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Digital divides among microenterprises: Evidence from sub-Saharan Africa

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Abstract

This paper investigates digital inequalities in usage within African informal sectors. In particular, we examine whether the uneven digital diffusion is embedded in pre-existing socio-economic inequalities. After identifying three segments of informal firms, we rely on multivariate and decomposition analyses to identify predictors of usage of digital technologies for business purposes and explain usage gaps between segments. Our findings suggest that digital inequalities are rooted in the vertical heterogeneity of informal sectors, with some firm characteristics significantly predicting professional use of digital technologies. In addition, we find that there are both common and segment-specific levers for addressing digital inequalities between informal firms.

KEYWORDS
Africa, digital divide, digital technology, ICT, informal sector

JEL CLASSIFICATION
D22, O17, O33, O55

1 | INTRODUCTION

With an average informal employment rate of 76.8% in 2016 (Bonnet et al., 2019), informality is a persistent feature of sub-Saharan African economies. To tackle this phenomenon, some authors have recently argued that short- to medium-term policies should focus on pro-productivity interventions to induce sustainable formalization, as activities will not formalize unless they grow (Kanbur, 2017; Roy & Khan, 2021). In this context, the ongoing digital

transformation of African economies is expected to bring new opportunities to enhance informal firms' performance (Choi et al., 2020; Nguimkeu & Okou, 2021). Indeed, an emerging strand of literature demonstrates that informal firms in sub-Saharan Africa significantly benefit from the use of digital technologies in terms of economic performance (Berrou et al., 2020; Danquah & Owusu, 2021; Eekhout et al., 2022).

However, digital diffusion also brings new challenges and risks that can impede or reduce the benefits associated with digital transformation. Depending on supply-side and demand-side factors, the diffusion of digital technologies is uneven and generates digital inequalities – or digital divides – between and within countries (Mutsvairo & Ragnedda, 2019; Van Dijk, 2020). Initially defined as "the divide between those with access to new technologies and those without" (NTIA, 1999), this prior definition is no longer relevant as it has become clear that the digital divide continues to expand even after physical access becomes universal (Donner, 2015). Notably, the literature shows that digital divides have emerged across populations having the same physical access to digital technologies, depending on individuals' socio-economic and demographic characteristics (Hargittai, 2002). This second-level digital divide is often an extension of pre-existing socio-economic inequalities, making digital inclusion a social rather than a technological challenge (Ragnedda & Muschert, 2013). As a result, the diffusion of digital technologies may not necessarily imply greater inclusion. It may induce the opposite effect by leading to the emergence of new inequalities and the reproduction of existing ones (Heeks, 2022; Ragnedda et al., 2022; Van Dijk, 2017).

While they are already excluded from the benefits of having a formal status, informal entrepreneurs are particularly vulnerable to digital exclusion because of a lower ability to access, use and benefit from digital technologies (Cirera et al., 2021; Esselaar et al., 2006). Their exclusion, or partial inclusion, into the digital transformation risks widening their vulnerability and deepening the productivity gap with their formal counterparts (Nguimkeu & Okou, 2021). Furthermore, different forms of mobile technologies appropriation among informal micro and small enterprises in Senegal have been identified (Eekhout et al., 2022). Given the entrepreneurial and productive heterogeneity of informal activities, all informal workers probably do not have the same opportunities to embrace digital technologies in their business operations (Bhattacharya, 2019), potentially leading to a digital divide between the different fringes of informal sectors. Such a new dimension of inequality not only risks exacerbating the pre-existing socio-economic inequalities in informal sectors, but also curbs the expected productivity gains and greater economic inclusion that digital transformation must provide to informal actors.

This study aims to provide an in-depth description and understanding of digital inequalities occurring in informal sectors of sub-Saharan African countries. Specifically, its main contribution is twofold. First, it is the first study that explores the determinants of digital inequalities in usage, that is, the second-level digital divide, among informal firms from several African countries. The benefits provided by digital technologies depend mainly on how individuals appropriate them, which is, in turn, socially determined (Ragnedda et al., 2022). Thus, we argue that focusing on the differences in material access to digital technologies is not sufficient (Donner, 2015), and that attention should be given to ways in which informal enterprises appropriate and use digital technologies. To this end, we provide extensive descriptive evidence on the use of digital technologies by informal businesses in Africa, considering three main functions: external coordination, financial transaction and internal management (Berrou et al., 2020; Eekhout et al., 2022). Moreover, compared with existing empirical evidence, which mainly considers socio-demographic traits of users to explain usage disparities among informal firms (Atiyas & Dutz, 2023; Eekhout et al., 2022), we also account for firm-level characteristics that are likely to explain disparities in opportunities and willingness to use digital technologies. Second, this study provides the first evidence that digital inequalities are rooted in the vertical heterogeneity of informal sectors (Dasgupta & Lloyd-Jones, 2018), meaning that the most successful firms use these new technologies to a greater extent than subsistence and constrained entrepreneurs (Grimm et al., 2012). This approach allows us to further understand whether informal heterogeneity conceals structural digital inequalities and, if so, to which extent there are common and segment-specific constraints that can be addressed to bridge the second-level digital divide within informal sectors.

For this purpose, we rely on the After Access business surveys conducted by Research ICT Africa (2020) in 2017–18 among 3 300 firms and entrepreneurs in eight sub-Saharan African countries.[1] In order to confront the heterogeneity of informal firms with their level of digital inclusion, the empirical strategy follows the approach proposed by Grimm

et al. (2012) to identify three informal segments in each country: top performers, constrained gazelles and survivalists. After describing the segments of informal firms according to their socio-demographic and productive traits, the descriptive analysis reveals significant gaps in access and usage of digital technologies across segments. To gain insight into these descriptive findings, a multivariate analysis is conducted to identify the main determinants of digital technologies usage for business purposes, considering entrepreneurs' and firms' characteristics. We first conduct this analysis for the overall sample and then for each informal segment, to observe general and segment-specific determinants of digital inequalities. Finally, we use a multivariate decomposition for nonlinear response models (Powers et al., 2011; Yun, 2004), to decompose segment differences in the probability of using digital technologies into disparities in observable characteristics, on the one hand, and disparities in the effect of these characteristics, on the other.

The remainder of this paper is organized as follows. Section 2 provides a literature review of digital divides and their determinants across individuals and firms in sub-Saharan Africa. Section 3 describes the data and the conceptual framework used to investigate the professional uses of digital technologies. Section 4 presents the approach for defining the three informal segments and the empirical strategy for identifying the determinants of the second-level digital divide. The results are presented in Section 5. Finally, we discuss the results and conclude in Section 6.

2 | LITERATURE REVIEW

2.1 | Digital divides definition

The digital divide concept initially referred to the gap between those who have and those who do not have access to certain forms of information and communication technologies (ICT) (NTIA, 1999), mainly computers and the internet. The concept now also encompasses other digital technologies, hardware and software, such as feature phones and smartphones (Van Deursen & Van Dijk, 2019). Initially, most studies considered this binary distinction between haves and have-nots, focusing on disparities in physical access (e.g., infrastructures and devices) across demographic groups and countries (Riggins & Dewan, 2005; Van Dijk, 2006). This access gap, referred to as the first-level digital divide, considered mainly digital inequalities through a narrow perspective, reducing access inequalities to mere technological and economic issues, which should disappear over time with market liberalization and deployment of telecommunication infrastructures (Fuchs & Horak, 2008; Norris, 2003; Thierer, 2000).

However, some scholars have argued that providing universal physical access to digital technologies will not be enough to bridge the digital divide, which in fact, arises when the use of digital technologies becomes ubiquitous in daily life (Van Dijk, 2017). This shift towards a broader perspective in the interpretation of digital inequalities refers to the second-level digital divide (Hargittai, 2002; Van Dijk, 2006). It aims to examine issues 'beyond access', considering that digital inequalities mainly occur within the group of digital technology users itself, because of disparities in quality of access, digital skills and actual usage of digital technologies (DiMaggio et al., 2004; Hargittai, 2002; Hilbert, 2011; Van Deursen & Van Dijk, 2014; Van Dijk & Hacker, 2003). Recognizing the digital divide as a complex and multi-dimensional phenomenon (Van Dijk, 2006), the second-level digital divide has transcended the dichotomous 'access approach', by considering digital inequalities as a continuum with real social implications (Ragnedda, 2019). Since digital inequalities are linked to existing socio-economic inequalities and can exacerbate them, the digital divide is now a social issue rather than just a technological one (Ragnedda, 2018; Ragnedda & Muschert, 2013; Van Dijk, 2017).

The resource and appropriation theory developed by Van Dijk (2005) is in line with this theoretical shift, moving beyond methodological individualism and adopting a relational or network approach instead (Van Dijk, 2017). The core argument of this theory is that digital inequalities in access, skills and usage are rooted in already existing socio-economic inequalities, as the latter leads to an unequal distribution of resources and, thus, to inequalities in the process of appropriation of digital technologies. Moreover, these digital inequalities may bring unequal benefits and tend to exacerbate pre-existing inequalities. Indeed, even if access to and use of digital technologies do not automatically

translate into tangible benefits, these first and second-level digital divides can also produce disparities in terms of social, economic, political or cultural benefits, leading to a third-level digital divide (Scheerder et al., 2017). Following this assumption, Heeks (2022) recently proposed a new conceptual framework to understand the relationship between growing digital inclusion and digital inequalities in the global South. Through the concept of 'adverse digital incorporation', the author argues that inclusion in a digital system can lead to unequal benefits or even adverse outcomes for some groups and positive outcomes for others, resulting in greater digital inequalities despite growing digital inclusion.

