Gender Gap Productivity in Digital Era: the case of Sub-Saharan Africa SMEs

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Abstract:

Despite the rapid adoption of ICTs over the past two decades in sub-Saharan Africa, it remains widely recognized that women benefit less from the benefits associated with these technologies compared to their male counterparts. However, there is still very little empirical evidence on the contribution of ICTs to the gender productivity gap. Thus, this research aims to examine the effect of ICT adoption on the gender productivity gap in sub-Saharan Africa. Specifically, we analyze whether women-led firms are less productive than male-led firms on the one hand. and on the other hand, we also examine whether ICT adoption in these SMEs hinders or reduces gender labour productivity gaps. The paper uses data from the World Bank's Business Survey of Fifteen Sub-Saharan African Countries for the years 2013-2018. ICT is captured here by three key variables, including: Email; the website; and finally, mobile money. After estimating the determinants of productivity by MCOs, the results show that email and website variables have a positive effect on SME productivity, while mobile money has a negative effect. These results are confirmed when we correct for endogeneity bias with IVs. The breakdown of productivity by the Blinder-Oaxaca method shows a productivity gap of 44.7% to the detriment of women managers. The results are confirmed with the RIF decomposition which shows us a more pronounced gap in the 75th and 95th quantiles of productivity. These variances are mainly due to staffing factors, namely mobile money and the number of years of experience of managers. In addition, we find that the level of adoption of mobile money helps to close the gap, while the return on website usage by female CEOs helps to reduce the gender productivity gap. At the same time, we also find that the interaction between the level of adoption and the performance of a website can reduce the productivity gap between men and women managers. Based on these results, we recommend that women managers increase their level of ICT adoption on the one hand and make up for their low number of years of experience with training and retraining programs that can improve their managerial capacity.

Keywords: ICT; the gender gap; Productivity; SME; IV; MCO; RIF; Oaxaca-Blinder.

Introduction

Small and medium-sized enterprises (SMEs) are very often defined based on two different criteria: employment, turnover or investment (Mausumi & Naveen, 2016). In this research, we define SMEs according to the employment-based approach, which states that SMEs are "any firm with between 5 and 99 employees" (Beck & al, 2005). The critical role of SMEs in achieving the SDGs[1] (SDG 1[2]; SDG2[3]; SDG3[4] and SDG5[5]) has made it a priority area and a key policy instrument for achieving structural transformation in developing countries (Gries & Naude, 2010; Dias and McDermott, 2006). Although an important and significant lever for economic development, SMEs very often face many challenges and constraints (Baig & al, 2020; Espinoza-Mendez and Correa, 2022). Among these challenges we can mention the capacity to adapt and absorb new technologies (in this case Information and Communication Technologies-ICT).

Indeed, under the conditions of the new economy, ICT development has become one of the most important sources for increasing the productivity of enterprises (productivity being understood as the relationship between inputs and outputs in the production process). ICT refers to any tools for storing, sharing, and transforming information (Taylor, 2019). There is extensive literature on the socio-economic role of this technology. Among other things, ICTs allow the various actors in economic and social life to have quick and easy access to information and knowledge (Sepehrdoust, 2018). They also allow access to new markets with lower investment costs thanks to the increased efficiency of the functioning of markets, they reduce regional disparities in income and productivity, allow access to human capital via telegrid (Pradhan & al, 2018); the use of ICTs, especially internet access, can promote sustainable development, entrepreneurship of small and micro-enterprises as it reduces the difficulty of obtaining finance by mitigating information asymmetry and reducing agency costs (Chen & al, 2018).

A study by McKinsey, conducted in 2014, indicates that companies that succeed in their digital transformation have a potential gross increase in their operating income of 40% while those that do not run the risk of seeing their operating profit fall by 20% (World Bank, 2016). Recently, the AUC/OECD report (2021), based on company data, argued that the existence of a website within a structure can increase annual sales by: 37 to 38%; 22 to 23% sales per worker; from 12% to 14% the number of full-time workers and 5.5% the share of direct exports in business sales.

[1] Sustainable Development Goals
[2] Eradicating poverty
[3] Zero hunger
[4] Robust
[5] Gender equality

From a theoretical point of view, *the leapfrogging theory* proposed by Brezis & al, (1993) highlighted the role of technological revolutions in stimulating a reversal of fortunes between nations on a global scale. This theory states that, in the context of major technological change, an "advanced" country's dependence on old technologies can make a new technology unattractive in the short term, as it is less profitable, thus delaying its adoption. On the other hand, countries lagging in old technology, which are less wealthy and have lower wage levels, have a much stronger incentive to abandon the old technology and adopt the new technology in a catch-up perspective of advanced countries (Cariolle & Caroll, 2020), which is much more cost-effective from their perspective. The adoption of new technologies by lagging countries leads to increased productivity, employment and output in sectors using the new technology. Countries that were previously lagging then take the lead in technology-intensive sectors.

Thus, based on the catching-up theory described above, the future of economic progress on the African continent will undoubtedly depend on the diffusion of digital technologies (Aker & Mbiti, 2010; Schuman & Kende, 2013). While the continent has particularly distinguished itself in terms of the adoption of mobile technologies over the past decade (which has facilitated the proliferation of internet-based innovations), this dynamic has quickly been confronted with the problem of the digital divide. In 2015, Internet penetration rates in African countries did not exceed 60% of the population, with some countries such as Niger, Sierra Leone or Guinea-Bissau having penetration rates below 5% of the population (Carriolle & Caroll, 2020).

According to the IMF (2020), 20 million jobs are expected to be created per year in sub-Saharan Africa to absorb the subcontinent's demographic dividend. Yet, in the formal sector, less than 50% of SMEs in the formal sector have a website compared to 87% of large enterprises (AUC/OECD, 2021). This has a direct impact on job creation because, today, in Africa, only 17% of start-up entrepreneurs hope to create at least six jobs, the lowest percentage in the world (Up Cit.). In addition to technological capacity, the literature also identifies the role of the principal manager as a determinant of SME productivity (Forbes & Milliken, 1999; Daily & Dalton, 2003).

Starting from the "*upper echelon*" theory (Hambrick & Mason, 1984; Hambrick, 2007) and *resource-based-view* (RBV) theory, which state that it is the combination of the CEO's personal traits and a firm's productive capabilities that lead to a sustainable competitive advantage (Barney, 1991; Madhani, 2010), several authors have pointed out in their work that strategic decisions made by the company's top executive would have a direct impact on the company's performance (Lee & al, 2018; Saeed & Zaialhaq, 2018). To this end, the literature has increasingly focused on determining whether the demographic characteristics (*in this case the gender-specific character*) of the CEO of the firm could explain the differences in productivity between SMEs (Flabbi & al, 2019; El-Shal & Morsy, 2020; Novita & Ariani, 2022).

In fact, the gender performance gap within firms is a key topic in female entrepreneurship that has received considerable attention over the past decade (Barasa, 2020). While the efforts of economic development programs through their implementation (notably SDG5) tend to try to address gender inequalities, the problem remains as intense as ever. Indeed, there is still an imbalance between the role of men and women as actors and beneficiaries of development results within companies (Novita & Ariani, 2022). In their leadership role, women often face constraints ranging from discrimination of any kind to access to human and technological capital (Sabarwal & al, 2009). This is very important in the African context where women are very often marginalized from CEO positions (Up Cit.).

Many studies have examined the effect of CEO gender on firm performance indicators (Kiefer & al, 2022). These studies have attempted, through various methodologies, to highlight the existence of a gap between women's and men-led businesses. While several of them report that firms with women senior managers have lower sales and profits compared to male-managed firms, (Coleman, 2007; Fernando & al, 2020; Islam and Amin, 2023). Other studies find no difference in firm performance by gender (Kepler & Shane, 2011; Watson, 2002). Still others even find that female-owned and/or female-owned firms perform better in terms of sales and profits than firms that are owned and/or managed by men (Hashimzade & Rodionova, 2013; Vershinina & al, 2020).

Although the literature on the gender productivity gap seems voluminous, it is important to note that most existing work concerns SMEs in advanced economies and Asian countries, evidence on middle-income economies in this case SSA is scarce (if one excludes of course the gender productivity gap in the agricultural sector which has received sufficient attention). Moreover, despite the proliferation of ICTs around the world, few studies have looked at their impact on the gender disparities of the company's senior manager. Thus, in view of all the above, this research attempts to answer the following question: **What is the effect of ICT adoption on the productivity gap of SMEs according to the gender character of the leader in sub-Saharan Africa?** To answer this question :

- We first examine the existence of the gender productivity gap;
- Then we determine the gender productivity gap;
- Finally, we analyze the contribution of ICT to this productivity gap.

To answer these questions, we opt for a quantitative methodological approach. Our data comes from the World Bank's Enterprise Surveys for the period 2016-2018. Companies run by women are defined as companies where the top manager is a woman, and, conversely, companies run by men are defined as companies where the top manager is a man. Business surveys are nationally representative and use the same questionnaire and methodology across countries. This characteristic is important given that most studies on gender and labor productivity gaps

are either country-specific (especially in agriculture) or region-specific (Islam & al, 2020). ICTs are captured here by three variables: the use of e-mail to communicate; The website and mobile money.

Our contribution to the economic literature is threefold. As a first step, we document and develop a theoretical framework highlighting the channels of transmission and potential interaction between ICTs, women leaders and SME productivity.

Our second contribution is to decompose the observed gender productivity gaps by going beyond traditional decomposition methods. Indeed, a widely used approach to decomposing the sources of gender productivity gaps was to attribute the average deviation to differences in observable characteristics (staffing effect) and differences in performance of these same observable attributes (structure effect). This approach, derived from Oaxaca (1973) and Blinder (1973), thus called the Oaxaca-Blinder decomposition, has been widely applied in previous studies. However, more recently, it has been argued in the gender gap literature that the observed gap is a very complex phenomenon that can only be aggravated by average comparison analysis and can also vary across the productivity distribution. The productivity potentials of women at the top or bottom of the distribution may be significantly different. It would therefore be misleading to assume a constant productivity gap throughout the productivity distribution. To account for the possibility that covariates have marginal effects that are not constant and vary according to the position of the firm in the productivity distribution, we rely on unconditional quantile regressions that decompose gender gaps across the distribution. The fundamental advantage of the quantile decomposition approach over the traditional mean-based approach such as the Oaxaca-Blinder method is that it allows the possibility that individual characteristics may have differential returns at different points in the distribution (Mukasa & al, 2015).

