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Advancing digital frontiers in African economies: lessons learned from firm-level innovations

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Abstract

Multiple initiatives across sub-Saharan Africa are currently leveraging digital technologies to provide transformative solutions to micro, small and medium enterprises (MSMEs) as well as consumers across the region. This paper presents a deeper dive on several promising key players currently pushing frontiers in the digitalisation landscape in sub-Saharan Africa, with a particular focus on West Africa where possible. All highlighted firms use cutting-edge technologies and digital innovations to improve MSME development and job creation by addressing key obstacles to development prevalent in many regions of sub-Saharan Africa, including market failures, missing infrastructures, and insufficient levels of public intervention. Some of the firms described are MSMEs themselves or are in the start-up phase, while others are larger, more established firms that serve MSMEs among their clientele bases. Although the description of sectors, technologies, and enterprises presented in this paper is by no means exhaustive, it nevertheless provides an in-depth picture of several African firms leveraging a diverse set of technologies, serving diverse communities, and offering a wide array of products and services destined for MSMEs and consumers alike.

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1 Introduction

Africa's population is expected to double by the year 2050, reaching 2.5 billion people and one quarter of the total world population (Economist, 2020). Much of this population growth is expected to occur in the sub-Saharan African (SSA) region. To meet the economic needs of this growing population, 20 million new jobs must be created each year in SSA (IMF, 2020). Across the region, micro, small, and medium enterprises (MSMEs) are the most important engines of wealth generation and job creation in many communities, employing approximately 80% of SSA's workforce (World Economic Forum, 2015). However, many MSMEs have lagged behind larger enterprises to date in their adoption of email, Internet, and mobile technologies with the potential to transform business development. The reasons for this are numerous, ranging from low overall rates of Internet penetration in certain SSA countries to a large Internet divide along socioeconomic and rural/urban lines within other countries (Aker & Cariolle, 2020). World Bank Enterprise Surveys conducted between 2013 and 2018 reveal that across the region, close to 60% of SMEs were using email for their business activities, but less than 30% had established a website for their business (Cariolle & Carroll, 2020).

Despite the challenges mentioned above, many innovative firms across SSA, ranging from start-up microenterprises to large transnational businesses, are currently taking advantage of digital technologies to provide transformative solutions to MSMEs and individual consumers across the region. Digital technologies have also increased the opportunities available for firms to pool their resources and participate in cooperative competition; for example, numerous local and international mobile network operators (MNOs) have engaged in infrastructure sharing to reduce the digital divide and expand the reach of mobile networks, and MNOs have also partnered with firms in other sectors to offer integrated, technology-based services (Arakpogun et al., 2020). This paper presents a deeper dive on several promising key players currently pushing frontiers in the digitalisation landscape in sub-Saharan Africa, with a particular focus on West Africa where possible. All highlighted firms use cutting-edge technologies and digital innovations to improve MSME development and job creation in their respective markets. This paper is a synthesis of case studies conducted on nine separate firms operating in various business and service provision sectors. Some of the firms described are MSMEs themselves and are still in the start-up phase, while others like Jumia have become larger, more established firms that serve MSMEs among their clientele bases. Although the description of sectors, technologies, and enterprises presented in this paper is by no means exhaustive, it nevertheless provides an in-depth picture of several African firms leveraging a diverse set of technologies, serving diverse communities, and offering a wide array of products and services destined for MSMEs as well as individual consumers.

Following this introductory section, sections two through seven describe key obstacles to development and digital solutions for overcoming these obstacles in the following respective markets or sectors in sub-Saharan Africa: goods and services, labour, agriculture and crop insurance, transport infrastructure and logistics, electricity infrastructure, and tax collection/public service provision. Each section begins with a subsection describing key obstacles to development commonly affecting the specific market or sector, followed by one or two subsections describing firms employing innovative digital technologies to overcome these obstacles. When possible, a particular emphasis is placed on digital innovations developed in West Africa, a region of Africa that has received less attention from research studies and analyses on digitalisation than have Eastern and Southern Africa. The eighth and final section concludes by discussing future directions both for the highlighted firms in particular and for the digitalisation landscape in sub-Saharan Africa in general.

