

# The Impact of Tax Digitization on the Informal Sector

## A Closer Look at Sub-Saharan Africa

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### Abstract

The objective of this study is to assess the impact of tax administration reforms on the informal sector and informal employment in 40 Sub-Saharan African (SSA) countries. To do so, we apply the Difference-in-Differences method for empirical evidence, focusing on three key tax administration reforms: the digitalization of tax procedures (DIGIT), the implementation of a unit or strategy for the informal sector businesses (ISU), and the possibility of tax payments via « mobile money<sup>1</sup> » (MT). The results are varied and depend not only on the reform implemented but also on the measurement of informality applied. In particular, we find that both tax digitalization and tax reform on the informal sector have negative effects on informal production as a proportion of GDP. In contrast, the digitalization tax of procedures and the reform of the informal sector positively affect the share of informal employment in the economy. In addition, the possibility of tax payment via mobile money has a negative effect on informal employment but does not significantly impact informal production. We recommend better diversification and implementation of informal sector reforms, and pave the way for a better understanding of the importance of digitalizing tax procedures.

### Keywords

Informal sector, digitalization of tax procedures, difference-in-differences method, informal employment, Sub-Saharan Africa

### Key Findings

- The digitalization of tax procedures and the reform of the informal sector have a negative impact on the informal sector and informal employment.
- The use of e-money has a negative effect on informal employment.
- Digital governance is an important channel through which tax reforms affect the informal sector in Sub-Saharan Africa.

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1 Mobile Money: Mobile Banking Services

## Introduction

**P**revalent in the production units of goods and services, the informal economy is an issue that concerns all countries worldwide. Indeed, beyond its primary consequence on tax revenue mobilization (TRM) (Colombo et al., 2022) it leads to an increase in public debt (Elgin & Oyvatt, 2013), inefficient use and allocation of resources (Barussaud & Lapeyre, 2022), disrupting the adequate supply of public goods, damaging the environment, and failing to promote tourism (My et al., 2022). It also contributes to urban insecurity, corruption, income inequalities, and unequal access to healthcare (Nose & Viseth, 2020 ; Traub-Merz et al., 2022) perpetuating poverty (ILO, 2019).

The shift of production activities from the formal to the informal sector is of crucial importance for developing economies in general, and particularly for those in Sub-Saharan Africa (SSA). The informal economy is a key component of most economies in sub-Saharan Africa, contributing between 25 and 65 percent of GDP and accounting for between 30 and 90 percent of total nonagricultural employment (Nose & Viseth, 2020 ; Traub-Merz et al., 2022).

The development of Sub-Saharan African countries is diverse, making it very difficult to forecast the informal economy and implement mitigation policies. This article defines the underground or informal economy as any economic activity hidden from official authorities for monetary, regulatory, and institutional reasons (Medina & Schneider, 2021). The monetary reasons include the fact of avoiding paying taxes and social security contributions, the regulatory reasons relate to evading government bureaucracy and the burden of the regulatory framework, while the institutional reasons involve anti-corruption law, the quality of political institutions, and the weakness of the rule of law. This definition is primarily focused on business compliance and is first linked to the work of Alaka Alaka (2006), who argued that a business can be considered informal when the tax administration struggles to produce the necessary tax information related to that entity. It is also connected to family<sup>2</sup> businesses or SMEs that generate wealth but are not legally registered. In the end, this definition includes underground economic activities that may not be declared to the authorities either in order to evade heavy tax regulation or because those activities are illegal.

This recent triple perspective of the informal economy has led tax administrations to make efforts to improve the level of business compliance. To do so, tax authorities have implemented informal sector management strategies similar to those used for large companies. For instance, the West African Economic and Monetary Union (WAEMU) has created tax-approved management centers (TMC) to facilitate the taxation of businesses in the informal sector (ILO, 2018); Senegal, for its part, has implemented a special accounting system for micro-businesses. These various reforms aim to improve tax equity for businesses. In the same vein, Central African countries have developed special regimes based on informal activity groups to relieve entities of tax burdens (ILO, 2018). For example, Cameroon has implemented an annual flat-rate tax for informal sector businesses, replacing monthly contributions. Similarly, other countries rely on information and communication technologies (ICT) to digitalize tax procedures. Indeed, several East African countries have taxation systems organized based on taxes, tax decentralization, and procedures digitalization (ATAF, 2021). In this way, Rwanda and Ethiopia have digitalized tax procedures to facilitate the formalization of informal businesses. Furthermore, following the Kenyan experience and the advent of electronic money, some African countries that have introduced mobile money allow businesses to pay their taxes via cell phone banking services, in partnership with telecoms operators. By way of illustration, tax authorities in Cameroon, South Africa and Tanzania allow taxpayers to declare and pay their tax obligations over the Internet, using mobile money services.

2 Family businesses are microbusinesses composed of paid individuals, but self-employed. Subsistence farming is included in this sector if its production is marketed. Despite the importance of these microbusinesses in the global production of African economies, they contribute to an increase in informal and vulnerable employment, partly due to weak regulations in these countries.

At the operational level, the implementation of reforms is tied to the activities of the entities delegated within the tax administration, as well as to the recommendations of the African Tax Administrations Forum aimed at improving tax capacity and taxpayer compliance. Additionally, some countries face pressure from international donors to improve tax revenue mobilization in order to offset indebtedness. Countries such as Kenya, Uganda, Cameroon, Senegal, Ghana, Nigeria, South Africa, Tanzania, and Zambia have implemented all three reforms. Côte d'Ivoire, Burkina Faso, Ethiopia, and Malawi have limited themselves to digitalizing tax procedures and implementing strategies to regulate the informal sector. Approximately 25 countries in Sub-Saharan Africa have only digitalized their tax procedures. For instance, the Democratic Republic of Congo has developed tax strategies for the informal sector but has not yet digitalized its tax procedures. However, digitalization is a significant opportunity for both businesses and tax institutions, as it reduces transaction costs associated with tax reporting activities and the tax collection process by tax administrations (World Bank, 2021). In this study, we place particular focus on the influence of tax procedures digitalization.