Finally, our final contribution is to estimate the potential productivity gains that would be achieved if we gradually or completely reduced the differences in ICT adoption between male and female managers. We are thus carrying out a forecasting study where the reduction of the gender productivity gap would be the result of a more than proportional increase in access to and use of ICTs in women-owned enterprises but also of the complementary framework that makes the use of ICT effective for a company.

The rest of this work is organized in three main sections: the first relating the essence of the economic literature on our question; The methodology is then presented in the second section and finally our last section concludes our research while elaborating the economic policy recommendations.

1. Lessons from the economic literature on the ICT-gender labour productivity gap

This section is divided into two subsections: the first highlights the theoretical and empirical framework related to gender differences in productivity (1.1). This first subsection is very important because the magnitude of the effects of ICT adoption on the productivity gap between male- and female-led firms will depend heavily on how the main channels of ICT transmission on labor productivity could affect the gender of the leader. And our second subsection looks at the effect of ICT on productivity (1.2). In this second part, we focus on the mechanisms by which ICT affects factor productivity.

1.1. Gender productivity gap

Despite the increase in women's economic participation in most countries, gender wage inequalities, occupational segregation and the underrepresentation of women in leadership positions in both the private and public sectors persist. Similarly, more recent research has highlighted gender differences in labour productivity (Campos & Gassier, 2017; Nagler & Naudé, 2017; Islam & al, 2020; Tsou & al, 2019; Tahir & al, 2021; Islam & Amin, 2022). The theoretical basis of this research on gender and labour productivity within firms very often comes from two main theories: social role theory and resource theory.

Social role theory suggests that women will underperform because of institutionalized and systematic discrimination against women that deprives them of access to essential resources that can be called endowment factors (Fischer & al, 1993). Thus, this theory assumes that higher economic development and gender equality will break down gender roles, thereby reducing or eliminating gender differences in preferences and performance (Falke & Hermle, 2018). In other words, if there are gender differences in performance, there must be some segregation in access to productive resources by female CEOs (Allison & al, 2023).

While the second theoretical current, resource theory, holds that men and women have inherently unique characteristics that can explain differences in productivity (Cirera & Qadim, 2014). This argument is based on the precondition that self-expression contributes to the satisfaction of basic resource needs (Haushofer & Fehr, 2014). This expression counterintuitively leads to more pronounced gender differences because women and men have sufficient resources to independently increase and express their respective preferences. So, starting from these two theoretical currents, the purpose of this subsection will be to review the constraining factors that influence the choices of women managers and therefore these strategic choices have an impact on the performance of the company in a broad way. For this purpose, we classify these factors into two main categories: staffing factors and preference factors.

1.1.1 Endowment factors and gender gap

It is well recognized in the literature that production depends on several factors that significantly impact the performance of companies, whether turnover or productivity. Therefore, differences in endowments may help explain the gender gap in business development (Campos & Gassier, 2017). Specifically, we analyze three main staffing factors here: *(a)* access to finance; *(b)* access to human capital and skills and *(c)* adoption of new technologies and innovation.

(a) Access to finance :

Financial capital is undoubtedly one of the most essential resources for the success of any business (Beck & al, 2005). However, many research studies indicate that women employ lower levels of debt and/or equity than men (Coleman & Robb, 2018; Bui & al, 2019; Babalola & al, 2021). Indeed, it is well established in the literature that women are more risk-averse than men (Powell & Ansic, 1997; Jianakoplos & Bernasek, 1998). Since this risk hesitancy is precisely related to financial barriers and investment portfolios, women CEOs become less likely to be granted outstanding loans, use business credit cards, or borrow using trade credit (Robb & Wolken, 2002; Zalata & al, 2019; Dadanlar & Abebe, 2020). To this extent, women-led businesses tend to be smaller, less internationalized, and grow more slowly than those run by men (Allison & al, 2023). As a result, difficulties in obtaining financing are often cited as a key reason for their low returns. Empirical evidence partially supports the fact that female CEOs tend to be less solicited for credit than their male counterparts. For example, Demiguc-Kunt and Klapper (2014), based on global financial inclusion data and show that only 6% of women in Africa compared to 7% of men had obtained a loan from a financial institution in 2013. In addition, the authors also find that in terms of savings, 33% of men and 25% of women in sub-Saharan Africa had an account in a formal institution. And that 13% of men versus only 10% of women had mobile money accounts. However, other authors, such as Aterido & al. (2011), find no evidence that women are disadvantaged in terms of access to finance provided they can control the characteristics of the firm and entrepreneur.

(b) Access to human capital and skills:

To achieve their factor productivity targets, firms need to invest appropriately in labor and human capital. Employers may view overqualified workers as an "insurance package" against productivity losses in difficult times (Allison & al, 2023). For example, women CEOs may think that hiring a more educated and skilled workforce will generate better performance results to boost productivity in times of uncertainty or downturn. However, overqualified workers are also characterized by higher turnover rates (Verhaest & Omey 2009) compared to workers whose skills and education match their jobs appropriately. Staff turnover and dissatisfaction lead to a decrease in the productivity of existing employees, which contributes to an overall

negative corporate culture. Thus, the implication is that companies should hire to match skill and education levels to the actual requirements of the task associated with a given job. But the acquisition of an over-skilled workforce leads to disgruntled and uncommitted workers and increases the costs of recruitment, integration, and training.

All these factors are in addition to the fact that female CEOs are more likely to focus on social value goals than male CEOs (Hechavarria & al, 2012; Hechavarria & al, 2017). In addition, they may consider that improving employee well-being (for example, providing employees with a living wage and a permanent contract) is just as important, if not much more important, than maximizing the company's profits. These practices will drive up labor costs for women-led businesses and will once again create a productivity gap.

(c) Adoption of new technologies and innovation

Economic literature widely argues that the adoption of new technologies and innovation as well as access to finance are substantial for a firm's growth, survival and TFP (Ahudja & Thatcher, 2005; Aiello & Ricotta, 2016; Makarius & al, 2020). Overall, the adoption and conversion of new technologies into innovative processes and applications is fundamental to underpinning a company's long-term competitive position. However, a company's decisions to adopt or not adopt a technology or undertake innovative activities depend heavily on a few factors, such as the skills of the workforce and the strategic decision-making that very often falls to the company's CEO. These decisions, in turn, depend on factors related to the business environment (which is, as discussed above, hostile depending on the gender of the CEO) that influence incentives and risk-return considerations. For example, when it comes to ICTs, internet adoption rates have spread unevenly, becoming a likely source of productivity difference between female and male CEOs (Orser & al, 2018; Voss & al, 2021; Alam & al, 2022).

Although the literature on SME adoption of new technologies and gender diversity has grown rapidly in recent years, few studies attempt to explain gender disparities in management decisions regarding innovation and technology adoption, and the evidence provided to determine whether women-led firms are more or less likely than male-led firms to undertake activities. innovative are mixed. For example, focusing on the case of Vietnamese SMEs, Hoang & al, (2021) analyze whether women-led enterprises are innovative than those run by men and whether this affects their respective productivity. The authors find that although female managers innovate less than their male counterparts, they are not less productive if and only if the role of innovation in the firm is controlled by other variables. However, they also find that overall, innovative firms are nevertheless 23% more productive than non-innovators. This gap was mainly due to the fact that innovative firms adopted new technologies more than less innovative ones. On the contrary, Wu & al, (2021), in examining the impact of women CTO

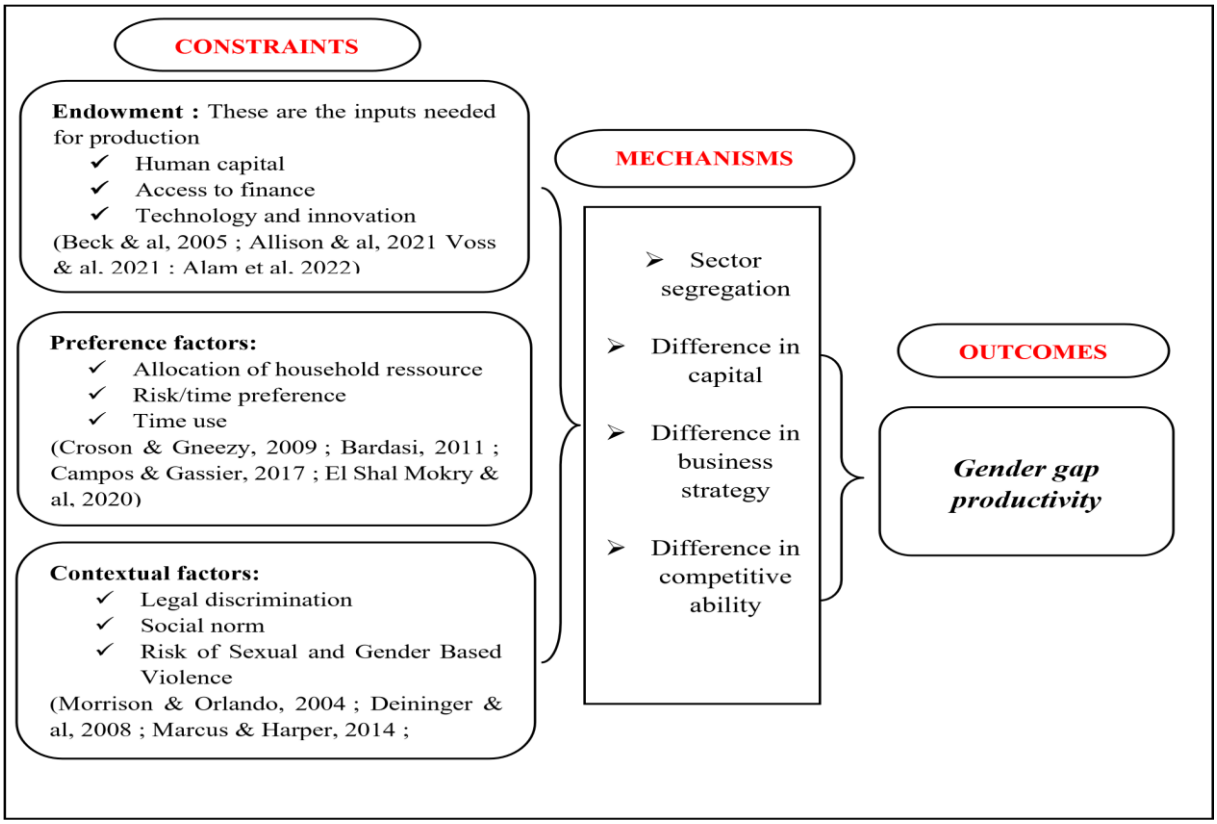
(Chief Technology Officers) on innovation within Chinese companies, find that companies whose director is a woman are more innovative (in terms of patents and patent citations) than those therefore the CTO is a man. Moreover, they argue that this effect is much more pronounced for SMEs with a favorable environment for innovation (strong diffusion of new technologies in particular) and for those whose CEO was also a woman.