2 Goods and services markets

2.1 Obstacles to development

Numerous obstacles conspire to create significant levels of inefficiency in SSA's goods and services markets. One of the foremost problems is poorly developed communications infrastructure, evidenced by the stark rural-urban divide in Internet and mobile phone penetration within countries as well variations in Internet and mobile penetration across countries throughout the region (Aker, 2017). Poor communications infrastructure increases the likelihood of market failures such as informational

asymmetries, which are related to abnormally high search, transportation, verification, and other transaction costs (Aker, 2010; Aker & Fafchamps, 2014). These costs are inflated in part due to lacking telecommunications infrastructures which prevent buyers and sellers located in neighbouring markets from communicating effectively with one another and sharing information on prices of goods, commodities, and services (Aker & Blumenstock, 2014). Increased mobile phone contact between neighbouring markets would potentially increase the options available to buyers and sellers, resulting in reduced price dispersion across markets. Research has shown that while mobile phone adoption has the potential to reduce price dispersion, many smallholder farmers use phones chiefly for interpersonal communication and not for marketing their produce or obtaining and sharing information about prices; concerted awareness campaigns spearheaded by stakeholders in the telecommunications industry are necessary to incite increased adoption and use of mobile phones for overcoming obstacles to development (Kabbiri et al., 2018).

In addition to lacking telecommunications infrastructures, high transaction costs are also exacerbated by poorly developed transport infrastructure. Throughout the region, missing road and transportation networks and the poor condition of existing roads often render travel between rural and provincial markets prohibitively time-consuming and expensive (Aker, 2010). These conditions can lead to high levels of price dispersion from market to market, since vendors are forced to sell at their local market or make a risky, often costly trip to another market without knowing the prices in that market beforehand (Aker, 2017). High price dispersion results in market inefficiencies for both producers and consumers, lowering supply and demand below optimal levels.

Additional institutional failures also negatively impact goods and services markets in many regions of SSA (Fafchamps, 2004). For example, poorly developed market structure can stunt the development of formal consumer markets and create significant barriers to entry for would-be retailers. Such factors can include: weak infrastructure that drives up transaction and transport costs; organised crime and extortion that often makes transporting goods risky and costly; cumbersome customs requirements and other regulatory measures that can change without notice; and a general lack of strong regulatory frameworks to promote growth in retail markets and protect retailers (Signé, 2018). As a result, formal retail services are undersupplied in many communities, and many consumers in SSA shop primarily in informal markets, mostly purchasing consumables for their household consumption (Uzo et al., 2018). Finally, missing banking infrastructure and lack of accessible financial products among lower income households, together with poor logistics infrastructures, are ultimate obstacles to suppliers and customers' access to goods and services markets (Munyegera & Matsumoto, 2016). Adoption of internet and communications technology in SSA has been shown to increase several measures of financial development, including bank assets and access to credit (Owusu-Agyei et al., 2020).

2.2 Digital marketplaces as an integrated solution to missing infrastructures and markets imperfections: the case of *Jumia*

A notable firm which has successfully leveraged digital technologies and developed an innovative business model to address the various obstacles described above is *Jumia*, arguably the most well-known eCommerce firm in SSA. *Jumia*'s expansion to 18 countries in SSA since its founding in 2012 in Nigeria has been facilitated and driven in part by the emergence of an African middle class with higher purchasing power and a larger disposable income. The region's growing middle class has created an increasing demand for a diverse array of retail products and services that have typically been in relatively low supply in traditional markets, and this has opened the door to firms such as *Jumia* to fill gaps in the market (Ncube et al., 2011; Deloitte & Touche, 2014). *Jumia* proposes a series of integrated digital tools that address: missing transport infrastructures through a digital marketplace and digital logistics platform; poorly developed banking sectors, evidenced by both missing banking infrastructure and significant populations excluded from formal financial markets, through a digital payments platform integrated with major mobile money (MM) services in the countries where *Jumia* operates; and low levels of digital literacy and numeracy through the *Jumia* Academy, with programs designed to boost digital capacity across SSA. Through its package of digital services and platforms, *Jumia* makes it possible for households with internet access but which are located far from physical marketplaces to tap into a wide range of product and services markets. The growth of eCommerce markets such as *Jumia*

also provides incentives for informal businesses to formalize, as they stand to obtain better access to customers, additional resources for capacity building and training, and access to needed financial capital through participation in these markets.