2.2 | Determinants of digital divides in sub-Saharan Africa at the individual-level

The determinants of the digital divide at the individual-level have been widely studied in developed countries, but overlooked in sub-Saharan Africa, and often limited to demographic and socio-economic characteristics (Srinuan & Bohlin, 2011). Evidence suggests a rural–urban divide, consistent with findings in developed countries. Rural location is associated with lower access to and use of digital technologies, partly due to the lower mobile network and internet coverage, as remoteness and low population density make the deployment of terrestrial infrastructure less profitable than in urban areas (Buys et al., 2009). Similarly, access to a stable source of electricity appears to be a key correlate in mobile phone ownership or internet adoption in West Africa (Adeleke, 2021; Forenbacher et al., 2019; Ochoa et al., 2022), highlighting the importance of complementary investment in electricity infrastructure to bridge the digital divide. This rural–urban divide can also be explained by the fact that income is an important determinant of digital inclusion in sub-Saharan Africa, as low-income households or individuals are less able to spend a significant portion of their income on digital devices or services (Birba & Diagne, 2012; Ochoa et al., 2022). The affordability of digital services and devices remains a strong demand-side constraint, with very few countries currently meeting the accessibility target set by the UN Commission on Broadband for Sustainable Development of 2% of monthly GNI per capita for entry-level broadband service (ITU, 2021).

The lack of skills and capabilities to use digital technologies is another important demand-side constraint. Thus, a lack of basic literacy is a barrier to digital inclusion, as most services and devices are designed for people who can read and write. Furthermore, knowledge of English or French is positively associated with greater digital inclusion, which can be explained by the greater availability of internet content in these languages (Ochoa et al., 2022; Pénard et al., 2012, 2015). More generally, because literacy and other digital skills are necessary to fully use and benefit from digital technologies, educational attainment appears to be a key determinant of digital inequalities (Birba & Diagne, 2012; Deen-Swarray, 2016; Forenbacher et al., 2019; Hasbi & Dubus, 2020; Ochoa et al., 2022; Pénard et al., 2012, 2015).

Basic demographic characteristics are also significant determinants of the digital divide in sub-Saharan Africa. As in other regions of the world, a gender gap in the access and use of digital technologies is observed in most African countries (Birba & Diagne, 2012; Forenbacher et al., 2019; Gillwald et al., 2010; Hasbi & Dubus, 2020; Ochoa et al., 2022; Pénard et al., 2012, 2015). This gender gap may be due to differences in average digital skills or income levels, combined with social and cultural gender norms unfavourable to women (Hafkin & Taggart, 2001; Mumporeze & Prieler, 2017). Age of individuals is another common determinant of digital inequalities, with younger people being more likely to adopt digital technologies than older ones, probably because of higher education attainment and technology familiarity (Birba & Diagne, 2012; Forenbacher et al., 2019; Hasbi & Dubus, 2020; Ochoa et al., 2022; Pénard et al., 2012, 2015).

2.3 | Digital divides among small firms in sub-Saharan Africa

There is little evidence on the level and determinants of the digital divide among firms in developing countries (Lythreatis et al., 2021; Srinuan & Bohlin, 2011). Yet the heterogeneous nature of these firms, which are for the most

part informal microenterprises, has been widely recognized as a key feature for several decades (Cunningham & Maloney, 2001; La Porta & Shleifer, 2014). The literature traditionally distinguishes between subsistence and growth-oriented entrepreneurs, which differ in their motivations, socio-economic characteristics, growth potential, access to technology and capital, and level of financial inclusion (Benjamin et al., 2012; Schoar, 2010). Grimm et al. (2012) argue for the existence of another intermediate group, called constrained gazelles, next to the lower tier of subsistence entrepreneurs (or survivalists) and the higher tier of growth-oriented entrepreneurs (or top performers). Commonly considered subsistence entrepreneurs, these constrained gazelles operate at low levels of capital and performance but share similar characteristics and skills with the top performers, revealing an untapped growth potential.

This heterogeneity in entrepreneurial attributes and productive characteristics may lead to significant additional digital divides (Bhattacharya, 2019). First, the uneven distribution of resources among informal firms may induce inequalities in their opportunities to access and use digital technologies for business purposes. The high cost of digital technologies is often the main barrier to adoption and use cited by firms in sub-Saharan Africa (Esselaar et al., 2006). It highlights that most firms face a lack of affordability of digital devices and services, potentially due to severe financial constraints such as low profits and no access to financial services. Thus, Atiyas and Dutz (2021) find that Senegalese micro-sized firms with access to bank loans are significantly more likely to own a smartphone. Moreover, the lack of knowledge and awareness of the potential benefits and the very existence of the new technologies may contribute to slowing down adoption, especially for advanced technologies or uses (Esselaar et al., 2006). In addition to some industry-specific adoption patterns, firm size, level of physical capital and access to electricity also appear to be positively correlated with access and use of digital technologies (Atiyas & Dutz, 2021; Berrou et al., 2020; Cirera et al., 2021).

Second, entrepreneurial orientation may induce specific patterns in the appropriation process of digital technologies. According to the technological acceptance theory, the motivation, attitude and intention to accept and use digital technologies may vary because of differences in perceived advantage, usefulness and ease of use (Chuttur, 2009; Van Dijk, 2005). Hence, growth-oriented entrepreneurs, who have entrepreneurial traits that encourage the search for and pursuit of opportunities, as well as better management of risks and uncertainties, are expected to be more receptive to new digital technology innovations and more likely to adopt them (Fafchamps & Quinn, 2018; Tang & Konde, 2020). Similarly, competition in the domestic market and industry-level adoption of new technologies can affect technology adoption at the firm-level through competitive concerns and spillover effects (Cirera et al., 2021). Finally, the level of formality has been pointed out as a key determinant of digital inclusion, with higher compliance with formal regulations being associated with greater access and use of digital technologies (Cirera et al., 2021; Deen-Swarray et al., 2013; Esselaar et al., 2006).

3 | DATA AND DESCRIPTIVE STATISTICS

3.1 | The data

We use data from the After Access business surveys conducted by Research ICT Africa (RIA, 2020) in 2017–2018 across eight African countries[2]: Senegal, Ghana, Nigeria, Rwanda, Kenya, Tanzania, Mozambique and South Africa. Not all businesses surveyed are necessarily informal, as no selection criteria were used, such as filter questions associated with a definition of informal enterprises. We restrain the sample of surveyed businesses to non-farm activities, as agricultural activities are specific in their mode of production and are few in the sample. In addition, we delete some observations because of missing values on key variables. The final sample considered in the following analyses comprises 3 300 firms from eight sub-Saharan African countries.

Although businesses were randomly selected for the survey,[3] they are not representative of the informal sectors in each country as the sampling frame of the Enumeration Areas (EA) is only representative at the household level.

Furthermore, the listing of all businesses in each selected EA omits the most hidden and elusive activities, those that take place in the homes of the entrepreneurs, as well as itinerant activities such as street vendors.

However, the data is particularly suitable for exploring in depth the level of digital inclusion of informal enterprises from diverse African countries with specific productive structures, business environments or stages of digital technology diffusion (Table A1). Indeed, harmonized surveys of informal enterprises in different countries asking them about their digital practices are valuable, and random sampling ensures the internal validity of the results.

3.2 | Description of firms and entrepreneurs

Table 1 reports some characteristics of firms and entrepreneurs for the total sample and for each country. Although we observe significant differences across countries, it is difficult to draw any conclusions about the composition of countries' informal sector, given that the samples for each country are not nationally representative.[3]

In the whole sample, the entrepreneurs are mostly sole proprietors of their businesses and are 38 years old on average. The proportion of firms led by women is slightly lower than that of men, while 8% of businesses are joint ventures between men and women. The data also shows that entrepreneurs' level of education remains low, with 36% of them having no education, and only 20% and 12% having reached secondary or tertiary education, respectively.[5] Half of the entrepreneurs report that the main reason for starting their business was the lack of other job opportunities, implying that they would have been unemployed and resourceless otherwise.

Most businesses are located in urban areas (63%). They have on average been set up for seven years and operate predominantly in the trade sector (68%). The vast majority of businesses are not considered by any type of registration. However, one-third of enterprises are registered with some local or municipal authorities, and just over one-tenth are registered at the national level. This is consistent with the fact that most of the firms in the sample are not subject to any form of taxation. Indeed, while 39% pay taxes at the local or municipal level, only 17% are registered for national value-added tax (VAT) or sales tax. The data also provides information on one of the other main formality criteria considered in sub-Saharan Africa, namely keeping accounts in conformity with national or regional standards. It can be considered that only 5% keep advanced accounts that are probably compliant with standards, while 43% carry simple bookkeeping and the remainder none. This low level of formality is combined with low financial inclusion, as only 25% of businesses have access to a bank account.

The firms we consider are mainly micro-sized, with 97% having less than five full-time paid workers, and 63% having any such employees. If the absence of labour force is often observed, this is also the case for fixed assets, as 33% of the entrepreneurs declare that they do not own any fixed assets of value (machinery, vehicles, furniture, etc.).

3.3 | Global overview of digital technologies usage

Table 2 proposes an overview of access to and usage of digital technologies for business purposes for the whole sample and each country.

We consider the first-level digital divide through the ownership of mobile phones, landline phones and computers. The entrepreneurs in the sample widely own mobile phones, with a penetration rate of 79%, which is consistent with the fact that the access gap is narrowing in the region, making them increasingly ubiquitous (GSMA, 2021).[6] Access to other ICT devices is extremely limited, with only 6% and 4% having access to a computer and a landline phone at the workplace, respectively, confirming the hegemony of the mobile phone and the limited penetration of other devices in sub-Saharan Africa. Overall, about 21% of the businesses in our sample do not have direct access to an ICT device, while the proportion of businesses with more than one ICT device only reaches 7%.

TABLE 1 Characteristics of firms and entrepreneurs.