1.1.2 The role of preference factors

Not only can labor productivity in women-led firms be limited by staffing factors, but also CEO preferences and social responsibilities (within the household to be precise) can also lead to a gender productivity gap (Campos & Gassier, 2017; El-Shal & Morsy, 2020). Indeed, in a world without market failures, standard economic theory would predict that business leaders and entrepreneurs would separate the maximization of business profits from other decisions in their lives. Subsequently, the individual earnings of their business would provide income to their household, with household decisions and business decisions remaining separate.

But when market failures exist and managers, for example, face staffing constraints (rigidity in access to credit, limited access to highly skilled labor), their decisions are influenced by their personal preferences (Campos & Gassier, 2017; Croson & Gneezy, 2009). This occurs with market failures that are not necessarily gender-specific (for example, in the absence of properly functioning credit markets, business owners must make decisions about consumption versus household or business investment) within the limits of the limited resources available. Therefore, in contexts where there are market failures – the norm in African countries – business choices will be limited and shaped by the preferences of the entrepreneur herself and other members of her household. Here we examine the importance of three types of preferences (*a*) biases in household resource allocation, *(b) women's prioritization of domestic spending and its relationship to time and risk preferences,* and (*c)* gender differences in time use and market activities. In conclusion, the following diagram can allow us to describe how different factors of constraint between the sexes can lead to differences in performance.

Figure 1: ICT adoption in SMEs in sub-Saharan Africa, by gender of CEO



Source : Campos & Gassier, (2017)

1.2. Effects of ICT on labour productivity

A wide range of economic literature has assessed the ICT-productivity relationship by trying very often to answer one of two questions: 1) what is the effect of ICT on productivity? 2) How can ICTs contribute to productivity growth? The two questions being closely linked, we will go around the answers by studying the transmission channels of ICT on productivity. Thus, first we address the spillover effect of ICT on productivity (1.2.1), then we then deal with the complementary effect of ICT on human capital (1.2.2).

1.2.1 Spillover effects: ICT a General-Purpose Technology (GPT)

The spillover effect of ICT assumes that ICT is a general-purpose technology (GPT) that can lead to indirect positive or negative consequences on the economy through the diffusion of digital technologies and digital knowledge outside the enterprise (Lipsey & al, 2005; Cariolle & Caroll, 2020). Indeed, considering ICT as GPT arises from the fact that it is part of the goods or services currently produced (e.g. smartphones; computers) and technological improvement and productivity growth in ICT-producing sectors have a direct effect on overall productivity that is proportional to the size of the ICT sector (Jorgenson & al, 2002; Gordon, 2012 Van Ark

& al, 2008). But, as they play a substantial role in the treatment; storage; The transmission of information and in reducing market failures related to information asymmetries, ICTs also affect productivity in the sectors that use them but indirectly. Specifically, ICTs are catalysts for product, process, and organizational innovation in user sectors, which, according to Bresnahan & Trajtenberg (1995), refers to them as general-purpose technologies (GPTs) ubiquitous technologies, i.e., technologies applicable for multiple purposes, leading to continuous improvement and experimentation and while facilitating innovation (through co-inventions). For example, the use of commercial platforms and even social networks nowadays have direct effects on the turnover of SMEs today. In general, these indirect externalities can occur at three levels.

First, the spillover effect of ICTs can result from "*network effects*", induced by a greater diffusion of digital technologies among firms, contributing to multiplying and accelerating interactions between adopters of these technologies (Stiroh, 2002; Van Reenen & al, 2010). For example, Leeuwen & Van der Weil (2003) find a positive spillover effect of ICT use and significant spillover effect on labour productivity and TFP growth for Dutch firms in the service sector for the period 1994-1998. Other authors find that this effect can only be important if they sufficiently shift their digital technological frontier (Crémer & al, 2000; Goldfarb & Tucker, 2019).

Second, the positive externalities of ICT result from the knowledge economy. This is the impact of improved information flow (e.g., when upstream and downstream firms share ideas, practices, and production processes) within industries induced by the use of ICT infrastructure (Harrison & al, 1999; Paunov & Rollo, 2016). While the first type of externalities has received sufficient attention, this second group, however, has not been sufficiently documented empirically.

Finally, the spillover effect of ICT can be negative if intensive use of ICT by other firms results in increased competition, which in turn may result in a loss of revenue for firms with limited technological absorptive capacity such as SMEs in most cases (Görg & Greenaway, 2004; Marsh & al, 2017). In fact, faster adoption, and more efficient use of ICT by large companies can reduce the market share of other companies or even cause them to exit foreign or domestic markets altogether. This limited adoption is often explained by the cost of the new technology; adaptability difficulties often related to the digital literacy problem (Orser & al, 2019). The latter justified the emergence of another current in the literature on the link between ICT and productivity: the complementarity effect between ICT and human capital.

1.2.2 Complementary effect of ICTs on human capital

In general, the hypothesis of complementarity dating back to Milgrom and Roberts (1990) states that the use of the full potential of new technologies, in this case ICT, requires complementary changes (investments in human capital or infrastructure) both at the micro level (work organization, investment in employees' skills, introduction changes in business processes) and at the macro level (increase in the capital stock). human, introduction of institutional changes favoring the flexibility of markets and thus the diffusion of new technologies). A list of these complementary effects of ICTs was presented by (Brynjolfsson & Brown, 2005). The authors identified seven pillars of the digital organization that improve a company's productivity and market value: moving from analog to digital; open access to information; employee empowerment; use of merit-based incentives; invest in the cultural company; recruit the right people; and investing in human capital.

Although it has emerged over the past two decades, several authors have nevertheless been interested in empirically verifying this hypothesis of ICT complementarity. To achieve this, they determine the combined effect of human capital (level of education; specific skills such as digital) and ICT tools (internet, smartphones, computers, software) on productivity. Bresnahan & al, (2001) examined the conditions for ICT investment to become productive within US firms (in terms of organizational adaptations). The authors find that in the short term, the introduction of ICT may involve layoffs of employees and low or even negative productivity gains, while in the medium to long term, the deep adoption of ICT requires a reorganization of the internal workplace and high skills to generate productivity gains.

Recently, Baker & al (2020) looked at the effect of the use of the internet mediator to human capital on labor productivity in 65 developing countries for the period 2000-2014. After estimating a fixed-effects panel, the results revealed a mediation effect of 24.20% of the internet on the total effect of human capital on total labor productivity, and 27% on labor productivity in services and 23% in industry. Mediation has been inconsistent in the agriculture sector. On the other hand, several studies in other contexts have shown that the expansion of ICT poses a risk to the labor market. For example, recent studies in industrialized countries (Akerman & al, 2015; Acemoglu & Restrepo, 2016) hypothesize that the introduction and penetration of digital technologies contributes to the polarization of the labor market by increasing the demand for skilled and educated workers at the expense of lower-skilled workers.

In conclusion, the literature provides conclusive evidence on gender constraints and firm performance on the one hand and the effects of ICT on productivity growth on the other. However, the issues of spillover related to the management of companies in relation to the effective use of ICT remain mostly unexplored. In addition, there is also a neglect of women's participation in work on the effect of ICT on productivity. And yet addressing this

aspect could provide solutions to the reduction of gender inequalities, particularly within SMEs. Moreover, most of the work has focused on developed economies rather than low-income countries such as SSA. It is with this in mind that this research attempts to improve the existing literature. To our knowledge, this is the first assessment of the effect of ICT adoption on gender gaps in labor productivity among SMEs. The use of productivity decomposition techniques makes it possible to disentangle the various factors that explain the gender gap in labor productivity. The analysis in this paper complements other recent analyses that have investigated the gender productivity gap using cross-national firm-level data (Islam et al, 2020; Allison & al, 2023; El-Shal & Morsy, 2020).

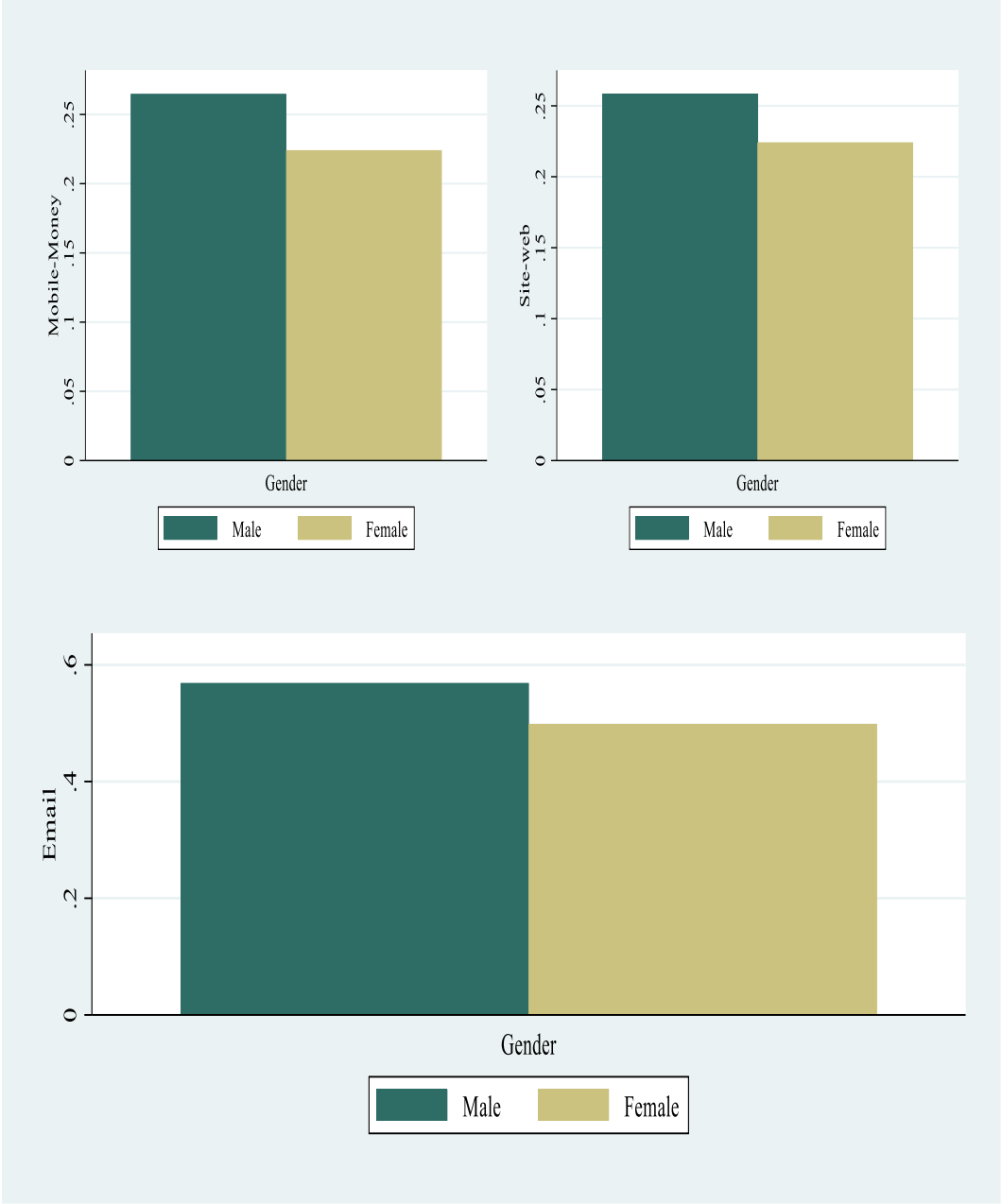
2. ICT Adoption and SME Labor Productivity in SSA: Stylized Facts

