Indeed, the results show that the less unemployment there is, the more financial inclusion increases through its dimensions of availability and use of financial services. Improved employment encourages individuals to be more active, aware and interested in financial activity in a bank, which ultimately accelerates the speed of financial inclusion. This result is consistent with [Kumar \(2013\)](#). GDP per capita positively and significantly affects financial services penetration and financial inclusion index. This result corroborates the result obtained by [Sarma and Pais \(2011\)](#) who believe that GDP per capita is a key ingredient of financial inclusion. Population density positively and significantly affects financial inclusion. Governance positively and significantly affects financial inclusion. Inflation negatively affects financial inclusion. Economic instability generally creates uncertainty and limits demand for financial services ([Lenka & Barik, 2018](#)).

## 6. Conclusion

The financial exclusion that continues to plague Sub-Saharan Africa despite the progress made in the area of banking is still a major problem for societies and carries many economic costs for economic agents. Thus, detecting the explanatory factors of this financial exclusion is important for a better design and implementation of effective policies. A large literature has highlighted both micro and macro factors of financial inclusion. These include economic factors such as income, employment, inflation, etc., and non-economic factors such as education, age, gender, institutional environment, etc.

Thus, this study aims to analyze the effect of the informal sector on financial inclusion as well as the potential transmission channels of these effects in 25 SSA countries. Due to the limited availability of data on both financial inclusion and the informal sector, the period 2004-2015 was selected. Furthermore, the rapid growth of Information and Communication Technologies (ICT) in SSA and the key role that economic freedom plays in the formation of financial contracts and the improvement of the business climate led us to retain these variables as potential transmission channels of the informal economy on financial inclusion.

Using the fixed-effects model for the estimation of our baseline models as well as the system generalized method of moments (S-GMM) technique as a robustness test to correct for endogeneity problems, the study arrived at two main empirical results. i) First, the informal sector negatively and significantly affects financial inclusion in SSA in terms of penetration, availability, usage of financial services as well as the financial inclusion index. ii) And secondly, the interaction between ICT and the informal sector on the one hand and economic freedom and the informal sector on the other negatively and significantly affects financial inclusion. Furthermore, the originality of this study lies in the analysis of the relationship from the informal sector to financial inclusion compared to previous works.

Three recommendations can be derived from these results. The first is to strengthen the legal, policy and regulatory framework likely to promote a transition from informality to formality. This can be achieved through the formalization of micro and small enterprises. The expansion of the formal sector leads to the decline of the informal sector in relative and possibly absolute terms (La Porta & Shleifer, 2014). For example, sensitizing informal sector actors with the aim of channeling those who have opted for informal sector-specific financing modes such as tontines to microfinance services in order to optimize the financial inclusion process.

The second, which is a consequence of the first, is to improve the business climate (economic freedom) in the countries of SSA. Specifically, this involves simplifying procedures for the creation and establishment of small and medium-sized enterprises, reducing tax burdens, controlling predatory lending rates, and strengthening the protection of property rights in order to encourage increased demand for financial services. Informal enterprises are generally seen as an untapped reservoir of entrepreneurial energy, constrained by government regulations. From this perspective, unleashing this energy by reducing entry rules or improving property rights would fuel growth and development (De Soto, 2000).

And the third recommendation is to strengthen the telecommunications infrastructure, which contains many positive externalities for both the financial sector and the goal of formalizing economies. For private innovations that operate in the informal sector to affect financial inclusion, they need to be supported by the appropriate public goods. Public goods form the underpinnings of financial inclusion (Frost et al., 2021) and the formalization of the economy. Governments can use new digital infrastructure to reach informal households and workers. Furthermore, investment in human capital can also help to move people out of informality and promote financial inclusion.

## Acknowledgements

We are grateful to the anonymous referees and associate editor for excellent, helpful comments and suggestions.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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