Three key areas of focus regarding the use of ICT in tax systems emerge after reviewing the literature. The first area examines the impact of digitalization on the capacity of tax administrations (Bassongui, 2023; Bassongui & Hounghédji, 2022; Gnanon & Brun, 2018, 2020; Ongo Nkoa & Song, 2022). The second focuses on the effect of tax digitalization on the quality of public institutions and the reduction of corruption (Gnanon & Lyer, 2018; Lin et al., 2018; Lio et al., 2011). The final area analyzes the relationship between digitalization and the informal economy (Ilavarasan, 2019; Masiero, 2017; Medina & Schneider, 2021). These key areas of study lead to a consensus on the benefits of a digitalized tax system: firstly, in terms of the compliance and monitoring costs borne by taxpayers and tax administrations, respectively; secondly, there is broad agreement on the positive relationship between digitalization and tax revenue mobilization (TRM). However, the results are mixed regarding the effectiveness of achieving the objectives in the contexts studied, and the behavior of taxpayers in response to digitalized processes (Bassongui & Hounghédji, 2022).

This article aligns with the final area of study, aiming to address gaps in the existing literature. First, no study has evaluated the impact of tax procedures digitalization on the informal economy in terms of employment and production units. Previous studies have focused mainly on the effect of ICT usage and digital governance on the informal economy (Ajide & Dada, 2022; Chacaltana et al., 2024; Nguyen et al., 2023). However, the digitization of tax filing and payment could lead to the formalization of small production units and the declaration of employees (Masiero, 2017). Furthermore, previous studies have limited themselves to evaluating the impact of tax policies on the informal sector, primarily focusing on the tax base (Bidzo, 2019; Solomon, 2011). This article focuses on the joint implementation of a tax strategy for informal sector businesses, digitalization of tax procedures, and the possibility of tax payment via mobile money. Its goal is to assess the impact of tax reforms on the informal sector and informal employment in Sub-Saharan Africa (SSA). These reforms include implementing a strategy for the informal sector, digitalizing procedures, and paying taxes via e-money in 40 SSA countries. The data used in this study comes from the works of Elgin et al. (2021) and Medina et Schneider (2021), the World Development Indicators database (World Bank), the e-Government Knowledgebase (United Nations), and the Africa Infrastructure Knowledge Program (African Development Bank), covering the period from 2000 to 2018. The sample is conditioned by the availability of data on the levels of informality in the economies. To analyze these data, we apply an impact evaluation method. The Difference-in-Differences (DiD) method is chosen for its ability to neutralize local effects, and the conditional independence assumption is respected. Indeed, the differences between Sub-Saharan economies can be fully explained by the reduction in transaction costs resulting from the various tax reforms.

The research is organized into five sections. Following this introductory section, Sections 2 and 3 present the literature review and the methodological framework, respectively. Section 4 presents and discusses the research results. Section 5 concludes and proposes economic policy implications.

## Theoretical Framework

The informal economy draws the attention of academics and policymakers due to its impact on economic planning and development. Indeed, the informal economy encompasses all economic activities, whether legal or illegal, that are not recorded by the bureaucratic institutions of the public and private sectors (Ajide, 2021; Ihrig & Moe, 2004).

First, several schools of thought, sometimes complementary, help to understand the dynamics of the informal sector. While the *dualist school* argues that the informal sector encompasses marginal activities that provide income and a safety net for the most disadvantaged (Hart, 1985) the *structuralist school* views it as including subordinate workers who help reduce input and labor costs (Portes et al., 1989; Roberts, 1994). Furthermore, the *legalist school* sees the informal sector as a haven for micro-entrepreneurs, allowing them to avoid the costs, time, and effort associated with formal registration (Portes & Haller, 2005), while the *voluntarist school* emphasizes the tax evasion associated with informal activities. However, both the dualist and structuralist schools recognize that workers in the informal sector are disadvantaged, and therefore call for government intervention to reduce inequalities and injustices, and to provide credit and development services to informal operators, as well as basic infrastructure and social services to their families.

Moreover, the theoretical link between innovations (ICT), and informality has been widely discussed in the literature. Indeed, since the work of Dismukes (2005), it has been generally accepted that technological innovations can lead to a profound transformation of economic and institutional practices. In this regard, the Diffusion of Innovations theory posits that ICTs are associated with a substantial reduction in transaction costs and an increase in access to information, which encourages the transition of economic actors from the informal sector to the formal sector. However, another branch of the literature, in relation to social network theory, suggests a different perspective. Granovetter (1990) argues that ICTs facilitate the creation and maintenance of extensive and strong social networks, which can help informal workers access broader resources and markets.

Furthermore, the modernization theory suggests that the dynamics of economic development can be driven by macroeconomic factors and specific social changes, such as technological progress (ICT) (Jane, 2016; Nam, 2018). Indeed, with the implementation of digitalized tax procedures, tax administrations can mitigate informality in a country and encourage economic actors to declare their operations.

Finally, we have the rational choice theory in terms of crime, proposed by Becker (1968), which demonstrates that economic transactions and crime are interdependent. Previous studies have applied rational choice theory and modernization theory to analyze the relationship between tax evasion and digital public governance (Nam, 2018; Uyar et al., 2021) as well as the relationship between the underground economy and financial inclusion (Ajide, 2021; Ajide et al., 2022; Njangang et al., 2020) among others.