The objective of this section is to provide descriptive evidence on ICT adoption among African SMEs by focusing on gender differences. Three main ICT measures are discussed here: use of e-mail; Website and financial technology or mobile money. On the other hand, we also graphically analyze the correlation between the adoption of these technologies and labour productivity within SMEs. These stylized facts focus on 15 SSA countries over the period 2013-2018 using standard data from Enterprise Surveys.

2.1. ICT adoption in SMEs by gender of manager

This subsection deals with the dissemination of ICTs (Email; website and mobile money). First, we compare the level of use of mobile money in the various financial transactions within the company according to the gender of the CEO. We observe that on average 27% of male-led SMEs use mobile money in their various financial transactions compared to 22% of SMEs with a female CEO. Similarly, when we look at the graph of website availability, we see that 25% of SMEs run by a man say they have a website compared to 22% of SMEs run by women. Similarly, the email usage graph shows us that on average 57% of male-led companies regularly communicate with email compared to only 50% of female CEOs. Overall, these figures reflect striking differences in ICT diffusion by CEO gender. This could certainly influence the productivity of the company and therefore widen gender inequalities.

Figure 2: ICT adoption in SMEs in sub-Saharan Africa, by gender of CEO



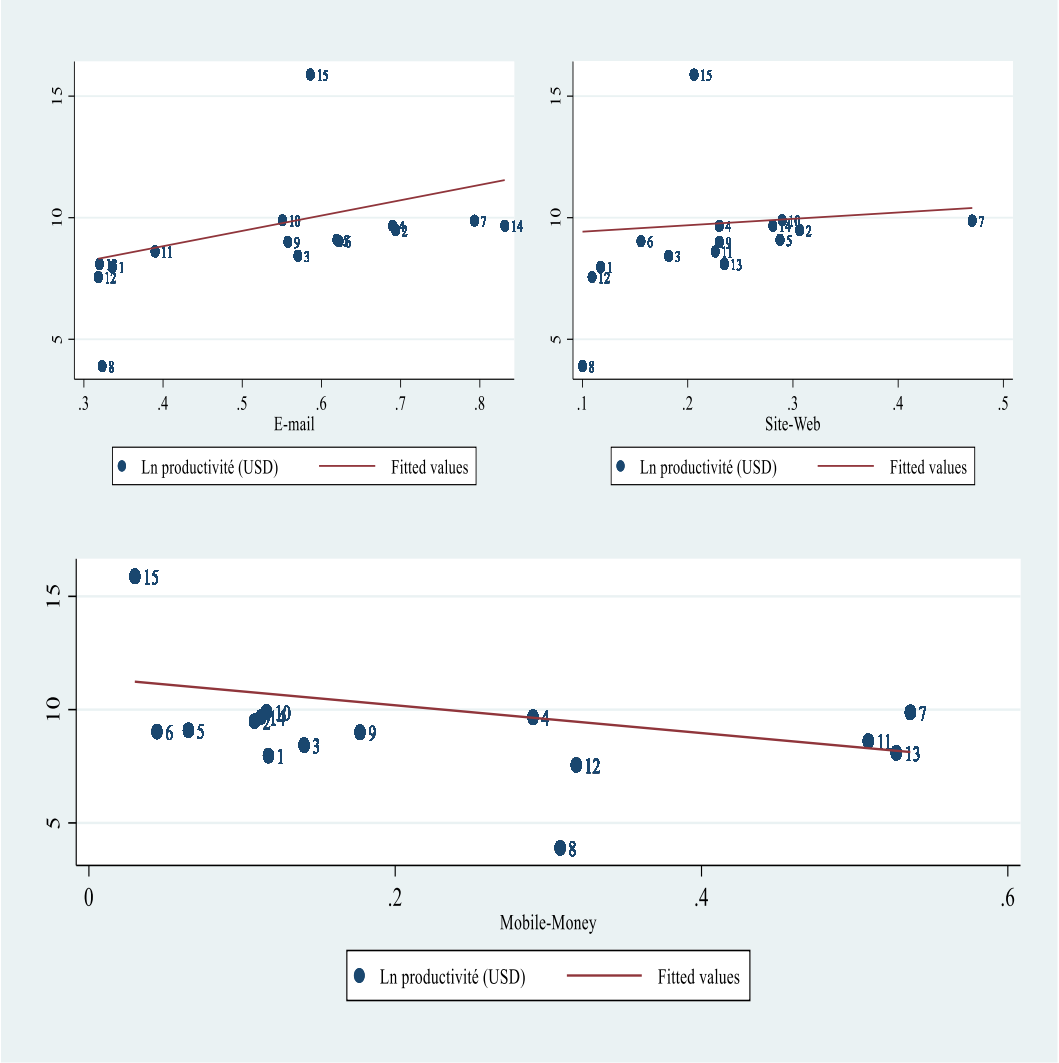
Source : Author

2.2. Effect of ICT adoption on SME labour productivity

Figure 3 illustrates the correlations between the impact of ICT adoption (email, website and mobile) on firm productivity at the year level and the country averages of our sample and the variables considered. Based on this simple graphical correlation, we make two major observations. On the one hand, there is a positive relationship between labor productivity and e-mail and the website. And on the other hand, there is a negative relationship between the use of mobile money and labor productivity. This is not surprising given the relatively low

percentage of companies using this technology. This graph therefore suggests a mixed effect of ICT adoption on labor productivity because depending on the indicator it can be positive or negative.

Fihure 3: Correlation between ICT adoption and SME productivity, by country



Source: Author

3. Econometric evaluation of the effect of ICT adoption on gender gap productivity in SSA

Following the work of Essers & al, (2021) we assume a production function that takes the form of the standard Cobb-Douglas specification:

$$y_i = A_i L_i^{\beta_1} K_i^{\beta_2} \qquad with\ \beta_1\ et\ \beta_2 > 0 \quad \textbf{(1)}$$

Where Y, L, K represent production, labour inputs and capital respectively within firm *i*. A is the Hicks neutral efficiency level, which captures total factor productivity or unincorporated

technical change (Hsieh & Goel, 2019). Here it is approximated by the stock of R&D as in the work of Essers & al, (2021). A logarithmic transformation of the above equation allows us to introduce linear modeling as follows:

$$y_i = \beta_0 + \beta_1 l_i + \beta_2 k_i + \varepsilon_i \qquad \textbf{(2)}$$

With β_0 captures the average efficiency between firms over time and $\varepsilon_i$is the error term has two components. Based on the work of Nkama, (2014) and Kim & al., (2021), we now assume that the overall capital stock K can be adjusted in such a way that it can be divided into ICT and non-ICT capital as follows:

$$y_i = \beta_0 + \beta_1 l_i + \beta_2 ICT_i + \beta_3 NICT_i + \beta_4 Z_i + \varepsilon_i \qquad \textbf{(3)}$$

With Z the vector of our control variables. This model is estimated to meet the first objective of this research work, namely, to examine the determinants of labor productivity in SSA SMEs.

Model 3 above is estimated based on fixed-effect OLMs because the temporal dimension is not available as in the panel data. This equation is estimated in two subregions (North and Central Asia and South-South-West Asia) because of their well-balanced country representation, and for each country covered by this study. However, given that the MCO method is not the most efficient estimation method in econometrics, and that the economic literature highlights the existence of endogeneity bias (Cette & al, 2021; Vaumi & al, 2022) due to a bidirectional causality between ICT and productivity, we perform a robustness analysis of our results using the Instrumental Variables (IV) method.

On the other hand, one of the questions that arises is whether the productivity gap is pervasive in all sectors of activity, or whether it is a function of the size of the firm or the geographical area. The possibility that the productivity gap is limited to one sector or firm size group cannot be excluded, as men and women tend to be separated by sector and by firms of different types (Amin & Islam, 2014; Goldin 2014). A productivity gap that is limited to one sector or firm size group has very different policy implications than those that are pervasive across all sectors and firm sizes. Thus, we check the productivity gap for each sector, group of companies, according to the size and gender of the CEO.

3.1. Method of decomposition of labour productivity

After Aterido & al, (2013); Kilic & al, (2015) and Islam & al, (2020), an Oaxaca-Blinder decomposition approach (OB, 1973) is first applied to examine the various factors contributing to productivity gaps between female-led and male-led firms. As a result, we first run a model of the determinants of labor productivity for each country and sex group by including the same set of control variables, including ICT.