	South Africa	Nigeria	Ghana	Kenya	Senegal	Tanzania	Rwanda	Mozambique	All
Entrepreneur characteristics									
Man	0.56	0.38	0.42	0.40	0.68	0.56	0.64	0.39	0.50
Woman	0.30	0.57	0.51	0.48	0.28	0.38	0.25	0.56	0.42
Joint venture (Woman and man)	0.13	0.04	0.07	0.12	0.04	0.05	0.11	0.05	0.07
Age	42.6	38.0	39.6	34.9	36.6	37.7		38.2	38.1
No education	0.09	0.28	0.18	0.02	0.51	0.68	0.55	0.47	0.36
Primary education	0.71	0.17	0.39	0.20	0.22	0.24	0.36	0.35	0.32
Secondary education	0.16	0.40	0.34	0.49	0.06	0.02	0.08	0.04	0.20
Tertiary education	0.04	0.15	0.08	0.29	0.21	0.05	0.02	0.13	0.12
No other opportunity	0.49	0.48	0.53	0.28	0.43	0.67	0.48	0.61	0.50
Firm economic performance[a]									
Sales	1245	345	454	498	837	398	461	131	448
Value-added	527	129	235	280	586	187	169	28	205
Net profit	622	86	144	174	314	14	131	44	113
Firm characteristics									
# of full-time paid workers	2.9	1.5	2.2	2.1	2.5	1.4	2.2	1.2	2.0
Any full-time paid worker	0.36	0.79	0.54	0.59	0.49	0.74	0.59	0.86	0.63
One or two full-time paid workers	0.45	0.14	0.34	0.34	0.34	0.24	0.32	0.12	0.28
Three or more full-time paid workers	0.09	0.04	0.06	0.04	0.11	0.02	0.05	0.02	0.05
Five or more full-time paid worker	0.10	0.03	0.06	0.04	0.07	0.01	0.05	0.01	0.04
Physical capital[b]	1556	246	312	249	418	225	236	53	249
No capital	0.39	0.24	0.36	0.36	0.50	0.13	0.21	0.48	0.33
Urban	0.73	0.44	0.64	0.67	0.68	0.59	0.65	0.69	0.63
Manufacture	0.07	0.15	0.15	0.06	0.14	0.10	0.10	0.18	0.12
Service	0.27	0.18	0.20	0.26	0.21	0.15	0.24	0.07	0.20
Trade	0.65	0.67	0.65	0.69	0.64	0.75	0.66	0.76	0.68
Age of firm	5.7	7.6	6.8	3.6	6.1	4.8	17.6	6.0	7.1
Registration with any local or municipal authority	0.34	0.21	0.35	0.40	0.33	0.18	0.78	0.11	0.32
Registration at the national level	0.29	0.03	0.14	0.15	0.13	0.04	0.32	0.02	0.13
Pay local or municipal taxes	0.27	0.44	0.47	0.41	0.44	0.15	0.78	0.22	0.39
Registration for national VAT or sales tax	0.26	0.10	0.22	0.16	0.23	0.12	0.20	0.04	0.16
Formal accounts	0.06	0.02	0.01	0.01	0.21	0.02	0.02	0.02	0.05
Access to electricity	0.85	0.56	0.60	0.63	0.68	0.50	0.81	0.27	0.60
Bank account	0.55	0.26	0.32	0.28	0.14	0.09	0.38	0.10	0.25
Observations	364	492	387	388	470	457	349	393	3300

Notes: All monetary values are expressed in 2017 Intl.$ PPP.

[a]Median values.

[b]Median values among firms with non-zero capital.

Source: Author's computations based on After Access Surveys, RIA, 2017–2018.

TABLE 2 Digital technologies ownership and usage among surveyed firms.

	South Africa	Nigeria	Ghana	Kenya	Senegal	Tanzania	Rwanda	Mozambique	All
Ownership of DT devices									
Mobile phone	0.92	0.66	0.78	0.87	0.89	0.81	0.67	0.7	0.79
Landline phone	0.14	0.02	0.04	0.01	0.09	0	0.01	0	0.04
Computer	0.19	0.01	0.05	0.03	0.1	0.03	0.04	0.02	0.06
Number of DT devices owned									
Any	0.07	0.34	0.21	0.12	0.11	0.19	0.31	0.3	0.21
One	0.7	0.63	0.72	0.84	0.77	0.77	0.66	0.68	0.72
Two	0.13	0.02	0.05	0.03	0.07	0.04	0.02	0.02	0.05
Three	0.1	0	0.01	0	0.05	0	0	0	0.02
DT usage for external coordination									
Bilateral coordination with suppliers	0.43	0.41	0.49	0.63	0.66	0.2	0.78	0.23	0.47
Bilateral coordination with customers	0.38	0.41	0.56	0.66	0.61	0.19	0.7	0.24	0.46
Multilateral coordination	0.28	0.09	0.13	0.11	0.23	0.06	0.05	0.03	0.12
DT usage for financial transactions									
Online or mobile banking	0.22	0.04	0.07	0.12	0.08	0.06	0.09	0.11	0.09
Mobile money to send money	0.05	0.02	0.25	0.56	0.31	0.11	0.42	0.12	0.22
Mobile money to receive money	0.03	0.02	0.28	0.41	0.24	0.13	0.4	0.2	0.21
DT usage for internal management									
Use of management software	0.09	0	0	0.01	0.07	0.01	0.02	0.01	0.02
Number of DT functions used									
Any	0.37	0.44	0.27	0.12	0.19	0.66	0.15	0.56	0.35
One	0.21	0.23	0.23	0.15	0.2	0.14	0.08	0.17	0.18
Two	0.18	0.26	0.21	0.26	0.25	0.08	0.34	0.14	0.21
Three	0.11	0.04	0.12	0.19	0.11	0.07	0.11	0.07	0.1
Four	0.05	0.02	0.11	0.18	0.1	0.03	0.23	0.04	0.09
Five	0.06	0	0.06	0.08	0.09	0.01	0.07	0.02	0.05
Six	0.01	0.01	0.01	0.02	0.04	0.01	0.01	0.01	0.01
Seven	0	0	0	0.01	0.01	0	0.01	0	0
Observations	364	492	387	388	470	457	349	393	3300

Source: Author's computations based on After Access Surveys, RIA, 2017–2018.

Among firms that do not own a mobile phone, more than half claim they do not need one, and almost a quarter report that the main reason is that it is too expensive.

The second-level digital divide is observed through the use of digital technologies for professional purposes. No information was collected on digital skills, and incomplete information was collected on the different interfaces used and the intensity of use. While it limits our consideration of the multidimensionality of digital technologies usage, the diversity of use is already relevant in characterizing second-level digital inequalities among African micro-enterprises. Subsequent analyses then focus on the purposes for which firms use digital technologies, rather than the way or frequency with which they use them.

While 79% of firms have access to a mobile phone, only 65% use it for business purposes. Among enterprises that do not own a personal device, just over a third still report using digital technologies for business purposes. It highlights the complexity of assessing access to ICT devices in a context where shared devices and the interweaving of business and social spheres can provide opportunities for indirect access. Conversely, ownership of a mobile phone or other ICT devices does not necessarily imply professional use, as the use of digital technologies may remain confined to the social sphere. More than a quarter of enterprises with access to an ICT device do not use it for business reasons, illustrating the importance of going beyond access and observing actual usage. Given that most businesses have undergone some degree of digitalization by integrating digital technologies into their business operations, it is essential to explore for what purposes businesses use these technologies.

Following Berrou et al. (2020), we consider three major functions of digital technologies in the business context: the external coordination function, the financial function and the internal management function. The external coordination function considers digital technologies as tools to improve market coordination with the firm's external partners. Businesses can use these technologies to communicate in a bilateral, or one-to-one, way in the context of interpersonal relationships. The available data allows us to consider whether businesses use digital technologies for bilateral coordination upstream of production with suppliers or downstream of production with customers. These uses are the most widespread among the sampled businesses, with 48% and 47% using digital technologies for bilateral coordination with their suppliers and customers, respectively. These two specific uses of digital technologies are significantly correlated, as three-quarters of the firms that practice bilateral coordination with their suppliers also do it with their customers, and conversely. However, face-to-face communication remains the most common mode of communication for most entrepreneurs, as only 24% and 18% report preferring digital technologies to communicate with their suppliers and customers, respectively. It is confirmed by the fact that these technologies are most often used as a complementary communication tool to face-to-face communication rather than as a substitute, as few businesses (11%) exclusively use digital technologies to communicate with their suppliers.

Digital technologies also allow for more extensive market coordination through multilateral, or one-to-many, coordination. It concerns the use of digital technologies, and mainly the use of the internet, for information retrieval, online sales or advertising, and group or mass communication through social media. Multilateral coordination is much less common among the businesses in our sample, with only 12% of them reporting that they use the internet or social media for business purposes. Although low, this is in line with the proportion of people using the internet in Africa in 2017, which stood at only 21.8% (ITU, 2017a). Then, social media and internet use are advanced usages. In addition to requiring an internet-enabled device and affordable, high-quality connectivity, such uses require higher digital skills than those needed to communicate with suppliers or customers in a bilateral way.

Then, the financial function considers digital technologies as tools for financial inclusion, allowing people to benefit from financial services other than through banking and to carry out cashless financial transactions. Mobile money services are used for business purposes by 27% of the businesses in the sample. Among them, 77% receive transfers from their customers, and 63% pay their suppliers with these services. Some of these businesses also use mobile money to pay bills (48%), taxes (13%) or wages (14%). The use of mobile money for business purposes does not necessarily involve sending and receiving transfers, as 41% of mobile money users are solely concerned with one type of transfer. In addition, the intensity of mobile money use is low among the group of users, with only 13% of them receiving payments daily. Mobile banking, which offers digital access to financial services for those with bank

accounts, is also considered, but the adoption rate stands at only 9%. It highlights the low financial inclusion of the businesses in our sample, with 57% of them neither having a bank account nor using mobile money services.

At last, the internal management function considers digital technologies as a tool for managing the firm's internal operations. We consider internal management through the use of software for inventory management, accounting or performance monitoring. Implementing the use of such software requires significant resources in terms of digital skills and equipment, as we are specifically considering computer software. Given the few enterprises owning computers, the use of management software concerns only 2% of the firms surveyed.