Consequently, this study aligns with these theories to analyze the relationship between the underground economy and digital reforms in tax administration in developing countries (DCs). The choice of economic actors who will engage in the informal economy depends on the extent of available economic opportunities and socio-economic factors (Ajide, 2021; Medina & Schneider, 2019; Plotnikov, 2020; Rangaswamy, 2019; Syed et al., 2021). Economic actors compare the cost of operating in an informal economy, which may involve sanctions or penalties from the government, with the benefits that result from success (Njangang et al., 2020). Thus, informal employment is a trade-off for employers or entrepreneurs between the cost of formalization and the penalty for running an informal business.

Empirically, studies on the informal sector have primarily focused on the use of ICTs, without reaching a consensus. Veiga and Rohman (2017) and Remeikiene et al. (2018) discuss the link between ICTs and the underground economy. The methods of conducting transactions and formalizing businesses are enhanced by ICTs. Remeikiene and Gaspareniene (2021) demonstrate that ICTs contribute to the formalization of activities because they facilitate the monitoring of transactions.

In the same vein, Apolo Quisphe (2023) shows that the connection between workers through digital platforms helps formalize jobs in a city. Garcia-Murillo and Velez-Ospina (2014) show that ICTs empower individuals; in particular, mobile phones reduce the transaction costs of informal businesses. Their study reveals that ICTs can transition people from the informal economy to the formal economy, based on data from a panel of 170 countries over five years. A recent study by Uyar et al. (2021) examines the moderating impact of ICTs on the relationship between online government services and tax evasion between 2006 and 2017. It shows that governance plays an important role in reducing tax evasion. In this context, implementing tax administration reforms can reduce informality. Indeed, a study by Masiero (2017) found a slight shift from the informal sector to the formal sector when biometric identification systems were introduced in India.

Some studies have shown growth in the informal sector following technological development. Bhattacharya (2019) demonstrates that ICTs facilitate payment and income protection in the informal economy. In fact, they promote underground activities, as non-traditional technologies do not help bridge the gap between the formal and informal economies. This result raises questions about the importance of ICTs in reducing digital divides and in formalizing economic agents operating in the informal sector. Indeed, Junko (2022) shows that workers excluded from innovations face significant difficulties in regularizing themselves and benefiting from reduced transaction costs. Other studies show that digitalizing public procedures leads to an increase in the informal sector. Muralidhara Hiriyur (2022) argues that the implementation of digital transaction platforms creates economic opportunities, but without legal and social protections. The lack of regulation automatically turns these activities into informal ones, for which the public sector receives no revenue. Digitalization can, however, become a force in organizing the informal economy and creating infrastructure that allows informal workers to collectively negotiate better terms.

In summary, although scarce, empirical studies on the relationship between ICTs and informality have been the subject of considerable scientific attention in recent years (Garcia-Murillo & Velez-Ospina, 2017; Masiero, 2017; ILO, 2018; Fafchamps & Quinn, 2018; Bhattacharya, 2019; Remeikiene et al., 2018; Ajide & Dada, 2022), often with varied results depending on the analysis methods, the technologies used, and the samples used. Studies that have focused on African economies mostly highlight that ICTs are an important tool for development and for promoting better-quality employment (Fafchamps & Quinn, 2018; Ajide & Dada, 2022).

The development of ICTs has a significant impact on economic actors, with varied results (Noh & Yoo, 2008). Given the theoretical and empirical arguments suggested by researchers in the previous literature, this paper proposes testing two hypotheses. The first hypothesis posits a reduction in the informality of economic actors in developing countries (DCs) through digital reforms in tax administration. Indeed, the use of digitalized procedures (MT and DIGIT) for transactions in various sectors of the economy has already been highlighted in the literature (Masiero, 2017; Muralidhara Hiriyur, 2022; Uyar et al., 2021), but to our knowledge, no study has specifically addressed the importance of digital tax reforms. Furthermore, we also take into account traditional tax reforms implemented to reduce the level of informality in the sector. Therefore, we test a second hypothesis, which suggests a reduction in the informality of economic actors in developing countries through reforms in tax administration.

## Empirical Framework

The empirical framework of this study is outlined in two stages. First, we introduce the data and study variables. Second, we present the empirical strategy.

### *Data and Variables*

The data for this study come from the World Development Indicators database (World Bank), the e-Government Knowledgebase (United Nations), and the Africa Infrastructure Knowledge Program (African Development Bank), covering the period from 2000 to 2018 for 40 Sub-Saharan African



countries<sup>3</sup>. The data on the informal sector come from the work of Elgin et al. (2021) and Medina and Schneider (2021). We use the data collected from Sub-Saharan African countries regarding tax administration reforms. Data on various reforms are drawn from the literature (Ebeke et al., 2016; Jeppesen, 2021; Mackenzie, 2021; Von Haldenwang et al., 2014) and reports from sub-regional tax organizations (ATAF, 2021; CIAT, 2013).