Consider *y* as the natural logarithm of labor productivity, g as the sex of the firm's chief executive, and *X* as a vector of *K+1* dimension comprising all observable factors as well as the use and intensity of labor, non-work-related and ICT inputs that encompass firm-level characteristics and elements of the business environment that can determine whether relationships are causal. The determinants of labor productivity can then be modelled using the following production function:

$$y = \beta_g + \sum_{j=1}^{k} \alpha_j X_j + \varepsilon \quad \textbf{(1)}$$

Where j and β are unknown parameters to estimate and ε is the error term. This model is first estimated for all the countries in the sample. Then, the existence of a productivity gap is assessed by testing the size of the β in our equation (1). If the estimated coefficient is negative and significant, this indicates the presence of a productivity differential to the detriment of women-led enterprises and a contrary conclusion will be drawn if it is not. We also estimated equation (1) separately according to the gender of the company director to identify any significant differences in the impact of ICT on labor productivity.

The advantage of this approach is that it isolates the impact of the gender of the firm manager on the level of labor productivity after controlling for differences in the other variables observed. However, given the inability of this model to identify the root causes that trigger productivity differences between male and female managers, the Oaxaca-Blinder (1973) decomposition procedure is necessary. This allows us to understand whether the estimated productivity differences are due to differences in levels of observable characteristics, particularly ICT endowment, between male and female managers (staffing effect), or to differences in the returns of these characteristics between the two groups (structural effect), or even to differences in the levels and returns of these observable characteristics (interaction effect). The decomposition begins with equation (1) which is estimated for the pooled sample as well as the sex of the entrepreneur as follows:

$$y_g = \beta_g + \sum_{j=1}^{k} \alpha_{gj} X_{gj} + \varepsilon_g \quad \textbf{(2)}$$

With g={m;f}; and ε_g is now the gender-specific random error term. The rationale for the Oaxaca and Blinder decomposition approach is therefore to show how much of the difference in average productivity, $G=E(y_m) + E(y_f)$, et $E(y_m)\ et\ E(y_f)$ designating the expected values of labor productivity by male and female managers, is explained by gender differences in the levels and returns of variables in vector X.

According to Daymont and Andrisani (1984) and Jann (2008), the productivity gap between gender G can also be written as follows:

Soit G l'écart of gender productivity:

$$G=E(y_m) - E(y_f) = \left[E(X_m) - E(X_f)\right]'\beta_f + E(X_m)'(\beta_m - \beta_f) + \left[E(X_m) - E(X_f)\right]'(\beta_m - \beta_f) \quad (3)$$

Endowment effect Structural effect Interaction effect

From the previous equation it follows that the gender productivity gap can be explained by three distinct factors:

(i) Endowment effect: this is the difference between male and female managers due to the attributes or influence of certain factors as explained on the productivity of the firm's work. A positive effect of any of these factors implies that male managers have a staffing advantage over female managers with respect to the variable in question, while a negative effect suggests the opposite. The same reasoning applies to all other components ;

(ii) Structural effect: structural effects refer to the role of output factors or attributes of firms that lead to the widening or narrowing of the labor productivity gap between women's and men's enterprises;

(iii) Interaction effect: captures the share of the productivity gap from simultaneous differences in predictors and their coefficient.

3.2. Data and choice of variables

The data source for our analysis is based on World Bank Business Surveys (GEs). The dataset covers a representative sample of approximately 3238 enterprises for 15 SSA countries studied between 2013 and 2018 (list of countries in the sample is presented in Table 1). The ES database are nationally representative surveys of formal enterprises (micro, small, medium, and large). These surveys cover manufacturing and service enterprises, excluding mining and quarrying and agriculture. The survey is implemented using stratified random sampling with location (in the country), sector and size as strata. Survey respondents are mostly business owners or senior executives. The use of a standardized survey instrument and methodology allows for the comparison of savings. The surveys cover several topics, including corruption, access to finance, infrastructure, competition, crime, labour, barriers to the business environment and business performance. We focus on the main manager, rather than the owner(s) of the company, because this is a well-defined concept, even for companies with multiple owners or shareholders, and because, as we mentioned above, strategic decision-making in the company strongly influences the performance of companies. A detailed analysis of the variables (dependent and independent) of the model is presented in the following paragraphs.

(i) k Dependent variable: Following previous work, as a measure of labour productivity we opt for the log of total firm sales divided by the total number of workers (Nkama, 2014; Wu & Cheng, 2016; Black, 2019; Islam & al, 2020, 2023). It is particularly suitable for a comparative analysis of productivity within firms because it allows for the heterogeneity of firms (Essers &

al, 2021). All local currency values are converted to USD. Since many companies do not give an answer to the question about shares held by women, we use as a measure of gender a dummy that takes one if the CEO is a woman and 0 if not. This measure is widely used in the literature on the gender productivity gap (Islam & Amin, 2015; El-Shal & Morsy, 2020; Gang & al, 2021).

(ii) Independent variables: Following the literature review developed in Section 1, our initial model of the determinants of labour productivity takes into account a number of factors that describe behaviour at the firm level and that may affect productivity. These factors are divided into three categories: staffing factors; contextual factors and control variables. We do not take preference factors into account in the present given the difficulty of measuring this.

- **Endowment Factors:**

Technology adoption and innovation: As we mentioned in our literature review, the adoption of new technologies is a very important factor for firm productivity, especially in view of its impact on the firm's innovation capacity (Wu & al, 2021; Tahir & al, 2021; Hoang & al, 2021). In the context of gender inequality analysis, this indicator becomes crucial since women are very often identified as being on the margins of technological progress (Orser & al, 2018; Alam &, 2022). As the objective of this work is to analyze the effect of ICT adoption on the gender productivity gap, we particularly opt for key measures of technology, namely: e-mail; The website and mobile money. However, since the literature defends that for an effectiveness of ICT on labor productivity it is necessary to consider certain factors that will be complementary to the use of ICTs such as innovation (Gaglio & al, 2022; Barasa & al, 2019).

Human capital: in the literature, the availability of a highly qualified workforce improves the company's performance. In addition, the authors mention that, to have a significant impact of ICT on the productivity of the firm it is necessary that the workforce can use the new technology effectively (Orser & al, 2018; Voss & al, 2021; Alam & al, 2022). Therefore, we measure human capital here by two variables: the percentage of employees with a secondary education and the number of full-time employees within the company. Although there is a consensus in the literature on the positive effect of human capital on productivity, Barro (2001) shows in a study of 100 countries that the quality of education of men is significantly related to economic growth but not for women. A plausible explanation is that the labor market was still largely discriminatory at that time, and therefore the proportion of male workers was much higher than that of women.

Physical capital: The literature supports a positive effect of physical infrastructure on labor productivity, for example (Islam & al, 2020). However, we must specify that everything depends on the indicator considered. For example, Falentina & Rososudarmo (2019) show

through a study of Indonesian companies that power outages reduce the average labor productivity of these companies and that the resulting losses amounted to about USD 4.91 million. Therefore, the authors advocate improving the reliability of electricity supply in developing countries. To do this, in this work we use the number of power outages as a measure of physical capital, which is a significant barrier in SSA countries that are still largely under-electrified (Chimbo, 2019; Hougbonon & al, 2021). This constraint imposes direct (operating and production) and indirect costs on the performance of firms that limit the firm's prospects of reaching full productivity potential.

Access to finance: An infinite number of authors indicate that financial constraints are associated with changes in productivity levels between firms and industries (Bopkin & al, 2017; Fowowe, 2017). For this purpose, several indicators are used in literature. But in this work, we focus on access to finance, which is very often discriminatory for women entrepreneurs and CEOs (Allison & al, 2023; Flabbi & al, 2019). This is a dummy that takes 1 when access to financing is an obstacle for the company and 0 if not. We expect this variable to be negatively correlated with labor productivity.

- **Contextual factors:**

Institutional constraints: there is ample empirical evidence on the importance of quality governance for firm performance (Bardasi & al, 2011; Mattina & al, 2018). To this end, we include two measures of the perception of the regulations in force to capture institutional constraints. The first is the tax which is a dummy that takes 1 if the tax rate in force constitutes an obstacle to the activities of the company and 0 otherwise. The second variable is corruption, which takes 1 if corruption is an obstacle to the company's activities and 0 if not.

- Control variables

As part of our analysis, we consider two control variables. The first is the number of years of experience of the CEO. The second concerns the variable woman owner, which is a variable that takes an if within the company of women hold shares and 0 otherwise.

3.3. Descriptive analysis

Table1 : Descriptive statistics

	All		Female Managers		Male Managers		Difference
Variable	**Obs**	**Mean**	**Obs**	**Mean**	**Obs**	**Mean**	
Productivity	3238	9,831	455	9,994	2783	9,804	-0,191
Email	3238	0,559	455	0,499	2783	0,569	0,07***
Website	3238	0,254	455	0,224	2783	0,258	0,034
Mobile money	3238	0,259	455	0,224	2783	0,265	0,041*
Women owners	3238	0,304	455	0,842	2783	0,216	-0,626***
CEO Experience	3238	16,347	455	14,725	2783	16,612	1,887***
Education	3238	49,092	455	48,354	2783	49,212	0,859
Taxes	3238	0,827	455	0,8	2783	0,831	0,032
Corruption	3238	0,745	455	0,721	2783	0,749	0,028
Access to finance	3238	0,832	455	0,829	2783	0,833	0,005
Innovation	3238	0,406	455	0,398	2783	0,408	0,01
Size	3238	2,559	455	2,36	2783	2,592	0,233***
Electricity	2691	9,299	382	10,191	2309	9,152	-1,04
R&D	3238	0,184	455	0,187	2783	0,184	-0,003

Source : Auteur

The table above shows the percentage of companies run by women in the countries in our sample is much lower than that of men, 455 versus 2783. However, when we look at the different variables.

Table 1 shows that the percentage of enterprises run by women in the countries in our sample is much lower than that of men, 175 versus 1135. However, when we look at the different variables we find a difference, but not always quite profound, between male- and female-led businesses.

Table 2 shows the correlation matrix. We observe no correlation coefficient greater than 0.50 between two independent variables.