Finally, this overview hides significant disparities between countries, as the level and pattern of digital diffusion among surveyed firms in each country vary. Access to ICT devices remains a major issue in the digital inclusion process in some countries, while access is now almost universal in others. Mobile phone ownership ranges from 66% in Nigeria to 92% in South Africa. Landline phone and computer ownership concerns the South African and Senegalese samples essentially, as these devices are almost absent in other countries. However, the access divide remains relatively narrow across countries compared with the usage divide. The proportion of businesses using at least one of the functions of digital technologies for business purposes varies significantly between countries. Less than half of the businesses in Tanzania (34%) and Mozambique (44%) have digital practices. In comparison, three-quarters or more of the businesses are users in Kenya (89%), Ghana (74%), Rwanda (85%) and Senegal (81%). These inter-country disparities could be explained by differences between countries in terms of structural and macroeconomic characteristics, level of ICT infrastructure and accessibility, as well as characteristics of firms and entrepreneurs. However, the non-representativeness of the data at the national level does not allow us to judge the determinants of these cross-country disparities, as they may be due to the structure of the samples in each country.

4 | EMPIRICAL STRATEGY

4.1 | Heterogeneity of micro-sized firms: a deductive approach

To examine whether informal firms' heterogeneity is related to their level of digital inclusion, we rely on the method proposed by Grimm et al. (2012). This method, originally used to classify informal enterprises in the context of some West African countries (Grimm et al., 2012; Lavallée & Roubaud, 2019), has also been applied in other contexts (Abebe et al., 2018; Adoho & Doumbia, 2022; Moosa, 2019; Negrete, 2022). The methodology follows a deductive approach as it assumes the existence of three distinct and homogeneous groups within the informal sector: (1) top performers, comprising a fixed proportion of entrepreneurs with the highest economic performance based on selected criteria; (2) constrained gazelles, who share similar characteristics with the top performers, but are far from their economic performance levels; and (3) survivalists, a group of subsistence entrepreneurs with fundamentally different characteristics and limited economic potential.

4.1.1 | Defining top performers

We define top performers based on a combination of two criteria, as described in Grimm et al. (2012). First, in each country, we select the top 40% firms with the highest value of fixed physical capital. This size criterion allows us to identify businesses that have had the capacity and the motivation to grow in the past. The size criterion, therefore, reflects past performance and the propensity to invest in the business. In a way, it ensures that we retain growth-oriented entrepreneurs and firms with access to capital, two significant factors of success among micro and small enterprises (La Porta & Shleifer, 2014). The second step consists of retaining from these firms the 50% with the highest net profit. This performance criterion aims to capture the current performance of the firm. This deductive method automatically assigns about 20% of the sampled firms to the group of top performers.

Our approach differs somewhat from that initially proposed by Grimm et al. (2012), which identifies the group of top performers by first selecting the firms in the top 25% of physical capital value distribution, from which they select the 40% of firms with the highest capital profitability. First, while we consider the same size criterion, we consider the net profit instead of capital profitability to assess the current economic performance of firms. We argue that in our context, where firms are mainly engaged in trade activities, capital productivity may not be the most suitable indicator for evaluating a firm's performance. We also prefer the firm's net profit over the turnover, as it measures the entrepreneur's net income and the firm's capacity to reinvest. Second, we adapt the thresholds to identify a group of top performers representing 20% of the sample and not only 10%. Compared to Grimm et al. (2012), which use 1-2-3 survey data, our sample of firms does not include the most vulnerable activities, such as household businesses or street vendors. Then, we argue that a 10% group of top performers is quite restrictive and risks assigning successful firms to the group of constrained gazelles.

4.1.2 | Identifying constrained gazelles and survivalists

Then, our empirical method aims to capture the heterogeneity of entrepreneurs who have not been defined as top performers. While this group of remaining entrepreneurs is traditionally defined as subsistence entrepreneurs, here we want to identify among them the entrepreneurs with the potential to become successful. These entrepreneurs, called constrained gazelles, have similar characteristics to top performers. Therefore, constrained gazelles are entrepreneurs with a high empirical probability of being top performers, given their observable characteristics. Following Grimm et al. (2012), the probability of being a top performer is estimated by the following probit model:

$$\Pr\left(Y_i^{TP}=1\right)=\Phi\left(\beta_0+X_i\beta_1+\omega_1\right) \quad (1)$$

where Y_i^{TP} is a dummy variable that takes the value 1 if the entrepreneur is a top performer, and 0 otherwise. X_i^0 is a vector of entrepreneur and firm characteristics. β_0 and β_1 are the vector of coefficients indicating how these characteristics influence the probability of being a top performer, and ω_i the error term. Finally, Φ is the cumulative density function of the standard normal distribution. Standard errors are clustered at the EA level.

To minimize endogeneity issues, the set of explanatory variables is limited to predetermined factors, i.e., characteristics that are observable prior to, or at the time of, the creation or starting management of the business by the entrepreneur. Although only predetermined factors are considered, we expect the model to identify a group of entrepreneurs, called constrained gazelles, with similar entrepreneurial behaviour and characteristics to top performers, but clearly different from survivalists.

The predetermined factors considered as regressors in the model are the entrepreneur's gender and level of education,[7] urban location, whether the main source of initial capital used to start the business is microfinance or bank loan, and the motivation of the entrepreneur to set up the business. This last variable is measured by a dummy variable, which takes the value 1 if the entrepreneur started the business because he or she had no other job opportunity, i.e., he or she would be unemployed otherwise. As in Grimm et al. (2012), in addition to these variables, we add controls for sectors and countries, as well as for the age of the firm.

Based on this binary response model, we predict for all the entrepreneurs in our sample the probability of being a top performer, using the estimated parameters $\hat{\beta}_0$ and $\hat{\beta}_1$, and the observed vector of entrepreneur and business characteristics:

$$\hat{Pr}\left(Y_i^{TP}=1\right)=\Phi\left(\hat{\beta}_0+X_i\hat{\beta}_1\right) \quad (2)$$

where "hats" indicate estimated parameters. Table A2 reports the estimated coefficients and the corresponding average marginal effects. We find that being a top performer is significantly correlated with the entrepreneur's gender, level of education, and motivation to start the business, while the firm's age, source of the initial capital, sector of activity, and geographical location are also significant predetermined factors of top performance.

In order to segment the sample of entrepreneurs in each country into these three groups - top performers, constrained gazelles, and survivalists -we use these predicted probabilities in the following way. For each country, we calculate the average predicted probability of the top performer group. Then, we identify the group of constrained gazelles in such a way that the average of the predicted probabilities of this group is identical to the average among the top performers. The group of survivalists comprises entrepreneurs who are neither top performers nor constrained gazelles. For the pooled sample, our partition identifies 20% of top performers, 40% of constrained gazelles, and the same proportion of survivalists. Table A3 reports the distribution of segments by country.

In the methodology described above, the choice of the criteria, the order in which they are applied, and the associated thresholds, partly determine the partition results. Moosa (2019) demonstrates that the modification in composition and characteristics of groups is limited when applying diverse alternative empirical specifications. Such consistency is verified in our case, with a high correlation between segmentation using different thresholds and variables for defining the group of top performers.

4.2 | Determinants of the second-level digital divide

4.2.1 | Multivariate analysis

To identify the main determinants of the second-level digital divide among microenterprises in sub-Saharan Africa, we rely on a standard logit regression model that estimates the effect of entrepreneur and firm-level characteristics on the likelihood of using digital technologies for business purposes. The dependent variable is a binary indicator taking the value 1 if the enterprise uses at least one of the following functions: bilateral coordination with suppliers, bilateral coordination with customers, multilateral coordination, sending money through mobile money services, receiving money through mobile money services, use of mobile or online banking, internal coordination through management software, and taking the value 0 otherwise. The following model is estimated:

$$DTuse_i = \beta_0 + \beta_1 X_i + \beta_2 B_i + \beta_3 DTownership_i + \beta_4 Region_i + \varepsilon_i, \quad (3)$$

where $DTuse_i$ is a binary dependent variable that indicates whether a firm i uses digital technologies for business purposes. X_i is a vector of entrepreneur-level characteristics, including gender, educational attainment, and motivation to start the business.[8] B_i is a vector of firms' basic characteristics, including firm age, the logarithm of monthly profit, access to electricity, number of full-time paid workers, level of informality,[9] sector of activity, and urban location. We add to this vector whether the entrepreneur has a bank account, separates business finances from personal finances, and keeps records, as well as some characteristics of the trading network, such as having formal partners, having businesses as customers, and having partners located further away than the surrounding villages and towns. As the ownership of ICT devices influences the use of digital technologies for business purposes, $DTownership_i$ is a set of dummies that indicate the number of ICT devices the firm possess among mobile phone, computer, and landline phone. $Region_i$ is a set of 82 region dummies controlling for intra- and inter-countries disparities in terms of levels of economic activity and infrastructural connectivity. ε_i is an error term clustered at the EA level. Only informal firms are considered in this regression, as being totally formal perfectly predicts the success of the binary outcome.[10]

We estimate this model for the whole sample and then for each informal segment, to observe general and segment-specific determinants of digital inequalities. As being located in some regions perfectly predicts the success

or failure of the binary outcome, we replace the region dummies with country dummies in the sub-sample regressions.

4.2.2 | Multivariate decomposition of usage gaps

To further explain the differences in digital technologies usage between the three segments, we use a multivariate decomposition for nonlinear response models (Powers et al., 2011; Yun, 2004), which extends the decomposition technique initially proposed by Oaxaca (1973) and Blinder (1973) to nonlinear models. It allows us to attribute differences in binary outcomes between groups to endowment and coefficient effects. The objective is to decompose segment differences in the probabilities of digital technologies usage into differences in observable characteristics (endowment effect), on the one hand, and differences in the effect that these characteristics have on the outcome of interest (coefficient effect), on the other. Similar analyses have been carried out by Galperin and Arcidiacono (2021) to decompose the gender digital gap in Latin America. We use the same predictors as in the logit model described above, with minor modifications. We replace region effects with country effects, the ICT equipment ownership indicator by its components, and the level of informality with two dummies indicating whether the firms are registered and pay taxes, to avoid that these indicators predict success perfectly.