CODE		Source	Measurement
VARIABLES EXPLAINED			
SI-L	Informal sector	Elgin et al., 2021	Share of the informal sector in GDP
SI-S	Informal sector	Medina and Schneider, 2021	Share of the informal sector in GDP
EI	Informal employment	Elgin et al., 2021	Share of informal employment in total employment
VARIABLES OF INTEREST			
DIGIT	Implementation of digital procedures	Authors/ATAF	1 for presence and 0 for absence
ISU	Implementation of a unit or strategy for the informal sector	Authors/ATAF	1 for presence and 0 for absence
MT	Implementation of "mobile money" payments	Authors/Apeti and Edoh, 2023	2 for the use of "mobile money" as a means of tax payment, 1 for the presence of "mobile money," and 0 for its absence
CONTROL VARIABLE			
EGOV	Digital governance	United Nations	Digital Governance Index
SP	Political Stability	WGI	Political Stability Index
RRN	Wealth in natural resources	WDI	Share of revenue from natural resources in GDP
VAA	Agricultural added value	WGI	Amount of agricultural added value
TM	Market size	WDI	Average income per capita
DF	Financial development	WDI	Credit volume as a percentage of GDP
FBCP	Gross fixed capital formation	WDI	Share in GDP
LAF	Labor force	WDI	Share of the labor force aged 15 and above
CORRUP	Corruption Index	WDI	Composite Index
TRADE	Trading opening	WDI	Share of the sum of trade in GDP

Table 1: Presentation of the Variables and Their Measurements

Source: authors.

3 Southern Africa (Angola, Botswana, Eswatini, Lesotho, Madagascar, Mauritius, Mozambique, Namibia, South Africa, Zambia, Zimbabwe); Central Africa (Cameroon, Central African Republic, Chad, Democratic Republic of the Congo, Republic of the Congo, Gabon, Equatorial Guinea); Eastern Africa (Burundi, Comoros, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, Uganda); Western Africa (Benin, Burkina Faso, Cape Verde, Ivory Coast, Gambia, Ghana, Guinea-Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo).

The use of e-money as a means of tax payment is recent in Sub-Saharan African countries. Therefore, we cannot assess its impact on the period of data availability before 2018. However, we can assess its effect on the mitigation of the informal sector. We evaluate the use of mobile money in the country for transactions (1) and then for declaring and paying tax obligations (2). Some countries in the sample do not yet have mobile money services, and others do not use it as a means of payment for taxes. The choice of control variables aligns with the literature on the evaluation of tax reforms (Dom, 2019; Ebeke et al., 2016; Jeppesen, 2021b; Mavungu & Krsic, 2017). Table 1 presents the study variables, and their descriptive statistics are provided in the appendix in Table A2.

## Empirical Strategy

The use of causal inference is one of the methods for assessing the impact of reforms or public policies. We align with studies that have evaluated the impact of tax reforms on revenue mobilization (Ebeke et al., 2016; Mann, 2004). In our investigation, the local effect and the selection effect are not verified. Indeed, the implementation of digital tax reform does not depend on the level of informality, but rather on the level of revenue collected. The local effect assumes that countries that reduce their informal sector without implementing a tax reform do not exist (Angrist et al., 1996). However, a country that has not implemented a reform may have more formal businesses than one that has. The non-validation of these two effects leads us to avoid using the synthetic control method proposed by Mann (2004).

We cannot fully adhere to the study by Ebeke et al. (2016), as the assumption of conditional dependence is not respected. This assumption means that whether a country implements a tax reform or not is not due to expected differences in the level of informality in the country (Givord, 2014). The implementation of reforms is linked to differences in tax revenue mobilization. Therefore, the hypothesis that the level of informality among taxpayers in countries can evolve in a similar and parallel manner in the absence of tax reforms is validated. Consequently, in contrast to previous studies, we use a difference-in-differences model based on two approaches.

The first approach aligns with the modeling by De Chaisemartin and d'Haultfoeuille (2024), which allows for considering intertemporal heterogeneity with variation in the treatment timeline. The innovations they introduce enable us to capture the effects over two periods and the average treatment effects  $\delta_{g0,2}$ .

$$\begin{aligned}\delta_{g0,2} &= E[Y_{g0,3}(1, 2, 0) - Y_{g0,3}(1, 1, 1)] \\ &= E[Y_{g0,3}(1, 2, 0) - Y_{g0,3}(1, 1, 0)] - E[Y_{g0,3}(1, 1, 1) - Y_{g0,3}(1, 1, 0)]\end{aligned}\quad (1)$$

For our investigation, we adopt the dynamic DID estimator proposed by De Chaisemartin and d'Haultfoeuille (2024), expressed as follows:

$$Y_t(D_{n,t}) = a_3 + \sum_{e=0}^L b_e A_t^e + d_{tn} + \varepsilon_{3t}\quad (2)$$

Where  $Y_t(D_{n,t})$  represents the level of the informal sector in country  $D$  at period  $n$ , ranging from 1 to 2 under treatment  $t$ ,  $d_{tn}$  captures the temporal effects common to all countries,  $A_t^e$  is a binary variable taking the value 1 if country  $D$  is treated by the adoption of the reform at  $n$  periods before or after time  $t$ , and  $b_e$  represents the effect of digital tax reforms.

$A_{it}^e = 1\{t - D = e\}$  is an indicator for country  $D$  that is  $e$  periods away from the adoption date  $t$ .

The second approach is the application of a linear regression using the difference-in-differences (DID) method. Indeed, we also want to evaluate the slippery slope and social contract theories to explain taxpayer compliance. Furthermore, this method will allow us to corroborate the results

obtained in the first approach. For the modeling, we follow the proposal by Villa (2016) and the investigation by Kochanova et al. (2020), who conducted a similar analysis by assessing the impact of digital tax administration on businesses' compliance costs.

In line with the DID evaluation, countries that had not adopted tax administration reforms by the end of the sampling period, or those that had already adopted them before the beginning of the sampling period, form the control or treatment group. We have countries that implemented or did not implement reforms in the control group. However, the presence of countries that had already adopted reforms recently, before the start of the sampling period, may underestimate the desired treatment effect if this produced effect is not constant but increases over time. This is a limitation of the first approach. Nevertheless, the results remain robust when considering a time  $t$  in the estimation, which ensures that the reform has been implemented in at least half of the countries in the selected sample (Kogueda et al., 2024). Moreover, considering a level  $t$  makes it difficult to obtain the average effect through mean difference tests.