Table 2 : Correlation matrix

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*
(1) Productivity	1,000													
(2) Email	0,212	1,000												
(3) Website	0,116	0,421	1,000											
(4) Mobile money	-0,178	0,004	0,055	1,000										
(5) Women owners	0,102	0,111	0,093	0,013	1,000									
(6) CEO experience	-0,009	0,118	0,027	-0,026	0,035	1,000								
(7) Education	0,276	0,266	0,219	0,029	0,099	-0,057	1,000							
(8) Taxes	-0,070	0,022	0,017	0,026	-0,035	0,009	0,002	1,000						
(9) Corruption	-0,151	0,032	-0,019	0,078	-0,026	0,068	-0,054	0,262	1,000					
(10) Access to finance	-0,044	-0,057	-0,059	0,009	-0,039	-0,020	-0,022	0,209	0,154	1,000				
(11) Innovation	0,066	0,121	0,180	0,123	0,088	-0,028	0,164	0,015	-0,002	0,024	1,000			
(12) Size	0,120	0,384	0,361	-0,072	0,017	0,116	0,131	0,047	0,039	-0,072	0,117	1,000		
(13) Electricity	-0,067	-0,024	0,015	0,026	0,022	0,049	-0,068	0,009	-0,001	-0,004	-0,025	-0,044	1,000	
(14) R&D	0,105	0,170	0,193	0,052	0,074	-0,007	0,138	0,019	-0,014	0,018	0,244	0,174	0,023	1,000

Source: Author

4. Empirical results and discussions

This section is divided into two parts: the first concerns the results of regressions of the determinants of labour productivity within SMEs, and the second refers to the decomposition of labour productivity to deduce the productivity gap and the role of ICT.

4.1. Determinants of SME labor productivity

Regression results for the effect of ICT adoption on labor productivity are presented in column 2 of Table 3. The results of the determinants of labor productivity for the entire sample are presented in column 5. But first, the sample was divided according to the size of the enterprise (Small or Medium).

Regarding the effect of ICT on labor productivity: the email and website variables are positively associated with labor productivity in all our regressions and are significant at 1%. Specifically, SMEs that use email to communicate have 89.1% higher productivity than SMEs that do not use email. Similarly, SMEs that have a website have a productivity 7.6% higher than that of companies that do not. These results corroborate those obtained by Islam & al, 2020; Islam & al, 2023 Allison & al, 2023. The use of mobile money has a negative effect in all our regressions. However, this variable is only significant when we do not control for the other explanatory variables (see column 2). This negative effect can be explained by the weak financial culture of companies. And the majority of the companies in the sample being surveyed in 2013, it is important to specify that at that time Mobile Banking did not have the same magnitude as we observe today. The manager's gender has a negative but not significant effect in all our regressions. In addition, women-led enterprises achieve lower productivity than those run by men. This indicates the potential existence of a gender productivity gap in SSA. However, the manager's experience is positively correlated with labor productivity and is statistically significant in all our regressions. This testifies to the importance of the specific characteristics of the eater in relation to the performance of the manager (Novita & Ariani, 2022). Education is also positively associated with labor productivity and is significant at 1%. Access to finance is negatively associated with labor productivity and is significant at 10%. This implies that the tax base constitutes an obstacle to the activities of SMEs in SSA. Power cuts are also negatively correlated with labor productivity. However, this variable is not significant in all our regressions.

Table 3 : Determinants of labour productivity

	Model 1	Model 2	Model 3	Model 4
VARIABLES	**Productivity**	**Productivity**	**Productivity**	**Productivity**
Email	1,235***	0,857***	0,857***	0,891***
	(0,120)	(0,0950)	(0,0950)	(0,0758)
Website	0,295**	0,352***	0,352***	0,368***
	(0,127)	(0,130)	(0,130)	(0,0845)
Mobile money	-1,126***	-0,0282	-0,0282	-0,123
	(0,0941)	(0,106)	(0,106)	(0,0753)
Gender of CEO	0,255	-0,131	-0,131	-0,0510
	(0,157)	(0,133)	(0,133)	(0,106)
Women owners		0,250**	0,250**	0,139*
		(0,106)	(0,106)	(0,0787)
CEO Experience		0,0173***	0,0173***	0,0128***
		(0,00418)	(0,00418)	(0,00311)
Education		0,00817***	0,00817***	0,00678***
		(0,00108)	(0,00108)	(0,000835)
Taxes		-0,118	-0,118	-0,114
		(0,116)	(0,116)	(0,0882)
Corruption		0,0548	0,0548	-0,0125
		(0,0946)	(0,0946)	(0,0740)
Access to finance		-0,218*	-0,218*	-0,218**
		(0,129)	(0,129)	(0,0923)
Innovation		-0,0176	-0,0176	-0,0814
		(0,0847)	(0,0847)	(0,0646)
Size		-0,111	-0,111	0,0525
		(0,0891)	(0,0891)	(0,0445)
Electricity		-0,00117	-0,00117	-0,000584
		(0,00220)	(0,00220)	(0,00122)
R&D		0,209*	0,209*	0,231***
		(0,115)	(0,115)	(0,0825)
Constant	9,762***	8,036***	8,036***	8,040***
	(0,0989)	(0,249)	(0,249)	(0,167)
Individual effects	Yes	Yes	Yes	Yes
Observations	3,238	1,691	1,691	2,691
R-squared	0,235	0,728	0,728	0,732

Source: Author; **Note**: Robust standard errors in parentheses ***p < 0,01, **p < 0,05, *p < 0,1.

Heterogeneity

One of the concerns with SME data is whether the productivity gap is pervasive when controlling for the gender of the manager or the type of industry. The possibility that the gender of the CEO may have a different effect on the productivity of the company cannot be excluded because, as mentioned in the literature, the constraints related to the activities of SMEs most often affect women-owned or women-owned businesses to a greater extent. Moreover, the

probability that the productivity gap will be limited to one sector of activity cannot be excluded because men and women tend to be separated by sector of activity (Goldin, 2014; Amin & Islam, 2014). A productivity gap that is limited to sector of activity with different repercussions at the level of economic policy recommendations. Thus, Annexes 3 and 4 respectively present the determinants of productivity according to the sex of the manager and according to the type of sector of activity. The following important points emerge from the analysis of these results.

First, for the determinants of productivity by gender of the manager (see Appendix 3), column 2 gives the regression results of the determinants of productivity for all firms with a female CEO. And column 3 gives us the results for companies where the CEO is a man. Overall, email and website variables are positively correlated with labor productivity. However, the website is significant at 5% for female CEOs and 1% for men. Emails are 1% significant for both sets. When we look closely at the coefficients, we see that the impacts of the use of ICT adoption are relatively less important in women-led firms compared to those of their male counterparts. This may indicate a digital divide from a gender perspective due to low digital literacy on the part of women (Orser & al, 2018). The mobile money variable is not significant but has a mixed effect (because positive for women and negative for men). The manager's experience is positively correlated with productivity and is significant for both of our regressions.

Deuxièmement, quand nous contrôlons le type de secteur d'activité (manufacturier et service), nos résultats tendent toujours à corroborer notre premier tableau de résultats en termes de l'effet de l'adoption des TIC sur la productivité du travail. Autrement dit les variables email et site web ont un effet positif sur la productivité du travail et sont significatives respectivement à 1% et à 5%, tandis que la variable mobile money demeure avec un effet négatif. Les variables éducation et expérience du manageur ont aussi un effet positif sur la productivité du travail dans les différents secteurs d'activité et sont significatives à 1%.

4.2. Oaxaca-Blinder decomposition of labor productivity results

So far we have analyzed correlational regressions to identify the determinants of SME labor productivity. In this subsection, we first determine the gender productivity gap. And second, we try to distinguish which of these determinants contribute to the gender gap and more specifically what role ICT adoption plays in this phenomenon.

Table 4: Decomposition of the gender productivity gap

VARIABLES	overall	endowments	Structural	interaction
Group_1	9,941***			
	(0,0628)			
Group_2	10,39***			
	(0,178)			
Difference	-0,447**			
	(0,188)			
Endowment	0,218			
	(0,292)			
Coefficients	-0,135			
	(0,198)			
Interaction	-0,530*			
	(0,298)			
Email		0,0230	0,281	0,0241
		(0,0222)	(0,224)	(0,0235)
Website		0,0359	-0,265**	-0,0437
		(0,0274)	(0,114)	(0,0317)
Mobile money		-0,112**	0,156*	0,0418
		(0,0510)	(0,0920)	(0,0296)
Women owners		0,382	0,922**	-0,667**
		(0,278)	(0,402)	(0,291)
CEO Experience		-0,0109	0,108	0,0112
		(0,0290)	(0,291)	(0,0304)
Education		-0,00531	0,287	-0,00274
		(0,0237)	(0,242)	(0,0124)
Taxes		-0,0137	0,0262	0,00120
		(0,0183)	(0,382)	(0,0175)
Corruption		-0,0264	-0,00808	-0,000391
		(0,0228)	(0,292)	(0,0141)
Access to finance		0,0116	-0,663*	-0,0146
		(0,0159)	(0,370)	(0,0194)
Innovation		-0,00632	0,0834	0,00597
		(0,0120)	(0,153)	(0,0123)
Size		-0,0994*	1,171**	0,125**
		(0,0573)	(0,536)	(0,0617)
Electricity		0,00387	-0,0377	0,00385
		(0,00828)	(0,0710)	(0,00893)
RD		-0,000131	0,0812	0,00164
		(0,00187)	(0,0900)	(0,00950)
Constant			-2,404***	
			(0,926)	
Individual effects	YES	YES	YES	YES
Comments	2,691	2,691	2,691	2,691

Source: Author; **Note**: Robust standard errors in parentheses ***p < 0,01, **p < 0,05, *p < 0,1.

Thus Table 4 presents the analyses of the productivity decomposition with the Oaxaca-Blinder method. The first observation is the following, the labor productivity of women-led companies is on average 44.7% lower than that of male CEOs as indicated in column 2 of the table above. Using the Blinder-Oaxaca decomposition method, this productivity gap is broken down into three factors experienced by the company: staffing factors; structural factors and interacting factors.

4.2.1. Endowment effects

Staffing effects refer to the impact of the difference in staffing level of the explanatory variables in our model. Regarding the role of ICTs in the gender productivity gap, column 3 shows us that only the level of mobile adoption widens the gender gap by 11.2%, which is in line with the results obtained by Islam et al, 2020. This can be explained by the fact that few female executives adopt this technology more than men. This indicates the existence of a digital gender divide specific to mobile money adoption.

4.2.2. Structural effect

This is the share of the gender gap attributable to the performance of staffing factors. We find that the website's performance widens the gender gap by 26.5%, which is at odds with previous findings in the literature. However, this low productivity performance in website use can be explained by the low level of digital literacy that women managers generally suffer. On the other hand, the return of mobile money brings the gender productivity gap down by 15.6%.