As mentioned above, *Jumia*'s business model has enabled the firm to effectively leapfrog missing logistics infrastructures by managing deliveries through its own logistics arm, *Jumia* Logistics. The firm also leapfrogs missing financial infrastructures through partnering with major mobile money providers throughout SSA to offer MM payments on its platform. For example, *Jumia* signed a deal with Equity Bank of Kenya in 2016 enabling customers to use the bank's EazzyPay platform on the *Jumia* market (James, 2016). The firm also developed a mobile application, *Jumia* One, that enables purchase of airtime for prepaid mobile phone services. The company's principal fintech service, *Jumia* Pay, facilitates online payment for all *Jumia* transactions for products and services, including electronics, fashion, travel, and other markets. *Jumia* also has a lending program that enables third-party vendors, including MSMEs using the firm's eCommerce platform to increase their customer base, to access the capital they need to grow their enterprises.

In 2016, *Jumia* was the first African tech start-up to receive unicorn status, with a valuation of over 1 billion USD. The company reported 700 million visits to its online marketplace for the 2018 year, with one transaction or lead every two seconds, 81,000 active sellers on its platform, over 29 million products, hotels, restaurants, and other service listings, representing 2.1 million mobile money transactions during the third quarter of 2019 alone (Jumia, 2020). Additionally, in April of 2019, the company became the first African tech start-up to be listed on the New York Stock Exchange (NYSE). The firm's initial successes and continued growth are a testament to the growing demand for retail goods and services propelled by an expanding middle class; with its transnational structure and administrative and technical staff located on multiple continents, *Jumia*'s success also demonstrates how globalisation can spur increased productivity through technology transfer from developed to developing nations (Das & Drine, 2020).

3 Transport infrastructure and logistics industry

3.1 Obstacles to development

Overcoming obstacles in goods and services markets as described in the previous section requires a well-functioning logistics industry to efficiently move products and services between sellers, buyers, and other market actors. However, obstacles such as poorly developed transport infrastructure and underdeveloped market structure impede the development of efficiently functioning logistics systems in SSA (Russon, 2019). Roads and land transportation infrastructure, which are common-pool goods, are underprovided in most SSA countries, leading to inefficiencies in transport of goods and people (Arvis et al., 2010; Beuran et al., 2015; Plane, 2019). Unpaved roads slow down travel significantly during the dry season and often become impassable during the rainy season, cutting off communities for extended periods of time (Hervey, 2020; Njoh, 2012). In other regions, transportation infrastructure is missing, and many communities are not connected to road networks. Where road infrastructure does exist, it is often poorly equipped for handling increasing daily traffic volumes as car ownership rises in SSA, leading to higher rates of traffic jams, accidents, and persistent slowdowns (Akorede, 2019).

Additionally, logistics markets are underdeveloped in many regions of SSA, with few formal busing or trucking companies available to ensure rapid and efficient movement of goods and people. In the absence of formal services, informal logistics services providers prevail, often consisting of private truck or vehicle owners. Informational asymmetries such as adverse selection and moral hazard abound in the informal logistics market, as clients have limited options for obtaining information on trustworthiness and reliability of a given provider's services. Due to lack of economies of scale as well as informational asymmetries between truck and cargo owners, truck owners often lose significant time finding cargo to fill up their vehicles before making a trip, or they make trips with only partially filled trucks, losing out on potential income in the process. On the other hand, cargo senders and recipients often have to wait long periods of time to send and receive goods, losing out on valuable time that could be used to increase their retail, manufacturing, or service activities. Additionally, there is a higher risk

of cargo being damaged or lost in route, and most informal logistics providers do not offer insurance on cargo (Giuliana & With, 2019).