For this approach, we adhere to Villa (2016) DID estimator with a linear regression approach supported by literature (Kochanova et al., 2020; Xiao & Yuchen, 2020), expressed as follows:

$$Y_{gdi} = a_{gdi} + [\delta_1 Raf_d \times t_g + \delta_2 t_g + \delta_3 Raf_d] + \sum \beta_n Vc_{gdi} + \varepsilon_{gdi} \quad (3)$$

Where  $Y_{gdi}$  is the level of taxpayer compliance for taxpayer  $g$  in the country  $d$  in year  $i$  during the survey.  $[\delta_1 Raf_d \times t_g + \delta_2 t_g + \delta_3 Raf_d]$  is the implementation of the difference-in-differences approach, which may influence the effect of other variables compared to a regression without the approach.  $Raf$  represents the implementation of the reform in country  $d$ .  $t$  is the time frame for considering post- and pre-evaluation applications. For this study, we take the year 2010. This variable follows the measurement of Equation 4.  $Vc$  is the group of control variables composed of the country's macroeconomic characteristics. Table 1 distinguishes these variable groups.  $\beta$  and  $\delta$  are the coefficients of the variables.

$$t = \begin{cases} 0 & \text{si } i < 2010 \\ 1 & \text{si } i \geq 2010 \end{cases} \quad (4)$$

Variable	Obs	Average	Standard Error	Min	Max	VIF	1/VIF
SI-L	760	38,189	8,534	19,342	65,144	—	—
SI-S	760	36,655	9,875	5,1	61,4	—	—
EI	513	84,787	15,126	32,06	98,62	—	—
MT	760	0,449	0,629	0	2	1,69	0.592
DIGIT	760	0,146	0,353	0	1	1,764	0.567
ISU	760	0,499	0,5	0	1	1,424	0.702
EGOV	760	0,254	0,116	0	,668	2,84	0.352
SP	760	-0,554	0,892	-2,699	1,224	1,944	0.514
DP	760	14,348	6,476	0,952	43,484	1,52	0.658
RRN	760	11,589	10,668	0,001	58,688	1,688	0.592
TM	760	1654,234	2016,324	110,461	11645,982	3,118	0.321
DF	760	19,484	22,534	0	142,422	2,359	0.424
FBCP	760	22,466	10,218	0	79,401	1,371	0.729
LAF	760	68,359	11,552	42,39	90,34	1,425	0.702
TRADE	760	65,976	30,626	0	175,798	1,926	0.519
Average VIF						1,922	

Table 2: Descriptive Statistics and Multicollinearity Test

Source: authors.

To avoid potential multicollinearity between the variables, we performed a tolerance test on our explanatory variables. The results of the variance inflation factor (VIF) for each variable are presented in the last two columns of Table 2. According to Bressoux (2008), multicollinearity is



considered present when the average VIF coefficient is greater than 5. The results shown in Table 2 indicate that there is no multicollinearity, as the average VIF coefficient is close to 1, and none of the tolerance values for the independent variables are less than or equal to 0.2 [1/VIF].

## Results

The results obtained from the application of the empirical framework are presented based on two DID estimation approaches. While the first approach is dedicated to the main results, the second approach provides robustness checks. In this second estimation approach, we use an alternative size measurement of the informal sector proposed by Medina and Schneider (2021). Additionally, the effect of using mobile money payment in the informal sector in SSA economies is analyzed through the second approach.

### *Result of the Intertemporal DID Approach with Treatment Calendar Variation*

The application of the estimation model presents results on the heterogeneous impact of the reform on taxpayer compliance. Table 3 presents the estimation results, and Graph 1 illustrates the effect of the tax reform and the digitalization of tax procedures on the informal sector. We observe that the implementation of digital procedures has a negative impact on the share of the informal sector in SSA economies. The obtained result is consistent with that of Masiero (2017) and further strengthens the literature that supports the idea that the use of ICT by populations reduces the level of informality in developing economies (Chacaltana et al., 2024; Nguyen et al., 2023). Indeed, digitalizing tax procedures leads to an average decrease of 9% in the informal sector's participation in the economy's income. Its implementation allows informal sector businesses to comply more easily with their tax obligations at a lower cost. The estimation results in Table 3 show that the effect of this reform is equal to the average effect. Therefore, the impact of the reform is not influenced by economic cycles.

DIGIT						
Estimation of treatment effects estimation: effects of event studies						
	Estimation	Standard error	BI IC	BS IC	N	Switchs
Effect_1	-0,0990465	0,0665838	-0,2295484	0,0314554	399	20

Estimation of treatment effects: average total effect per treatment unit						
	Estimation	Standard Error	BI IC	BS IC	N	Switchs x Periods
Av_tot_eff	-0,0990465	,0665838	-0,2295484	0,0314554	399	20

Notes: BI IC: Lower bound of the confidence interval; BS IC: Upper bound of the confidence interval.

**Table 3: Estimation Results of the Effect of Digitalizing Tax Procedures on the Informal Sector**

Source: authors.

We observe in Table 4 and Graph 1 that this tax reform has a negative impact on the informal sector. The adoption of targeted tax reforms for informal production units reduces the informal sector's participation in the income of SSA economies by an average of 12%. This result is consistent with findings from the literature (Bidzo, 2019; Solomon, 2011) and demonstrates the effectiveness of the reforms implemented to reduce the informal sector in SSA countries. Indeed, the implementation of tax policies for the informal sector helps make the tax system more equitable and promotes the transition of informal activities to the formal sector. African countries are implementing special regimes to relieve entities from tax burdens based on activity groups that cannot produce accounting

information (ILO, 2018). Developing countries (DCs) have struggled to improve employment levels through industrialization and the structural transformation of their economies. Furthermore, in several DCs within the sample, a transition to service-based economies is observed, characterized by a significant presence of self-employment. Self-employment is a niche within the informal sector.