4.2.3. Interaction effect

The interaction effect captures the share of the gender productivity gap resulting from simultaneous differences in staffing level and performance of observable variables. None of the ICT adoption indicators considered in this work appear to have an interaction effect on the gender productivity gap.

5. Robustness

The results presented above could be influenced by different biases from which our data may suffer, endogeneity bias (Bertschek & Niebel, 2016). Moreover, despite the extensive use of the mean decomposition based on the standard Oaxaca-Blinder regression, it is important to note that, although very informative, this approach leaves out the possibility of heterogeneous behavior of company leaders at different points of distribution of productivity. And this can potentially mask large differences in staffing and structural factors in the productivity distribution (Backiny-Yetna & McGee, 2015). For this purpose, as a robustness we use the instrumental variables first to solve the potential endogeneity bias, then we resume the decomposition of productivity using the method of the refocused influence function (RIF) of Firpo & al (2011) and recently applied by Kilic & al (2015), El-shal & Morsy, (2020); Ackah & al, (2021).

5.1. Instrumental variables

The results obtained from the MCO estimation technique presented in Table 3 above so far assume that firms with female CEOs have lower productivity levels than their male counterparts

(see Model 2; 3 and 4). However, it should be noted that the CEO gender variable is not significant in any of our estimated models, which could call into question the results obtained. In addition, estimates based on OLS could potentially conceal endogeneity bias (due to possible reverse causality between labor productivity and ICT adoption) on the one hand and/or omissions of relevant variables observed at the firm level (Bertschek & Niebel, 2016; Vaumi & al, 2022).

Indeed, we argue that different types of ICT use can be distinguished by their potential endogeneity. On the one hand, productivity and the use of ICT tools can be determined simultaneously since firms choose their inputs based on the output they plan to achieve and vice versa (Bertschek & al, 2016; Cette & al, 2020). On the other hand, ICT is also likely to be correlated with the error term, as omitted variables can influence both labor productivity and ICT. Therefore, he concludes that the possibility of reverse causality as a source of endogeneity bias is not negligible.

To correct for this potential inverse causality between labor productivity and ICT adoption, we apply an instrumental variable approach (more precisely Double Least Squares). However, adequately controlling for endogeneity is not an easy task in survey data that does not come from a natural experiment. However, we use two sets of instruments. First, following the work of Commander & Svejnar (2011), and those of Vaumi & al, (2022) we use skills as the first instrument. Our second instrument is the labor regulatory framework.

Our estimates involving DMCs include validity tests so the most important are the Kleibergen-Paap test (K-P); the Stock and Yogo test (S-Y) and finally the Hansen test. The K-P test is a robust heteroscedasticity test for under-identification. The Stock and Yogo test is a test of under-identification of instruments. And finally, the Hansen test is a test of the validity of the instruments.

The main results obtained by the estimate by the RCDs are shown in the table below.

Table 4: Determinants of productivity, IV results

	Model 1	Model 2	Model 3	Model 4
VARIABLES	**Productivity**	**Productivity**	**Productivity**	**Productivity**
Email	0,938***	0,922***	1,337***	0,961***
	-0,142	-0,108	-0,239	-0,153
Website	1,120***	0,400***	0,072	0,07**
	-0,342	-0,151	-0,188	-0,166
Mobile money	-0,194***	-0,244**	-0,980***	-1,186***
	-0,071	-0,117	-0,182	-0,126
Gender of CEO	-0,0243	-0,0817	-0,055*	-0,225***
	-0,0873	-0,149	-0,338	-0,219
Women owners		0,211*	0,348*	0,411**
		-0,121	-0,2	-0,161
CEO Experience		0,0184***	-0,00227	-0,00043
		-0,00498	-0,00824	-0,00654
Education		0,00615***	0,0176***	0,0171***
		-0,00128	-0,00271	-0,00167
Taxes		-0,509***	0,485	-1,129***
		-0,193	-0,378	-0,279
Corruption		-0,12	-0,612**	-1,261***
		-0,122	-0,304	-0,186
Access to finance		2,672***	-2,360*	4,348***
		-0,869	-1,225	-1,008
Innovation		-0,260**	0,0331	-0,0116
		-0,106	-0,179	-0,136
Size		-0,0913	-0,0505	0,215**
		-0,0999	-0,119	-0,0866
Electricity		-0,00153	-0,00794**	-0,00645***
		-0,00254	-0,00392	-0,00244
R&D		0,188	0,363*	0,253
		-0,142	-0,213	-0,18
Constant	8,194***	5,963***	10,95***	6,432***
	-0,0546	-0,679	-0,878	-0,763
Country fixed effects	Yes	Yes	Yes	Yes
Observations	3238	1691	1000	2691
R-squared	0,747	0,637	0,185	-0,11
H-3	146,505	32,648	29,604	71,029
C-D	198,081	14,147	21,488	37,966
S-Y	16,38	9,08	19,93	19,93
Hansen P-value	11,086	0,3604	0,181	0,1956

Source: Author; **Note**: Robust standard errors in parentheses ***p < 0,01, **p < 0,05, *p < 0,1.

Model 2 and Model 3 represent the estimate of labor productivity only for small and medium-sized firms, respectively. Model 4 includes all SMEs. We focus our attention on the latter. However, overall, the results obtained corroborate those of the MCO. Specifically, regarding the effect of ICT adoption on labor productivity, it is always positive for the email and website

variables, but negative for the mobile money variable. However, we note that the gender variable of the CEO, in addition to telling us that female CEOs have a productivity 22.5% lower than that of male CEOs, is in this case significant at 1% (which was not the case in the results obtained by the MCO. However, this rate is significantly higher than that of Table 3 which was 5.1%. In all our models, the instruments are exogenous because the value of the Kleibergen-Paap statistic is higher than that of the Stock-Yogo statistic when calculated at the 10% level. In addition, the instrument validity test proposed by Sargan (1958) and Hansen (1982) confirms that the instruments chosen are valid.

5.2. Refocused influence function (RIF) decomposition

The gender productivity gaps presented in Section 4 were calculated by comparing an average male CEO to an average female CEO. The analysis thus implicitly assumed that the estimated gender gaps were evenly distributed across the distribution of productivity. But this is not necessarily the case, and it can hide large variations in the gender gap depending on where we are on the distribution of productivity (Mukasa & al, 2015). For example, the gap between the least productive and least productive women managers and between the most productive women and men may differ considerably from that obtained using average decomposition approaches. Thus, to go beyond the standard Oaxaca-Blinder decomposition approach, we analyze the gender gaps in the entire productivity distribution of our sample using a quantile regression (QR) or refocused influence function regression (RIF) framework as proposed by Firpo & al, (2009).

It is primarily decompositions on al quantile regression procedure providing estimates of the Blinder-Oaxaca decomposition at each specified point in the productivity distribution. Indeed, an RIF regression is like a standard OLD regression, except that in this case, the dependent variable *Y* is replaced by the distributive statistic of interest of its refocused influence function. The approach assumes that the conditional expectation of the RIF *(y ; v)* can be modeled as a linear function of observable attributes *« X »*, such as $E[RIF(y; v)/X] = X_\gamma$ is the mean decomposition. Assuming that *IF(y ;v)* is the influence function corresponding to an observed productivity result Y, for distributive statistics $v(F_Y)$, the RIF is defined as follows:

$$RIF(y; v) = v(F_Y) + IF(y; v)$$

In the case of quantiles, the influence function is written as follows:

$$IF(y; Q_T) = \frac{(T - 1\{Y \leq Q_T\})}{f_Y(Q_T)}$$

Where $1\{Y \leq Q_T\}$ is an indicator function equal to 1 if the value of the outcome variable is less than or equal to the quantile Q_T and 0 otherwise, $f_Y(Q_T)$ is the density of the marginal distribution of Y and Q_T is the population quantile T of the unconditional distribution of Y.

We report estimates of the RIF decomposition of labour productivity by sex in Table 5 below. Overall, our results provide evidence of a gender gap in different productivity distributions, although for the gap is small for the 50th quantile (0.022%) and for the 25th quantile (4.86%). However, the gap becomes large when we compare high-productivity firms (100% for the 75th quantile and 67.4% for the 95th quantile). The increase in these differences in the 75th and 95th quantiles is mainly due to differences in unobservable characteristics (structural factors) of 122.5%. These are essentially: email; corruption; access to finance (see Table 5). Observable characteristics (staffing factors) explain only 37% of the gender productivity gap. The variables concerned are mobile money; CEO experience and company size (see Table 5). Among all these variables, it should be noted that the most relevant variables to consider here are: mobile money and CEO experience (because of their degree of significance in the different estimates and their recurrence). In addition, not only are women managers less likely to adopt new technologies (in this case ICT), but they also have less management experience than their male counterparts, which seriously hampers the productivity of their companies.