In addition to missing infrastructures and underdeveloped markets, many SSA countries also lack sufficiently robust institutional frameworks and mechanisms to ensure transparent and efficient movement of goods. This includes optimisation of customs and cross-border trade regulations, institutions to regulate drivers and road safety, and verification mechanisms to reduce transport price volatility (Giuliana & With, 2019). Undersupplied public goods infrastructure, lengthy transport times, dangerous road conditions, and lack of supporting institutional frameworks have resulted in subpar logistics markets in SSA, in particular through under-exploited truck and cargo space, thereby increasing inefficiencies in goods and services markets (Giuliana & With, 2019). While some companies such as *Jumia* have developed their own fully integrated internal logistics systems to overcome lack of supply in local and national SSA markets (Henry, 2020), other firms have invested specifically in logistics, leveraging mobile and Internet technologies to leapfrog missing infrastructures and provide vital logistics services to other firms and individuals in various market sectors. We present two separate examples of such firms in the subsections below.

3.2 Leapfrogging missing soft transport infrastructure by optimizing e-logistics: *Kobo360*'s "Uber for trucks"

One start-up that has had particular success in leapfrogging missing transport infrastructures is the Nigerian firm *Kobo360*, which became the most funded logistics start-up in SSA in 2019 (Bright, 2019b; Nsehe, 2019; Giuliana & With, 2019). *Kobo360* was founded in 2017 in Nigeria and has since expanded into Togo, Ghana, Kenya, and Uganda (Nsehe, 2019). *Kobo360* has marketed itself as an "Uber for trucks", developing and launching a mobile application where truck drivers and owners and cargo recipients and senders can interact, leading to formalisation and optimisation of the supply chain and reducing inefficiencies (Giuliana & With, 2019; Russon, 2019). The *Kobo360* digital platform addresses informational asymmetries between truck owners/drivers and cargo senders/recipients through its system of rating both providers and clients. The app also increases market efficiency by enabling truck owners to efficiently find clients to rapidly fill up their trucks, resulting in more frequent trips. Clients are also guaranteed a faster, more reliable and high-quality service than in the informal market, and they can track the status of their shipment while the driver is in route. The firm also offers insurance to both clients and truck drivers (Kobo360, 2019). The firm's mobile application is available in English, Hausa, and Pidgin to facilitate use by truck drivers speaking various languages commonly spoken in Nigeria (Bright, 2018). The company also has a call centre manned by staff able to monitor deliveries in real time and communicate with drivers, manufacturers, and distributors through GPS satellite positioning (Russon, 2019).

Kobo360's forthcoming Global Logistics Operating System (GLOS) is a blockchain-enabled platform that will enable the firm to continue expanding the supply chain services it offers to customers (Bright, 2019b). When a user creates a request via the mobile app, the digital platform gathers information on origin and destination locations and selects a truck type and other necessary parameters for the shipment. Then, the request is matched with an available driver. The app aggregates reliable transport providers, provides customers with real-time updates about their shipments, creates a mechanism for faster and more reliable feedback, and improves efficiency and cost-effectiveness of supply chain activities for all involved actors, including truck drivers, truck owners, cargo owners, and cargo recipients (Kobo360, 2019).

In the two years between its launching in 2017 and 2020, *Kobo360* moved over 760 million kilograms of goods worth an estimated 200 billion USD, aggregated a fleet of over 17,000 vehicles and drivers, and served thousands of MSMEs and more than 80 global logistics companies with over 700 total formal clienteles, including Dangote Group, DHL, Unilever, OLAM, African Industries, Flour Mills of Nigeria, and Lafarge (Gerretsen, 2020; Iyanda, 2019; Nsehe, 2019).

3.3 Drone technology for improving medical logistics – *Zipline*

One vital supply chain in particular that has traditionally been affected by poor logistics infrastructure in many regions of SSA is healthcare logistics, comprising distribution of blood and medications vital

for treating patients with chronic and emergency medical conditions (Bulage et al., 2015). Other factors leading to low availability of medical supplies include poorly developed procurement systems for imported drugs, lack of storage facilities, and weak manufacturing capacity (Pheage, 2017). Additionally, unreliable energy supply and cold chain facilities lead to frequent spoiling of blood (Pothering, 2019). As a result, only 2% of drugs consumed in SSA are produced there, and imported drugs are often costly due to logistical inefficiencies in the supply chain (Pheage, 2017). This renders SSA residents significantly more susceptible to diseases such as malaria, tuberculosis, and HIV/AIDS, which can all be effectively treated with proper access to medications (Pheage, 2017).