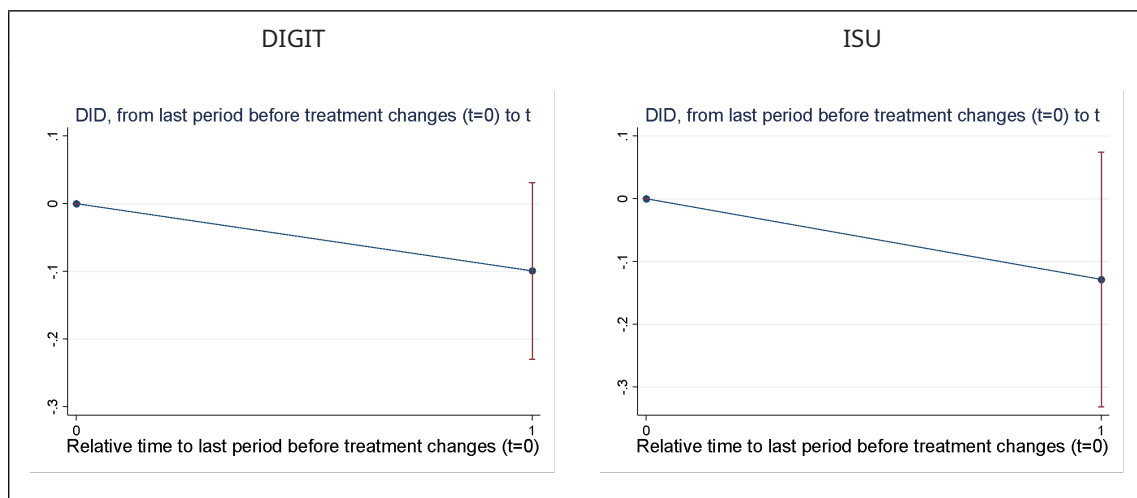
ISU						
Estimation of Treatment Effects: Event Study Effects						
	Estimation	Standard Error	BI IC	BS IC	N	Switchs
Effect_1	-0,1285878	0,1034067	-0,3312611	0,0740856	164	11

Estimation of Treatment Effects: Average Treatment Effect per Unit of Treatment						
	Estimation	Standard Error	BI IC	BS IC	N	Switchs x Periods
Av_tot_eff	-0,1285878	0,1034067	-0,3312611	0,0740856	164	11

Notes: BI IC: Lower bound of the confidence interval; BS IC: Upper bound of the confidence interval

Table 4: Estimation Results of the Tax Reform on the Informal Sector

Source: authors.



Graph 1: Representation of the Impact of Reforms on the Informal Sector at Different Time Periods

Source: authors.

Regarding the effect of tax reforms on the share of informal jobs within total employment, the results contrast with those for the share of the informal sector in GDP. Indeed, the results in Table 5 show that the reforms have a positive effect on the level of informal employment in the economy. On average, they lead to an increase in the share of informal jobs. Digitalization faces significant digital divides in some SSA countries. In fact, formal jobs are characterized by direct tax payments, which are collected at very low rates in developing countries (DCs) compared to developed countries. Moreover, if a formerly informal production unit is detected by the authorities, this does not necessarily mean that the jobs mobilized for this production have also been detected. Implicitly, it's likely that there is work behind this production, but it's difficult to know at what intensity. What's more, Africa's economic fabric is mainly made up of family-run businesses, whose employee status is difficult to formalize.

DIGIT						
Estimation of treatment effects: effects of event studies						
	Estimation	Standard Error	BI IC	BS IC	N	Switchs
Effect_1	0,4321777	0,2793538	-0,1153457	0,979701	217	15

Estimation of treatment effects: average total effect per treatment unit						
	Estimation	Standard Error	BI IC	BS IC	N	Switchs x Periods
Av_tot_eff	0,4321777	0,2793538	-0,1153457	0,979701	217	15

Notes: BI IC: Lower bound of the confidence interval; BS IC: Upper bound of the confidence interval.

Table 5: Estimation Results of the Effect of Digitalizing Tax Procedures on Informal Employment

Source: authors.

The tax reform of the informal sector has a positive effect on the level of informal employment (Table 6 and Graph 2). On average, the reform targeting informal production units leads to a 13% increase in the share of informal jobs within total employment. The countries of Sub-Saharan Africa (SSA), in contrast to those in Latin America, have implemented strategies for the informal sector that neglect employment and focus on tax payments by microbusinesses (CIAT, 2013). However, African countries have introduced special regimes for the liberalization of entities from tax burdens depending on activity groups that cannot produce accounting information (ILO, 2018). This situation may explain the positive effect of reforms on the level of informal employment. This is all the truer in most SSA countries, where the way in which activities are formalized differs from the way in which work is formalized, with different offices and procedures before being detected by the tax authorities.