We argue that each predictor can be linked to specific barriers hindering access to digital technologies. Specifically, we consider entrepreneurs' educational attainment and entrepreneurial practices as proxies for their digital skills. We also assume that the characteristics of their trading network may affect their motivation to use digital technologies for business purposes. Indeed, adopting a technology requires knowledge and awareness of its usefulness, which often comes from interaction with other agents (Comin & Mestieri, 2014). Firms' competitive and business environments shape these interactions. Therefore, the characteristics of trading partners can influence the firm's decision to adopt digital technologies and their specific usage through network effects. We consider the motivation and ability to use digital technologies as internal constraints. Furthermore, the level of economic inclusion measured through financial inclusion, level of informality, and access to public utilities, as well as the level of profits, are good proxies for the ability to afford digital devices and services. We consider digital services' affordability as an external constraint, as is material access.

Our assumption is that constrained gazelles and survivalists face different combinations and magnitude of barriers that can explain the usage gaps with the top performers. Specifically, the second-level digital divide between survivalists and top performers must be driven by higher internal and external constraints in the successive phase of access to digital technologies. In contrast, the usage gap between constrained gazelles and top performers is expected to be mainly explained by differences in external constraints, as they tend to share similar entrepreneurial characteristics.

5 | RESULTS

5.1 | Differences in the characteristics of firms and entrepreneurs across segments

5.1.1 | Socio-demographic and productive heterogeneity

Table 3 shows that the three segments differ significantly in terms of entrepreneur and business characteristics. Above all, the three groups differ in their economic performance,[11] with top performers being effectively the most successful businesses. Their average monthly sales are more than six times higher than those of the survivalists and constrained gazelles. This gap widens further with value-added and net profit. These observations are consistent with significant differences in firm size. While a significant proportion of survivalists (42%) and constrained gazelles

TABLE 3 Comparison of segments by firm and entrepreneur characteristics.

	(1) Survivalists	(2) Constrained gazelles	(3) Top performers	(4) t-Test (1) vs. (2)	(5) t-Test (2) vs. (3)
Entrepreneur characteristics					
Man	0.35	0.61	0.59	0***	0.429
Woman[b]	0.62	0.29	0.29	0***	0.923
Joint venture	0.03	0.10	0.12	0***	0.157
Age	38.1	38.1	38.2	0.852	0.939
No education[b]	0.66	0.13	0.20	0***	0***
Primary education[b]	0.25	0.38	0.34	0***	0.147
Secondary education[b]	0.07	0.29	0.27	0***	0.365
Tertiary education[b]	0.02	0.20	0.18	0***	0.315
No other opportunity[b]	0.67	0.38	0.39	0***	0.596
Firm economic performance					
Sales	1066	1205	8187	0.591	0***
Value-added	782	558	4727	0.519	0***
Net profit[a]	343	316	2558	0.736	0***
Firm characteristics					
# of full-time paid workers	1.5	2.1	2.9	0***	0***
Any full-time paid worker	0.73	0.59	0.49	0***	0***
Physical capital[a]	1354	1254	12471	0.922	0***
No capital	0.42	0.40	0	0.304	0***
Formal loan as initial capital[b]	0.01	0.05	0.07	0***	0.064
Urban[b]	0.48	0.74	0.72	0***	0.372
Manufacture[b]	0.10	0.14	0.14	0.004***	0.944
Service[b]	0.10	0.25	0.26	0***	0.565
Trade[b]	0.80	0.61	0.60	0***	0.642
Age of firm[b]	5.8	7.8	8.1	0***	0.464
Access to electricity	0.46	0.64	0.83	0***	0***
Registration (local level)	0.21	0.33	0.55	0***	0***
Registration (national level)	0.06	0.14	0.26	0***	0***
Taxes payment (local level)	0.27	0.43	0.63	0***	0***
Taxes payment (national level)	0.25	0.42	0.60	0***	0***
Keep accounts	0.36	0.51	0.66	0***	0***
Separate finance	0.24	0.42	0.54	0***	0***
Bank account	0.14	0.27	0.46	0***	0***
Trading network characteristics					
Any supplier	0.21	0.21	0.12	0.717	0***
One supplier	0.31	0.27	0.18	0.007***	0***
Two or three suppliers	0.32	0.33	0.40	0.309	0.002***
More than three suppliers	0.16	0.19	0.29	0.018**	0***
Formal suppliers	0.42	0.53	0.69	0***	0***

TABLE 3 (Continued)

	(1) Survivalists	(2) Constrained gazelles	(3) Top performers	(4) t-Test (1) vs. (2)	(5) t-Test (2) vs. (3)
Businesses as customers	0.13	0.20	0.35	0***	0***
Not locally located trading partners	0.06	0.11	0.22	0***	0***
Very reliable suppliers	0.15	0.20	0.27	0.001***	0.001***
Relational contracting	0.48	0.50	0.56	0.177	0.018**
Long relationship	0.29	0.44	0.49	0***	0.015**
Weekly contact with suppliers	0.47	0.50	0.57	0.088*	0.004***
N	1312	1329	659		

Notes: All monetary values are expressed in 2017 Intl.$ PPP.
[a]Variables used to identify top performers.
[b]Variables used to identify constrained gazelles.
*$p < 0.0$, **$p < 0.01$, and ***$p < 0.001$.
Source: Author's computations based on After Access Surveys, RIA, 2017–2018.

(40%) do not own any physical assets of value, top performers are by far the most capital-intensive segment. These differences are a mechanical consequence of the method used to identify the top performers, which considers the stock of physical capital as a size criterion and net profit as a performance criterion.

As we identify constrained gazelles based on a set of predetermined factors, they share similar sector occupation and socio-demographic characteristics with top performers. Indeed, they are more represented in the manufacturing and service sectors than the survivalists. Findings also show that only 29% of top performers and constrained gazelles are exclusively run by women, while this figure rises to 62% among survivalists. This is in line with previous literature that found that women are underrepresented among top performers (Grimm et al., 2012). Two tiers of survivalists have no education compared to a minority of top performers and constrained gazelles, which is consistent with the exclusion from the formal labour market traditionally attributed to survivalists. Indeed, findings confirm that the survivalists are entrepreneurs by necessity, as 67% declare that they started their activity because they would have been unemployed otherwise. However, a significant proportion of top performers and constrained gazelles also make this claim, highlighting the importance of entrepreneurship in earning a living in sub-Saharan Africa.

The three segments also differ in other characteristics that we have not used in the segmentation approach. In terms of structural business characteristics, we find that the majority of the survivalists (73%) and constrained gazelles (59%) are self-employed workers as they do not employ any full-time paid workers other than the owner. In contrast, the top performers are more likely to be employers with at least one additional full-time paid worker, but still exhibit a high proportion of self-employed (49%). Moreover, the top performers are also the oldest firms and those with the highest access to electricity. This difference in access to utilities probably illustrates significant disparities in operating conditions, with survivalists mainly conducting petty trading activities in markets or precarious premises, while the top performers, and to a lesser extent the constrained gazelles, are better established. Entrepreneurs in each segment also differ notably in how they conduct their business and comply with regulations. Top performers are the ones who more often keep financial records and strictly separate business accounts from personal finances. Similarly, survivalists and constrained gazelles are less subject to registration and payment of taxes than top performers. The latter also displays a higher level of financial inclusion, as almost half of them have a bank account, while only 14% and 27% of the survivalists and constrained gazelles have one, respectively. Finally, the firms' trade network characteristics differ in each segment. Top performers integrate more complex value chains than

the survivalists and the constrained gazelles, which are limited to retailing locally supplied goods to nearby inhabitants.

5.1.2 | Informal heterogeneity and digital technologies

Table 4 reports access to and use of digital technologies by segment. Descriptive statistics suggest significant access inequalities. While only 8% of top performers do not own a device, 18% of constrained gazelles and 31% of survivalists do not have access to digital technologies. We observe these access inequalities for all the devices considered, with top performers being the segment with the highest mobile phone, landline phone, and computer ownership rates. Constrained gazelles are almost as well equipped as the top performers regarding mobile phones, the most widespread equipment. The possession of other devices mainly concerns these two segments, with very few survivalists owning a landline phone or a computer. Thus, inequalities in access mainly affect survivalists, although constrained gazelles demonstrate lower access to digital technologies than top performers.

Looking at the second-level of digital divide, survivalists remain the most digitally excluded since only 49% of them use digital technologies for at least one of the functions defined above. These professional practices are much more widespread among constrained gazelles (69%) and top performers (85%). These disparities in usage rates are likely to be explained by differences in ownership rates. However, the transition from access to actual usage appears not equally important for each segment. Indeed, while 86% of top performers owning an ICT device use it for business purposes, this figure drops to 76% among constrained gazelles and falls to 58% for survivalists. Furthermore, digital inequalities persist within the user group, as top performers exhibit a greater diversity of use compared to the other segments. On average, top performers using digital technologies implement three functions compared to two functions for the other segments.

Disparities in usage exist between the different segments for each function of the digital technologies considered. Using these technologies for bilateral coordination with suppliers or customers is almost ubiquitous among top performers, with 79% engaging in such behaviour. While constrained gazelles also broadly use this type of function (64%), this is not the case for survivalists, whose use of bilateral coordination is less widespread (44%). The use of social media or the internet in general for multilateral coordination purposes concerns few firms, with only one-quarter of top performers and 13% of constrained gazelles doing so. These advanced practices, such as online advertising, selling products and services online, or searching for information, are employed by only 6% of survivalists.