Numerous development initiatives and private sector start-ups are using UAVs to leapfrog missing infrastructures and improve efficiency of healthcare supply chains. Notable in this field is the start-up *Zipline*, a firm that has harnessing UAV technology to deliver blood, medications, and other supplies to medical centres throughout Rwanda and Ghana, with plans to expand to other countries. Drone delivery of medical products overcomes obstacles such as underdeveloped market structure as well as the market failure of informational asymmetries between logistics providers and the healthcare industry that uses their services. *Zipline* manufactures its own UAVs, launching and landing systems, and logistics software at its headquarters in San Francisco (Bright, 2019a; Giuliana & With, 2019). Drone delivery of medical products occurs as the drone drops off a parachuted package from a height of approximately 80 meters which then lands in a designated area, often a small quadrangle in the courtyard or campus of a medical centre. In one instance, yellow fever vaccines were delivered to the New Tafo Government Hospital in the Eastern Region of Ghana in 21 minutes, a process that would have normally taken at least 2 hours if delivered by road (Asiedu, 2019). Drones can travel to any medical centres within an 80-kilometer radius of *Zipline*'s distribution centres, and they do not need to stop moving at any time between leaving the base warehouse, making a delivery, and returning to the base (Asiedu, 2019).

Since its founding, *Zipline* has been able to provide national-level distribution of medical products throughout Rwanda through its partnership with the Rwandan government. In Rwanda, *Zipline* claims to cover 65% of the country's blood supply deliveries outside of Kigali, cutting medical supply waste in the areas it services by 95%. 13,000 deliveries have been made in Rwanda to date, representing 170 different medical products (Pothering, 2019). With the launch of its first distribution centre in Ghana, *Zipline* can now deliver supplies to 500 medical centres within an 80-kilometer radius of the centre. With construction of four distribution centres in Ghana scheduled to be finished by late 2019, *Zipline* should be able to deliver 150 different medical products to 2,000 medical centres, servicing 12 million Ghanaians (Bright, 2019a). Under its contract with the Ghanaian government, *Zipline* is obligated to make 600 on-demand flights per day (Pothering, 2019).

4 Labour market

4.1 Obstacles to development

Many economies in SSA are characterized by low rates of participation in formal sector employment; indeed, over 80 percent of the SSA labour force works in the informal sector (Grunewald, 2020). As such, informal sector workers are key players in most SSA markets; for example, in Nairobi, Kenya, households and businesses, including MSMEs, purchase more than 80 million USD worth of products and services from informal sector workers every month (Grunewald, 2020), and the informal sector accounts for 45% of Kenya's total economic activity (PROPARCO, 2020). Due to market failures such as informational asymmetries and other obstacles including high transaction costs, missing telecommunications infrastructure, low mobile phone penetration in some countries and regions, and the digital divide existing between affluent and less-affluent households within a given population, informal workers may not have sufficient access to information regarding formal sector job postings. As a result, informal sector workers often find work through informal connections or pure luck, leading to lower wages, irregular work, and limited opportunities for professional advancement, job training, and skills acquisition.

The reasons for these inefficiencies are numerous; for example, potential customers and service providers are often located far from one another geographically, and they have few viable options for meeting, communicating, and transacting due to the limited development of formal markets and their resultant low capacity to absorb large numbers of workers. Additionally, low penetration of computers and home wireless Internet connections and low literacy, numeracy, and digital skills preclude many individuals from accessing web-based job postings and submitting electronic job applications (Grunewald, 2020). This results in decreased supply of and demand for skilled workers and their services, reduced market efficiency, and increased wage dispersion due to high transaction costs (Dupoux et al., 2019). However, despite the commonly held belief that informal workers are completely disconnected from digital job platforms, qualitative research conducted in Senegal has shown that many informal sector workers, including those with few years of formal schooling, report using the internet to search for jobs. Individuals in this study often reported using mobile devices due to lack of computer access (Shemin & Wallach, 2020). This shows the potential for digital job platforms to overcome the various obstacles to development described above by bringing workers and employers together and filling in gaps in supply and demand, especially using mobile technology.