ISU						
Estimation of treatment effects: effects of event studies						
	Estimation	Standard Error	BI IC	BS IC	N	Switchs
Effect_1	0,1369444	0,159166	-0,1750151	0,4489039	84	9

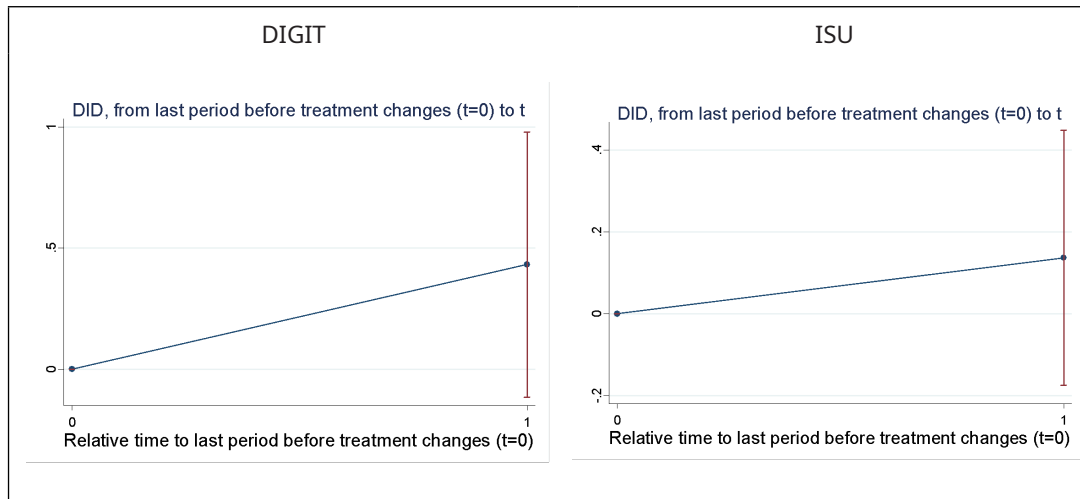
  

Estimation of treatment effects: average total effect per treatment unit`						
	Estimation	Standard Error	BI IC	BS IC	N	Switchs x Periods
Av_tot_eff	0,1369444	0,159166	-0,1750151	0,4489039	84	9

Notes: BI IC: Lower bound of the confidence interval; BS IC: Upper bound of the confidence interval.

Table 6: Results of the estimation of the tax reform of the informal sector on informal employment.

Source: authors.



Graph 2: Representation of the impact of reforms on informal jobs at different periods

Source: authors.

### *Results of the DID approach in a fixed-effects regression framework*

This approach allows us to assess the influence of control variables on the impact of the reforms. Models 1 and 2 assess the impact of digitalizing procedures reform and the informal sector reforms on the level of informality, respectively. Model 3 jointly evaluates the impact of both reforms. To ensure the robustness of our regression estimation, we perform the test of mean differences in Table A1 in the appendix. The results show that there are mean differences between the period before and after the evaluation year. Furthermore, we perform a triple difference by considering the impact evaluation of the DIGIT and ISU reforms as two distinct reforms. In the first approach, we do not have this possibility following the analysis of Wooldridge's work (2007). The results of the mean difference test are encouraging for conducting the regression (Table A2 in the appendix). To obtain more precise results, we perform marginalized estimates by sub-regions.

VARIABLES	Informal Sector			Informal Employment		
	1	2	3	1	2	3
DIGIT	-4,518*** (1,584)		0,761 (5,416)	7,266*** (2,599)		-4,551 (3,329)
ISU		1,784** (0,735)	3,380*** (0,807)		6,643*** (0,974)	6,275*** (0,997)
Double diff	4,160** (1,765)	1,030 (0,976)	11,40* (6,329)	-8,773*** (2,822)	-5,807*** (1,442)	-5,243* (2,801)
MT	0,289 (0,600)	-0,326 (0,534)	0,702 (0,700)	-10,64** (5,376)	-6,590 (5,108)	-4,292 (5,336)
EGOV	-2,329 (3,565)	-3,977 (3,417)	3,987 (4,155)	-1,775*** (0,541)	-1,519*** (0,528)	-1,434*** (0,530)
SP	0,142 (0,355)	0,424 (0,353)	0,734* (0,417)	-0,0905 (0,0872)	0,0398 (0,0869)	0,0381 (0,0877)
DP	-0,388*** (0,0422)	-0,330*** (0,0426)	-0,373*** (0,0508)	-0,0597 (0,0473)	0,00485 (0,0470)	-0,00343 (0,0473)
RRN	0,0575** (0,0271)	0,0663** (0,0270)	0,231*** (0,0317)	-5,248*** (0,660)	-5,236*** (0,642)	-5,367*** (0,645)
TM	1,437*** (0,452)	1,717*** (0,449)	-0,875* (0,529)	-0,319*** (0,0250)	-0,325*** (0,0232)	-0,339*** (0,0244)
DF	-0,153*** (0,0152)	-0,170*** (0,0146)	-0,089*** (0,0178)	-0,0765* (0,0445)	-0,104** (0,0429)	-0,0992** (0,0430)
FBCP	-0,185*** (0,0265)	-0,195*** (0,0265)	-0,00276 (0,0312)	-0,0789** (0,0338)	-0,157*** (0,0350)	-0,152*** (0,0351)
LAF	0,161*** (0,0263)	0,139*** (0,0270)	0,0822*** (0,0318)	1,639* (0,853)	1,395* (0,837)	1,487* (0,857)
TRADE	1,112** (0,479)	1,142** (0,472)	-2,541*** (0,559)	1,639* (0,853)	1,395* (0,837)	1,487* (0,857)
Constant	26,45*** (4,201)	25,38*** (4,152)	51,46*** (4,889)	130,0*** (6,137)	130,6*** (5,909)	130,6*** (5,918)
Observations	760	760	760	513	513	513
R-squared	0,427	0,436	0,425	0,741	0,758	0,761

(.) standard error.

\*\*\*, \*\* and \* represent statistical significance at the 1%, 5% and 10 % levels, respectively.

Table 7: Results of the difference-in-differences estimation.

Source: authors.