Table 5: RIF decomposition

A. Gender Differential												
	Q 0.25	**Q 0.50**					**Q 0.75**	**Q 0.95**				
Average productivity of men	8.001***	9.409***					11.06***	16.20***				
	(0.0603)	(0.0594)					(0.0857)	(0.108)				
Average productivity of women	7.952***	9.408***					12.07***	16.87***				
	(0.143)	(0.209)					(0.555)	(0.316)				
Gender productivity gap (M-F)	0.0486	0.000223					-1.006*	-0.674**				
	(0.155)	(0.217)					(0.562)	(0.334)				
B. Aggregated decomposition												
Staffing Factors	-0.112	-0.0865					-0.370**	0.551				
	(0.100)	(0.104)					(0.153)	(0.598)				
Factors of discrimination	0.160	0.0867					-0.636	-1.225*				
	(0.165)	(0.227)					(0.567)	(0.698)				
C. Detailed breakdown			**Staffing Factors**						**Factors of discrimination**			
			Q 0.25	**Q 0.50**	**Q 0.75**	**Q 0.95**			**Q 0.25**	**Q 0.50**	**Q 0.75**	**Q 0.95**
Email			0.0645*	0.0500*	0.0306	0.0210			0.0576	0.0472	1.167*	-0.0437
			(0.0372)	(0.0291)	(0.0196)	(0.0334)			(0.194)	(0.272)	(0.656)	(0.422)
Website			0.00849	0.00326	-0.00112	-0.00522			-0.0507	-0.126	-0.462	-0.0681
			(0.00719)	(0.00618)	(0.00908)	(0.0330)			(0.0863)	(0.136)	(0.345)	(0.247)
Mobile money			-0.0217*	-0.0406**	-0.0853**	-0.123**			0.114	0.182	0.640**	0.272*
			(0.0116)	(0.0179)	(0.0359)	(0.0571)			(0.0803)	(0.111)	(0.249)	(0.140)
Women owners			-0.150*	-0.160*	-0.318**	0.874			0.246	0.104	2.088*	0.473*
			(0.0769)	(0.0828)	(0.129)	(0.605)			(0.329)	(0.496)	(1.266)	(0.242)
CEO Experience			0.0275**	0.0149	-0.0188	0.0154			-0.107	-0.0857	1.788**	-0.223
			(0.0124)	(0.00993)	(0.0144)	(0.0448)			(0.250)	(0.356)	(0.908)	(0.509)
Education			-0.00698	-0.00693	-0.00867	-0.0121			0.227	0.190	-0.816	-0.630
			(0.0311)	(0.0308)	(0.0386)	(0.0539)			(0.200)	(0.287)	(0.724)	(0.445)
Taxes			-0.00622	-0.00987	-0.0178	-0.0246			0.0566	-0.336	-0.139	0.416
			(0.00683)	(0.00825)	(0.0139)	(0.0377)			(0.325)	(0.467)	(1.267)	(0.849)
Corruption			-0.00742	-0.0121	-0.0284	-0.0325			-0.165	0.219	2.405**	-0.331
			(0.00698)	(0.00975)	(0.0214)	(0.0352)			(0.244)	(0.352)	(0.959)	(0.632)
Access to funding			-0.00199	-0.00145	-0.00390	0.0204			-0.390	-0.218	-2.086*	-0.754
			(0.00358)	(0.00322)	(0.00636)	(0.0276)			(0.322)	(0.439)	(1.108)	(0.635)
Innovation			-0.00267	0.000278	0.00485	0.0262			0.0298	0.103	0.0121	-0.310
			(0.00421)	(0.00338)	(0.00684)	(0.0317)			(0.134)	(0.182)	(0.438)	(0.313)
Size			-0.0281	0.0714***	0.0650**	-0.218*			0.0453	0.724	2.005	2.998***
			(0.0184)	(0.0223)	(0.0292)	(0.113)			(0.477)	(0.629)	(1.597)	(1.156)
Electricity			0.00640	0.00347	0.0116	0.0102			-0.118**	0.00852	0.273*	-0.00186
			(0.00922)	(0.00541)	(0.0163)	(0.0150)			(0.0517)	(0.0798)	(0.152)	(0.0587)
R&D			0.00124	0.00139	0.000239	-0.00123			0.0244	-0.0215	0.152	0.150
			(0.00709)	(0.00790)	(0.00162)	(0.00795)			(0.0738)	(0.106)	(0.283)	(0.200)
Constant									-0.00893	-0.703	-7.662***	-3.172
									(0.794)	(1.116)	(2.823)	(1.960)
Country fixed bills		No	Yes	No	No	No	No	No	Yes	No	No	No
Observations	2691	2691	2691	2691	2691	2691	2691	2691	2691	2691	2691	2691

Source: Author; **Note**: Robust standard errors in parentheses ***p < 0,01, **p < 0,05, *p < 0,1.

Conclusion and implications of economic policies

Labor productivity is a fundamental measure of economic efficiency and, in general, a key determinant of structural transformation and well-being. However, despite the high rate of women's participation in entrepreneurial activities, data on the determinants of the variation in productivity levels between firms by CEO gender show that women are more often underperforming than men. Moreover, in the wake of the third industrial revolution, namely information and communication technologies, up to 52% of women still feel that technology is a male industry and 32% still consider gender bias to be a major obstacle in the process of business creation (World Economic Forum, 2017). This leads to a new form of gender segregation to the disadvantage of women. The objective of this research was therefore to analyze on the one hand the determinants of the labour productivity of SMEs in SSA on the one hand, and to examine the existence and extent of the productivity gap between firms according to the gender of the CEO on the other hand while highlighting the role played by the adoption of ICT. Following the main results presented in the previous section, we formulate some economic policy recommendations. First, the negative effect of staffing factors (especially mobile money) suggests that policies to improve women's mobile money would be effective in improving women's productivity and thus reducing the gender productivity gap. Second, the negative effect of website use suggests that women should improve their digital literacy to get the most out of website use like their male counterparts. And this includes the role of promoting women's education with a particular focus on digital skills.

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APPENDIX

Table A1: List of countries in the sample

List of countries in the sample
Benin
Cameroon
Ivory Coast
Ganha
Guinea
Kenya
Liberia
Mali
Niger
Uganda
Sierra Leone
Tanzania
Chad
Togo
Zambia

Source: Author

Table A2 : List of variables

Short name of variables	Definitions of variables	Spring
	Dependent variables	
Productivity	The logarithm of sales per employee	World Bank Enterprise surveys
	Variables of interest	
Email	Dummy that takes 1 if the company uses emails to communicate and 0 if not	World Bank Enterprise surveys
Website	Dummy that takes 1 if the company has a website and 0 if not	World Bank Enterprise surveys
Mobile money	Dummy who takes 1 if the company uses mobile money for its operations and 0 if not	World Bank Enterprise surveys
Gender of CEO	Dummy who takes 1 when the main manager is a woman 0 if not	World Bank Enterprise surveys
Women owners	Dummy who takes 1 if among the owners of the company there is a woman and 0 if not	World Bank Enterprise surveys
	Human capital variables	
CEO Experience	Number of years of experience of the main manager	World Bank Enterprise surveys
Education	Percentage of full-time employees waiting for a high school education	World Bank Enterprise surveys
	Innovation variables	
RD	Cost of formal research and development activities	World Bank Enterprise surveys
Innovation	Dummy which takes 1 if the company has introduced a new process and 0 otherwise	World Bank Enterprise surveys
	Access to finance variables	
Line of credit	Dummy who takes 1 if the company has subscribed during the year to a line of credit with a financial institution and 0 if not	World Bank Enterprise surveys
Institutional quality variables including business environment barriers		
Corruption	Dummy who takes 1 if the company considers corruption to be an obstacle for it and 0 if not	World Bank Enterprise surveys
Taxes	Dummy which takes 1 if the company considers that the current tax rate is an obstacle for it and 0 if not	World Bank Enterprise surveys
	Control variables	
Size	Logarithm of the number of full-time employees in the enterprise	World Bank Enterprise surveys
Electricity	Average number of outages in a month	World Bank Enterprise surveys

Table A3 : Determinants of productivity by gender of manager

	Female Manager	**Male Managers**
VARIABLES	**Productivity**	**Productivity**
Email	0,828***	0,911***
	(0,210)	(0,0874)
Website	0,540**	0,428***
	(0,247)	(0,0963)
Mobile money	0,0743	-0,109
	(0,239)	(0,0843)
Women owners	-0,152	0,135
	(0,255)	(0,0901)
CEO Experience	0,0314***	0,0132***
	(0,00971)	(0,00357)
Education	0,00603**	0,00749***
	(0,00250)	(0,000971)
Taxes	-0,0629	-0,0594
	(0,235)	(0,108)
Corruption	0,367*	-0,0340
	(0,202)	(0,0887)
Access to finance	-0,116	-0,252**
	(0,261)	(0,106)
Innovation	-0,0647	-0,0689
	(0,201)	(0,0737)
Sizes	-0,124	0,0307
	(0,116)	(0,0495)
Electricity	0,00143	-0,00180
	(0,00238)	(0,00159)
R&D	0,205	0,261***
	(0,238)	(0,0942)
Constant	7,630***	7,940***
	(0,491)	(0,187)
Individual effects	Yes	Yes
Observations	382	2,309
R-squared	0,749	0,681

Source: Author; ***Note*** *:* Robust standard errors in parentheses ***p < 0,01, **p < 0,05, *p < 0 ,1.

Table A4 : Determinants of productivity by type of industry

	Manufacturing	**Service**
VARIABLES	**Productivity**	**Productivity**
Email	0,987***	0,759***
	(0,118)	(0,113)
Website	0,514***	0,293**
	(0,129)	(0,123)
Mobile money	-0,160	-0,116
	(0,113)	(0,112)
Gender of CEO	-0,173	-0,107
	(0,173)	(0,145)
Women owners	0,00458	0,143
	(0,124)	(0,115)
CEO Experience	0,0122***	0,0230***
	(0,00445)	(0,00506)
Education	0,00538***	0,00536***
	(0,00136)	(0,00137)
Taxes	-0,111	-0,00905
	(0,139)	(0,133)
Corruption	-0,0281	0,130
	(0,115)	(0,117)
Access to finance	-0,286*	-0,247*
	(0,161)	(0,127)
Innovation	-0,131	-0,101
	(0,0990)	(0,103)
Size	0,0161	0,0873
	(0,0644)	(0,0678)
Electricity	-0,00220	-0,00108
	(0,00279)	(0,00163)
R&D	0,288**	0,284**
	(0,115)	(0,133)
Constant	8,576***	8,272***
	(0,305)	(0,292)
Individual effects	YES	YES
Observations	1,286	1,405
R-squared	0,751	0,646

Source: Author; ***Note****:* Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.

Table A5 : Determinants of productivity by industry type (IV results)

	Model 1	Model 2
VARIABLES	**Productivity**	**Productivity**
Email	1,024***	0,752***
	-0,205	-0,184
Website	0,0307	-0,123
	-0,224	-0,178
Mobile money	-1,281***	-0,978***
	-0,15	-0,148
Gender of CEO	0,0111	0,31
	-0,336	-0,251
Women owners	0,311	0,359*
	-0,213	-0,192
CEO Experience	-0,00767	0,000297
	-0,0084	-0,00779
Education	0,0180***	0,0158***
	-0,00224	-0,00193
Taxes	-0,267	-0,436*
	-0,34	-0,264
Corruption	-0,618***	-1,109***
	-0,238	-0,21
Access to finance	-0,625	1,313
	-0,891	-0,848
Innovation	0,0752	0,169
	-0,178	-0,167
Size	0,0206	0,135
	-0,105	-0,104
Electricity	-0,00862*	-0,00681***
	-0,00457	-0,00229
R&D	0,474**	0,33
	-0,206	-0,235
Country fixed effects	Yes	Yes
Constant	10,07***	8,598***
	-0,781	-0,7
Observations	1286	1405
R-squared	0,186	0,11
H-3	69,795	57,631
C-D	35,069	26,345
S-Y	9,08	9,08
Hansen P-value	0,3115	0,6703

Source: Author; ***Note*** *:* Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.