The use of digital technologies for financial transactions through mobile money or online banking services is also less widespread among survivalists. Only 17% of them receive or send money via mobile money for business purposes, compared to 29% and 43% among constrained gazelles and top performers, respectively. While top performers are already the most likely to have a bank account, they also benefit the most from financial technology innovations. In addition, the few users of software for inventory management, accounting, or performance monitoring are mostly top performers (68%).

5.2 | Digital divides among informal firms

5.2.1 | Determinants of professional usage of digital technologies

Table 5 reports the results of the multivariate analysis, which estimates the probability of digital technologies usage for business purposes on observable entrepreneurs' and firms' characteristics in the eight African countries. In this table, we show the average marginal effects,[12] which display the average change in predicted probabilities if the explaining variable is changed by one unit. Column 1 presents the average marginal effects estimated for the whole sample.

TABLE 4 Comparison of segments by DT equipment and usage.

	(1) Survivalists	(2) Constrained gazelles	(3) Top performers	(4) t-Test (1)vs.(2)	(5) t-Test (2)vs.(3)
Ownership of DT devices					
Mobile phone	0.69	0.82	0.91	0***	0***
Landline	0.01	0.04	0.09	0***	0***
Computer	0.01	0.06	0.16	0***	0***
Number of DT devices owned					
Any	0.31	0.18	0.08	0***	0***
One	0.68	0.76	0.75	0***	0.721
Two	0.02	0.05	0.11	0***	0***
Three	0	0.02	0.06	0***	0***
Second-level digital divide					
DT users	0.49	0.69	0.85	0***	0***
Number of functions used[a]	2.12	2.42	3.03	0***	0***
DT for external coordination					
Bilateral coordination with suppliers	0.36	0.49	0.66	0***	0***
Bilateral coordination with customers	0.33	0.50	0.65	0***	0***
Multilateral coordination	0.06	0.13	0.25	0***	0***
DT for financial transactions					
Online or mobile banking	0.04	0.09	0.02	0***	0***
Mobile money to send money	0.13	0.24	0.36	0***	0***
Mobile money to receive money	0.13	0.21	0.36	0***	0***
DT for internal management					
Use of software	0	0.02	0.09	0***	0***
N	1312	1329	659		

[a]The average number of functions implemented by firms that use at least one function of digital technologies.
*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.
Source: Author's computations based on After Access Surveys, RIA, 2017–2018.

The results indicate that certain socio-demographic characteristics of entrepreneurs are associated with the usage of digital technologies for business purposes. In line with previous research, our findings show that firms led by women are 6.7% points less likely than firms led by men to use at least one function of digital technologies for business purposes. Education attainment is also a significant driver, as primary and secondary education increase the probability of using digital technologies for business purposes by 3.5% and 6% compared to entrepreneurs with no education. No significant association is found between the digitalization of firms' business operations and urban location, which may be explained by the fact that the model includes region effects to control for cross-region disparities in terms of digital connectivity and urbanization rate, for example. All these findings show that some socio-demographic determinants of the digital divide usually identified in sub-Saharan Africa at the individual-level, such as gender and education attainment, persist in the productive sphere and the sub-population of informal entrepreneurs.[13] Beyond the fact that it indicates that personal and professional uses of digital technologies are intrinsically linked, it invites us to deepen our understanding of the digital divide at the firm-level by exploring the role of entrepreneurial attributes and firm characteristics.

TABLE 5 Determinants of digital technologies usage for business purposes.

	(1) All	(2) Survivalists	(3) Constrained gazelles	(4) Top performers
Gender of the owner (ref. Man)				
Woman	0.067***	0.010***	0.031	0.002
	(0.016)	(0.029)	(0.026)	(0.032)
Both	0.005	0.068	0.035	0.024
	(0.029)	(0.073)	(0.039)	(0.058)
Education of owner (ref. None)				
Primary	0.035*	0.056	0.108***	0.015
	(0.019)	(0.035)	(0.037)	(0.031)
Secondary	0.060**	0.135**	0.089*	0.021
	(0.024)	(0.057)	(0.047)	(0.053)
Tertiary: Diploma/Certificate	0.012	0.076	0.030	0.024
	(0.028)	(0.081)	(0.047)	(0.058)
Age of the firm	0.002	0.002	0.003	0.007*
	(0.001)	(0.003)	(0.003)	(0.004)
Age of the firm (squared)	2.48e-05	2.75e-05	2.54e-05	0.000136**
	(1.79e-05)	(4.01e-05)	(7.65e-05)	(6.13e-05)
Log monthly profits	0.019***	0.014	0.019**	0.001
	(0.005)	(0.010)	(0.008)	(0.017)
Number of full-time paid workers (Ref. None)				
1 or 2 full time workers	0.023	0.040	0.033	0.025
	(0.020)	(0.031)	(0.030)	(0.033)
3 or more full time workers	0.059*	0.004	0.091*	0.076
	(0.033)	(0.062)	(0.051)	(0.058)
Sector of activity (Ref. Manufacture)				
Service	0.038	0.004	0.063*	0.060
	(0.024)	(0.052)	(0.033)	(0.040)
Selling/Trading	0.097***	0.060	0.119***	0.143***
	(0.020)	(0.040)	(0.032)	(0.030)
Urban location	0.016	0.007	0.002	0.015
	(0.017)	(0.028)	(0.028)	(0.028)
Level of informality (Ref. Low level)				
High level of informality	0.044	0.136**	0.064	0.117***
	(0.028)	(0.053)	(0.043)	(0.039)
Totally informal	0.056**	0.014	0.155***	0.063
	(0.028)	(0.051)	(0.043)	(0.042)
Access to electricity	0.054***	0.073**	0.059***	0.037
	(0.016)	(0.029)	(0.023)	(0.035)
Bank account	0.093***	0.070**	0.094***	0.070**
	(0.022)	(0.035)	(0.029)	(0.030)

TABLE 5 (Continued)

	(1) All	(2) Survivalists	(3) Constrained gazelles	(4) Top performers
Not keeping accounts	0.068***	0.078**	0.039	0.062**
	(0.020)	(0.034)	(0.024)	(0.029)
Separate finance	0.024	0.008	0.019	0.015
	(0.016)	(0.031)	(0.023)	(0.030)
No other opportunity	0.038***	0.026	0.062***	0.018
	(0.015)	(0.029)	(0.023)	(0.025)
B2B relations	0.096***	0.141***	0.062*	0.070*
	(0.023)	(0.039)	(0.036)	(0.039)
Formal partners	0.062***	0.058**	0.063***	0.049*
	(0.015)	(0.024)	(0.024)	(0.028)
Not local trading partners	0.110***	0.280***	0.064	0.098**
	(0.033)	(0.072)	(0.048)	(0.045)
Number of ICT devices owned (Ref. Zero)				
1	0.168***	0.148***	0.228***	0.071
	(0.021)	(0.028)	(0.034)	(0.053)
2	0.290***	0.312***	0.321***	0.155**
	(0.042)	(0.114)	(0.058)	(0.062)
3	0.397***	-	0.392***	-
	(0.082)		(0.076)	
Region effects	Yes	No	No	No
Country effects	No	Yes	Yes	Yes
Observations	3191	1287	1297	601

Notes: Robust standard errors are in parentheses.
*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.
Source: Author's computations based on After Access Surveys, RIA, 2017–2018.

Findings reveal a positive correlation between monthly profits and the use of digital technologies. Although the relation is endogenous, as the adoption of digital technologies may enhance firms' economic outcomes, it highlights that successful firms may have a greater ability to pay for digital devices and services, and a greater need and willingness to use them. Additionally, we observe a significant association between the use of digital technologies and firm size, as firms with three or more full-time paid workers are more likely to incorporate digital technologies in their business operations than self-employed entrepreneurs. Access to electricity also appears to increase the probability of using digital technologies for business purposes by 5.4% points, confirming the importance of access to utilities and the quality of business premises.

Older firms are not associated with a higher probability of usage, while trade activities are less associated with digital technologies usage than manufacturing activities (9.7% points). These results highlight some sectoral specificities, as the nature of the economic activity probably shapes the professional use of digital technologies due to specific organizational modes, business relationships, and sales channels. Indeed, the characteristics of trading partners appear to influence the second-level digital divide at the firm-level. Firms with formal suppliers have a 6.2% points higher likelihood of using digital technologies. Similarly, having businesses as customers increases the estimated probability by 9.6% points. These results indicate potential network effects in the diffusion of digital

technologies, as having formal suppliers and expanding customer base to other businesses may create a greater need to adopt these technologies. Moreover, having business partners located further away than the surrounding villages or towns increases the likelihood of using digital technologies by 11% points.

Entrepreneurial behaviour also plays a significant role in the second-level digital divide among informal firms in sub-Saharan Africa. We find that opportunity entrepreneurs are more likely to use digital technologies for business purposes than others. Indeed, entrepreneurs who indicate that they started their businesses because of a lack of other employment opportunities are 3.8% points less likely to use digital technologies. While there is no significant association with the strict separation of business accounts from personal finances, the absence of record-keeping decreases the probability of using digital technologies by 6.8% points. Furthermore, financial inclusion is a significant determinant of the second-level digital divide among informal firms. Having a bank account is significantly correlated with a higher likelihood of using these technologies, with an increase of 9.3% points. The degree of informality is also a major factor of digital inclusion. In comparison to firms with a low level of informality, totally informal firms are 5.6% points less likely to use digital technologies for business purposes. Estimations are controlled by the number of devices that firms possess. As expected, material access is strongly correlated with using such technologies, confirming the sequential process of the digital divide. Furthermore, it appears that the cumulative possession of devices is strongly associated with being a user.