The results in Table 7 confirm those from the estimation of the intertemporal DID approach with treatment calendar variations. Indeed, the tax reform on digitalization has a negative effect on the informal sector's size and a positive effect on the level of informal employment. On the other hand, the results regarding the tax reform for the informal sector contradict those of the first estimation approach, as the reform's effect is positive on the size of the informal sector in the economy. This discrepancy may be linked to differences in the estimations of Elgin et al. (2021) and Medina et Schneider (2021) concerning the informal sector. Furthermore, the inclusion of control variables can influence the results obtained.

However, we observe that the use of e-money as a means of tax payment has a negative effect on the level of informal employment, but a positive effect on the size of the informal sector in the economy. This result is consistent with that of Jacolin et al. (2021). Indeed, financial innovation that reduces transaction costs has varied effects on the informal economy depending on transmission channels and economic regulation (Pankomera & van Greunen, 2019). Nevertheless, studies have already highlighted the importance of e-money in promoting equity and the performance of informal sector businesses (Hassan, 2023; Kabengele & Roessling, 2022).

Consistent with the results found in the literature (Ajide & Dada, 2022; Chacaltana et al., 2024; Nguyen et al., 2023), financial development, digitalization of public governance, investment, market size, and government expenditure have a negative effect on the level of informality in the economy.

## Conclusion

The objective of this study was to examine the impact of tax administration reforms on the informal sector and informal employment within Sub-Saharan African (SSA) economies, which are often characterized by a large informal sector. The reforms evaluated here are: i) the implementation of tax digitalization; ii) the introduction of a tax reform for the informal sector; and iii) tax payment via e-money. To this end, we used a difference-in-differences (DID) model for the empirical analyses, and the results obtained fall into two categories. On one hand, we find that tax digitalization and tax reform for the informal sector have a negative effect on the informal sector. On the other hand, the results show that digitalization and the reform of the informal sector positively affect the share of informal jobs in the economy. In light of these findings, it is important to emphasize that in several countries, self-employment is considered informal employment. These informal businesses perform better with the advent of ICT in economic activities. The tax administration reform in relation to the informal sector also positively affects informal jobs. Indeed, SSA countries have not implemented informal reforms benefiting entrepreneurs, especially in online activities that nonetheless generate income.

We recommend that countries adopt a dynamic implementation of ISU reforms, particularly in the area of employment. We contribute to a better understanding of digital reforms, but we cannot judge their absolute effectiveness compared to manual administrations, as African countries are characterized by a high level of digital divides. However, the focus of our study allows us to suggest the intensification and broadening of tax reforms, given their potential benefits for mitigating the informal sector. In addition, following a large body of literature, it is important to seize the opportunity to improve the quality of institutions and harmonize approaches based on successful experiences to optimize the performance of tax administrations. The main limitation of this study lies in the lack of data on the implementation of reforms in the countries. Case studies could explore how informal sector reforms are implemented and assess the outcomes of transitioning activities from the informal to the formal sector.

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## Annexes

	DIGIT & ISU (DDD)	
	PED	ASS
	Informal Sector	Informal Employment
<b>Before the tax administration reform</b>		
Non-adoptive (A)	54.845	136.857
Non-adoptive (B)	51.464	130.464
Adoptive (A)	48.687	140.823
Adoptive (B)	52.225	126.031
Difference (UN)	-6.919 (5.743)	8.517** (4.254)
<b>After the tax administration reform</b>		
Non-adoptive (A)	51.142	139.316
Non-adoptive (B)	46.712	138.519
Adoptive (A)	49.430	139.040
Adoptive (B)	40.519	133.9
Difference (UN)	4.9481* (2.692)	3.275 (2.692)
Differences in Differences	11.399* (6.329)	-5.243* (6.329)
<b>Number of observations</b>		
<b>Before the tax administration reform</b>		
Non-adoptive (A)	175	142
Non-adoptive (B)	244	143
Adoptive (A)	19	12
Adoptive (B)	2	0
Total	440	297
<b>After the tax administration reform</b>		
Non-adoptive (A)	106	87
Non-adoptive (B)	124	65
Adoptive (A)	79	58
Adopter (B)	11	6
Total	320	216

(.) standard error.

\* represent statistical significance at the 10 % level.

Table A1: Test of the mean difference on the difference-in-differences estimates using the second approach

Source: authors.



	Informal sector		Informal employment	
	DIGIT	ISU	DIGIT	ISU
<b>Before the tax administration reform</b>				
Non-adoptive (N)	26.454	26.168	130.019	130.636
Adoptive (UN)	21.936	27.913	137.285	137.279
Difference (UN)	-4.518*** (1.584)	1.745*** (0.669)	7.266*** (2.599)	6.643*** (0.974)
<b>After the tax administration reform</b>				
Non-adoptive (N)	24.240	23.693	135.613	138.085
Adoptive (UN)	23.882	26.597	134.106	138.922
Difference (UN)	-0.358 (0.963)	2.904*** (0.792)	-1.507 (1.259)	0.837 (1.205)
Difference-in-Differences	4.160*** (1.765)	1.030 (0.982)	-8.773*** (2.822)	-5.807*** (1.442)
<b>Number of Observations</b>				
<b>Before the tax administration reform</b>				
Non-adoptive (N)	419	246	285	143
Adoptive (UN)	21	194	12	154
Total	440	440	297	297
<b>After the tax administration reform</b>				
Non-adoptive (N)	230	135	152	71
Adoptive (UN)	90	185	64	145
Total	320	320	216	216

(.) standard error.

\*\*\* represent statistical significance at the 1 % level.

Table A2: Test of the mean difference on the difference-in-differences estimates using the second approach

Source: authors.