Within each segment, we observe specific patterns in the second-level digital divide, along with shared factors (Table 5, columns 2, 3, and 4). Common factors influencing digital technologies usage include the number of ICT devices owned, the access to a bank account, and the characteristics of firms' trading network. It confirms the importance of material access in bridging the second-level digital divide among informal firms, but also demonstrates the importance of financial inclusion and network effects in facilitating their adoption of digital technologies. In contrast, socio-demographic traits of entrepreneurs are not associated with the second-level digital divide among top performers, these characteristics being only significant drivers among the most vulnerable informal segments. While the educational level is significant for both constrained gazelles and survivalists, the gender gap in the use of digital technologies for business purposes is only significant for survivalists. Access to electricity appears to be a significant determinant only among survivalists and constrained gazelles, which probably face higher external constraints than top performers. Other structural characteristics of the firm are involved in the second-level digital divide for constrained gazelles and top performers. Sector specificities appear for both, while the firm size and profit level are significant only for constrained gazelles, and firm age is significant only for top performers. Finally, not keeping accounts decreases the probability of being a digital technology user only for survivalists and top performers.

5.2.2 | Decomposition analysis of usage gaps between informal segments

To further analyse the disparities in digital technologies usage between the three segments, we perform a multivariate decomposition for nonlinear response models (Powers et al., 2011; Yun, 2004). Table 6 reports the detailed decomposition results comparing survivalists with top performers (column 1), and constrained gazelles with top performers (column 2). The decomposition aims to explain the sources of the observed disparities in usage rates across segments that is 36% points between top performers and survivalists, and 16% points between top performers and constrained gazelles. These disparities can be attributed to endowment and coefficient components, and within these components, to specific factors.

In the first column, we find that the difference in the use of digital technologies between survivalists and top performers is mainly due to endowment effects (85%), that is, differences in the characteristics of firms and entrepreneurs.[14] Despite the significant disparities in material access between the two segments, shifting the survivalist's distribution of mobile phone and computer ownership to top performers levels would be expected to reduce the usage gap by only 11%. Thus, while addressing material access inequalities is important, it may not be sufficient to bridge the second-level digital divide between subsistence entrepreneurs and top performers. Indeed, the usage gap

TABLE 6 Decomposition of the usage gap between top performers and other segments.

	(1) Survivalists vs. Top performers (%)	(2) Constrained gazelles vs. Top performers (%)
Prevalence of DT usage		
Top performers	85.0	85.0
Survivalists/Constrained gazelles	49.3	69.4
Difference (in % points)	35.7	15.6
Difference in characteristics	85.2	86.6
Women	7.9***	0.1
No education	2.9	2.5**
Primary education	0.8	0.8***
Secondary education	4.9***	0.7
Tertiary education	4.4**	0.3
Age of firm	1.4	0.3
Monthly profits (log)	8.2	21.4***
Any paid workers	0.5	2.6
1 or 2 paid workers	0.5	0
3 or more paid workers	0.4	2.9**
Manufacturing sector	0.2	0.2***
Service sector	0.7	0
Trade/retail sector	2.1**	0
Urban	0.6	0
Registration	2.5	7.0*
Payment of taxes	7.1**	9.6***
Electricity	6.8***	6.9***
Bank account	5.4**	10.1***
No opportunity	1.8	0.9***
Separate finance	0.8	1.2
Bookkeeping	5.7***	3.0
Businesses as customers	7.3***	5.1*
Formal suppliers	3.8**	5.7***
Not local partners	9.7***	3.5
Mobile phone	8.1***	10.8***
Computer	2.6	5.3*
Number of observations	1934	1936

Notes: Coefficients of country dummies and the square of firm age are not presented.
*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.
Source: Author's computations based on After Access Surveys, RIA, 2017–2018.

is destined to persist given the disparities in terms of skills and motivation between firms in the two segments. The endowment effects associated with secondary education and bookkeeping emphasize that internal constraints associated with entrepreneurial skills explain the second-level digital divide between top performers and survivalists as much as material access disparities (11%). Similarly, survivalists appear to be constrained by their low level of

economic inclusion. Shifting the survivalist's distributions of bank account ownership, level of informality, and electricity access to top performers levels would decrease the second-level digital divide between the two segments by 19%. In addition, the firm's trading network characteristics appear to explain a large part of usage disparities (21%). Given that informal firms mostly use digital technologies for bilateral coordination with trading partners, it may indicate that subsistence entrepreneurs face weaker pull factors to use digital technologies for business purposes, as their trading network's structure may generate lower network effects. Finally, a non-negligible part of the disparities in usage between subsistence entrepreneurs and top performers is driven by more general gender inequalities (8%).

Column 2 shows that the usage gap between constrained gazelles and top performers is also largely explained by endowment effects (87%). Disparities in economic inclusion account for a significant portion of the observed difference in digital technologies usage between these two segments, with the level of informality, access to electricity, and access to a bank account remaining important factors. Indeed, bringing the distribution of these variables for constrained gazelles up to the level of the top performers' distributions would reduce the usage gap between the two segments by about 34%. Furthermore, equalizing the profit levels of constrained gazelles to those of top performers is expected to reduce the usage gap by about 21%. The first-level digital divide also contributes to the usage disparities, with mobile phone (11%) and computer ownership (5%) playing significant roles in the endowment effect. It highlights that, more than for survivalists, material access and affordability of digital technology services are key factors in the usage inequalities between the constrained gazelles and the top performers. This is further supported by the fact that entrepreneurial attributes do not appear to play a significant role in these usage disparities between the two segments, as constrained gazelles and top performers share similar socio-demographic characteristics and entrepreneurial behaviour. Finally, the characteristics of their trading networks remain significant drivers in the endowment component (11%), but to a lesser extent than for survivalists (21%).

6 | CONCLUSION

Major and ongoing investments in telecommunication infrastructures have greatly contributed to the diffusion of digital technologies in developing countries. However, despite similar network coverage, intra-country disparities persist in terms of material access and usage patterns. While these digital inequalities, or digital divides, between households or individuals have been largely studied, there is little evidence at the firm-level in sub-Saharan Africa (Lythreatis et al., 2021). Given that digital technologies have great potential to increase the performance of informal businesses by addressing market and state failures (Hjort & Tian, 2023; Nguimkeu & Okou, 2021), identifying the determinants of digital inequalities among informal firms seems to be of prior importance.

In this study, we analyse the digital inclusion of informal firms from eight sub-Saharan African countries, considering the diversity of devices and functions offered by digital technologies, and the heterogeneous nature of informal activities. Our findings suggest that informal entrepreneurs widely own mobile phones and use digital technologies for business purposes. However, they mainly rely on digital technologies for bilateral coordination with their suppliers and customers, with the appropriation of more advanced usage, such as the internet, mobile money, and management software, still in their early stages. In addition to significant disparities across countries, our findings reveal the existence of substantial digital inequalities between informal firms that align with the vertical heterogeneity of informal sectors in sub-Saharan Africa. The lower tier of survivalists is the most digitally excluded regarding ICT device ownership and professional usage. Conversely, the most successful firms, the so-called top performers, largely embrace digital technologies in their way of doing business. Despite being almost as well equipped and having similar socio-demographic characteristics and entrepreneurial behaviours as top performers, firms in the intermediate segment still exhibit a lower level of digital technologies usage than the most successful firms. Findings show that the disparities in the use of digital technologies by gender and educational attainment observed at the individual level persist in the productive sphere. At the same time, firms with a high level of informality, low profits, precarious operating conditions, no access to financial services, and less developed value chains are less likely to use digital

technologies. Addressing digital inequalities appears to have common and segment-specific levers. The results show that subsistence entrepreneurs face significant internal and external constraints in the successive phases of digital technologies appropriation. These barriers include motivation, material access, skills, and the affordability of digital services. Conversely, the usage gap between constrained gazelles and top performers is largely driven by differences in their ability to afford digital services. While differences in material access also contribute to the usage gap between these two segments, internal constraints, such as entrepreneurial skills and motivation, do not seem to play a significant role.

Hence, despite the benefits attributed to the adoption of digital technologies by businesses, their uneven spread risks exacerbating inequalities rather than creating new opportunities for inclusion for all. Indeed, this new technological dimension adds to the sources of exclusion already experienced by subsistence entrepreneurs, and is likely to dig the gap between the most successful entrepreneurs and those in the intermediate segment. Bridging the second-level digital divide in informal sectors of sub-Saharan Africa requires considering their heterogeneity, as entrepreneurs may face different combinations and magnitude of constraints in their professional appropriation of digital technologies. If material access is a prior condition for usage, policy intervention should focus on other important digital inequalities drivers. Indeed, access to mobile phones is almost ubiquitous, but the second-level digital divide remains significant in terms of professional appropriation of digital technologies, diversity of functions used, and probably intensity of usage between segments of informal entrepreneurs. Our findings show that constrained gazelles face mainly external constraints, especially the lack of affordability of digital services, in their professional appropriation of digital technologies. Individual or internal constraints, such as education, entrepreneurial skills, and motivation to adopt these new technologies, are not the most binding constraints for this segment of entrepreneurs with untapped potential. In contrast, survivalists also lack these internal capacities and are constrained by external factors. In this segment, we find that a gender digital divide persists, with female survivalists being less likely to use digital technologies, possibly because of cumulative socio-cultural norms that are unfavourable to women. In addition, digital inequalities across segments of informal entrepreneurs could be partially explained by disparities in digital skills or overall attitudes toward technology, but the limited data does not allow us to explore these important dimensions of access. Our results suggest that policy interventions should consider the heterogeneity of informal sectors, as addressing digital inequalities appears to have common and segment-specific levers.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in DataFirst at https://www.datafirst.uct.ac.za/dataportal/index.php/catalog/, reference number zaf-ria-rias-2017-2018-v1.1.

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ENDNOTES

[1] Senegal, Ghana, Nigeria, Rwanda, Kenya, Tanzania, Mozambique, and South Africa.

[2] The survey also covers Uganda, but this country is excluded from the analysis because of important missing values.

[3] See RIA (2018) for a description of the sampling procedure.

[4] See RIA (2018) for a description of the sampling procedure.

[5] If there are several owners, we consider the one with the highest level of education. Similarly, for the owner's age, we consider the youngest owner.

[6] The database does not allow for differences in the quality of devices owned by entrepreneurs, particularly between cell phones and smartphones. The ability of entrepreneurs to access a mobile broadband internet connection, a key determinant in internet access, is unknown. This figure, therefore, only guarantees access to basic telecommunication services for entrepreneurs.

[7] We do not include the entrepreneur's age due to missing data for all the sample of Rwanda. For the other countries, more than 90% of observations are assigned to the same group whether we consider or not the age of the owner in the model.

[8] We do not include the age of the entrepreneur due to missing data for all the sample of Rwanda.

[9] We construct an index of the level of informality of businesses by considering the following five criteria: (1) being registered with a local authority or municipality, (2) being registered at general registrar, (3) paying local or municipal taxes (tax stamps), (4) being registered for national VAT or sales tax, and (5) keeping accounts according to national or regional standards. Totally informal firms meet zero criteria, high informal firms meet one or two criteria, low informal firms meet three or four criteria, and formal firms meet all criteria.

[10] The 53 firms identified as being totally formal according to the informality index are then excluded from the analysis.

[11] To overcome the influence of extreme values on the average of quantitative variables, Table 3 reports the trimming means.

[12] Table A4 presents the underlying estimated coefficients.

[13] We do not include the age of the entrepreneur in the model due to missing data for all observations in Rwanda. However, when estimating this model for the whole sample without Rwanda, a negative association is found between the age of the entrepreneur and the use of digital technologies.

[14] As the coefficient effects explain only about 15% of the usage gap, we restrain the interpretation of the decomposition results to the endowment effects. Results of the coefficient effects decomposition are available upon request.

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APPENDIX A

TABLE A1 Structural characteristics and digital technology diffusion across countries in 2016–2017.

	South Africa	Nigeria	Ghana	Kenya	Senegal	Tanzania	Rwanda	Mozambique
Structural characteristics								
Region	South	West	West	East	West	East	East	South
GNI per capita, PPP (constant 2017 Intl.$)[a]	13564	4963	4687	4231	3168	2402	1874	1250
Income level category[a]	Upper middle	Lower middle	Lower middle	Lower middle	Low	Low	Low	Low
Informal employment (% of non-agri. employment)[a]	35	-	83	70	90	72	68	87
Urban population (%)[a]	65.9	49.5	55.4	26.6	46.7	33.1	17.1	35.5
Access to electricity (%)[a]	84.4	54.4	79.0	56.0	61.7	32.3	34.1	24.3
Adult literacy rate (%)[a]	87	62	79	81.5	51.9	77.9	73.2	60.7
Digital technology diffusion								
Population covered by at least a 3G mobile network (%)[b]	98.6	54	80	85	66.3	85	93.4	80
Mobile-cellular sub-basket (as % of GNI p.c)[b]	1.5	1.8	2.4	2.3	17.3	6.4	8.4	6.0
Mobile-broadband, prepaid handset-based, 500 MB (as % of GNI p.c)[b]	1.3	1.7	4.5	4.4	8.3	3.0	4.4	5.2
Mobile-cellular subscriptions per 100 inhabitants[b]	156	75	122	87	104	71	72	42
Active mobile-broadband subscriptions per 100 inhabitants[b]	70	20	78	35	28	9	35	27
Internet users (%)[b]	56	33	38	18	30	16	17	8
Have mobile money account (%)[d]	19	5.6	39	72.9	31.8	38.5	31.1	21.9
ICT index								
Network Readiness Index (Rank out of 143)[c]	65 (1)	119 (6)	102 (4)	86 (3)	107 (5)	126 (8)	80 (2)	123 (7)
ICT Development Index (Rank out of 176)[b]	92 (1)	143 (5)	116 (2)	138 (3)	142 (4)	165 (8)	153 (7)	150 (6)

Notes: The mobile-cellular sub-basket comprises approximately 50 minutes call time and 100 SMS messages per month. For the ICT indices, the ranking of the countries out of the eight observed is put in brackets.

[a]World Development Indicators, World Bank (2017).

[b]International Telecommunication Union, ICT Indicators Database, ITU (2017a), and ITU (2017b).

[c]World Economic Forum, Baller et al. (2016).

[d]Global Findex, Demirguc-Kunt et al. (2018).

TABLE A2 Decomposition of the usage gap between top performers and other segments.

	(1) Coefficients	(2) Marginal effects
Female	0.371***	0.095***
	(0.055)	(0.014)
No education (Ref.)		
Primary education	0.486***	0.110***
	(0.076)	(0.018)
Secondary education	0.738***	0.186***
	(0.092)	(0.025)
Tertiary education	0.739***	0.187***
	(0.103)	(0.029)
No other opportunity	0.217***	0.056***
	(0.060)	(0.015)
Age of firm	0.028***	0.007***
	(0.008)	(0.002)
Age of firm (squared)	0.0004**	0.0001**
	(0.0002)	(0.0001)
Initial capital (Formal loan = 1)	0.482***	0.124***
	(0.125)	(0.031)
Manufacturing (Ref.)		
Service	0.051	0.014
	(0.095)	(0.026)
Trading	0.101	0.026
	(0.079)	(0.021)
Urban location	0.196**	0.050**
	(0.077)	(0.020)
Country effects	Yes	Yes
Pseudo-R2	0.082	
Observations	3300	3300

*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.
Source: Author's computations based on After Access Surveys, RIA, 2017-2018.

TABLE A3 Distribution across segments by country.

	South Africa	Nigeria	Ghana	Kenya	Senegal	Tanzania	Rwanda	Mozambique
Survivalists	0.38	0.39	0.46	0.27	0.41	0.44	0.45	0.36
Constrained gazelles	0.42	0.41	0.34	0.53	0.39	0.36	0.35	0.44
Top performers	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Source: Author's computations based on After Access Surveys, RIA, 2017–2018.

TABLE A4 Determinants of digital technologies usage for business purposes.

	(1) All	(2) Survivalists	(3) Constrained gazelles	(4) Top performers
Gender of owner (ref. Man)				
Woman	0.497***	0.615***	0.233	0.0217
	(0.122)	(0.178)	(0.195)	(0.340)
Both	0.0391	0.419	0.275	0.269
	(0.228)	(0.447)	(0.314)	(0.671)
Education of owner (ref. None)				
Primary	0.259*	0.345	0.802***	0.153
	(0.140)	(0.218)	(0.260)	(0.314)
Secondary	0.451**	0.835**	0.652*	0.217
	(0.182)	(0.353)	(0.340)	(0.564)
Tertiary: Diploma/Certificate	0.0891	0.483	0.216	0.254
	(0.207)	(0.533)	(0.335)	(0.617)
No other opportunity	0.292***	0.163	0.480***	0.197
	(0.112)	(0.183)	(0.175)	(0.270)
Age of the firm	0.0111	0.0141	0.0194	0.0734*
	(0.0104)	(0.0173)	(0.0243)	(0.0386)
Age of the firm (squared)	0.000189	0.000173	0.000196	0.00145**
	(0.000136)	(0.000253)	(0.000589)	(0.000659)
Log monthly profits	0.144***	0.0871	0.146**	0.0156
	(0.039)	(0.061)	(0.060)	(0.181)
Number of full time paid workers (Ref. None)				
1 or 2 full time workers	0.172	0.246	0.247	0.260
	(0.148)	(0.191)	(0.226)	(0.348)
3 or more full time workers	0.455*	0.0227	0.725*	0.903
	(0.261)	(0.386)	(0.422)	(0.794)
Level of informality (Ref. Low level)				
High level of informality	0.331	0.839**	0.534	1.207***
	(0.214)	(0.328)	(0.391)	(0.415)
Totally informal	0.401**	0.085	1.193***	0.589
	(0.199)	(0.317)	(0.369)	(0.410)
Access to electricity	0.409***	0.463**	0.454**	0.394
	(0.124)	(0.183)	(0.178)	(0.377)
Separate finance	0.185	0.0481	0.144	0.162
	(0.124)	(0.193)	(0.174)	(0.321)
Bank account	0.710***	0.440**	0.722***	0.747**
	(0.166)	(0.222)	(0.224)	(0.334)
No bookkeeping	0.518***	0.489**	0.297	0.658**
	(0.152)	(0.217)	(0.186)	(0.317)

TABLE A4 (Continued)

	(1) All	(2) Survivalists	(3) Constrained gazelles	(4) Top performers
Sector of activity (Ref. Manufacture)				
Service	0.304	0.0245	0.533*	1.006
	(0.194)	(0.323)	(0.291)	(0.697)
Selling/Trading	0.751***	0.375	0.963***	1.889***
	(0.161)	(0.249)	(0.283)	(0.588)
Urban location	0.122	0.046	0.012	0.157
	(0.133)	(0.174)	(0.212)	(0.303)
B2B relations	0.734***	0.890***	0.474*	0.744*
	(0.172)	(0.247)	(0.276)	(0.418)
Formal partners	0.471***	0.364**	0.488***	0.527*
	(0.119)	(0.156)	(0.183)	(0.292)
Not local trading partners	0.836***	1.763***	0.495	1.051**
	(0.251)	(0.455)	(0.370)	(0.502)
Number of ICT devices owned (Ref. Zero)				
1	1.159***	0.902***	1.515***	0.662
	(0.142)	(0.173)	(0.220)	(0.463)
2	2.129***	1.896***	2.291***	1.770**
	(0.348)	(0.730)	(0.500)	(0.741)
3	3.299***	-	3.070***	-
	(1.117)		(0.901)	
Constant	0.776**	0.0581	0.169	2.596*
	(0.389)	(0.567)	(0.642)	(1.431)
Region effects	Yes	No	No	No
Country effects	No	Yes	Yes	Yes
Pseudo R2	0.376	0.303	0.347	0.324
Observations	3191	1287	1297	601

Notes: Robust standard errors in parentheses.
*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.
Source: Author's computations based on After Access Surveys, RIA, 2017–2018.