4.2 Digital job platforms to reduce labour market frictions: *Lynk*'s solution

As a result of increased Internet penetration in many SSA countries due to the recent progressive deployment of high-capacity submarine telecommunications cables along the coasts of the African continent, mobile and Internet-based solutions to challenges stemming from longstanding telecommunications difficulties are becoming more feasible (Cariolle, 2020). Although many of the firms leveraging these technologies in SSA are still in their nascent stages, other regions of SSA have more developed examples, such as the firm *Lynk* in Kenya. *Lynk* uses a two-pronged mobile and web-based platform to link skilled providers of technical and professional services in the informal sector to a base of potential clients throughout the greater Nairobi region, including both individuals and MSMEs (Grunewald, 2020). Enabling service providers and clients who have traditionally been left out of the formal sector to transact with one another on a mobile platform effectively addresses the issues of imperfect information and poorly developed market structure described in the previous subsection. As a result, informal sector workers are formalized and information search and transport costs are reduced, leading to greater overall market efficiency. Problems of moral hazard and adverse selection are addressed by the client and service provider ratings and evaluation system provided by the *Lynk* app.

Lynk was initially launched in Nairobi, Kenya in 2015. The firm is financed and accompanied by the Novastar East Africa Fund (PROPARCO, 2020) and has partnered with Safaricom, a leading Kenyan mobile network operator (MNO) with a large degree of involvement in the informal sector, to facilitate payments between customers and professionals and for marketing purposes. *Lynk* has also partnered with vocational training schools throughout the country to recruit and onboard skilled informal sector workers to use its platform (Grunewald, 2020). Job seekers and suppliers access the platform by searching and selecting from among available service packages on the mobile application or the website, customising their request (specifying a timeframe and other details), and paying for the service using the Kenyan MM service M-Pesa or a credit or debit card. Next, the job is matched with a professional service provider in the *Lynk* network, which usually takes between two and six hours. After the service provider confirms the request, the customer receives an initial notification, several reminder messages before the date and time of the job, and a request to rate the quality of the job once it is completed, all through the mobile app (GSMA, 2019).

To use the platform, informal sector workers must first set up a profile which is vetted by the *Lynk* team, after which they attend an in-person interview. After being approved, the professional receives job notifications regularly on their mobile device and must respond within fifteen minutes of notification to accept a job, upon which further details are transmitted through the app. The professional receives reminder messages before and during the job, marks the job as complete once finished, and finally completes a quality checklist and a customer rating. Payment is then disbursed via M-Pesa within 24 hours of job completion (GSMA, 2019). In addition to enabling payments through M-Pesa, Safaricom and *Lynk* have also collaborated to integrate Safaricom's e-commerce service, Masoko, with *Lynk*. Customers can buy beauty services from *Lynk* professionals through Masoko, and they can also add on installation services from *Lynk* professionals when buying appliances on Masoko (GSMA, 2019).

Between 2016 and 2018, *Lynk* connected Kenyan workers to over 25,500 jobs completed via its platform, with a customer retention of 80 percent and an average of 28 jobs completed per customer (SolveMIT, 2020). As of 2019, more than 2 million USD had already been transferred to workers through *Lynk*, and 3,500 customers were using the app (Global Innovation Exchange, 2019). The company currently has over 100 employees and 1,300 workers specializing in over 72 different fields (PROPARCO, 2020). The firm's successes are currently being used as a model by several nascent firms operating in various West African countries, including Senegal and Côte d'Ivoire.

5 Agriculture and crop insurance markets

5.1 Obstacles to development

Numerous obstacles negatively affect the efficiency of agricultural markets throughout SSA, and many challenges in the agricultural sector are compounded by the effects of climate change. Indeed, climate risk indices have identified West Africa as one of the most vulnerable regions of the world to climate change impacts, and the region has a relatively weak adaptive capacity compared to other areas (IPCC, 2014). On the one hand, many SSA countries are classed at the highest level of risk from shocks related to temperature increase, rainfall and droughts, extreme storms, sea level rise, and desertification, including several Sahelian West African countries (Feindouno et al., 2020). On the other hand, approximately 60% of the region's population is dependent on small-scale agriculture for economic sustenance, with agricultural systems characterized by a general lack of modern inputs and techniques, marginal and degraded soils, and a reliance on rain-fed agriculture (Fonta et al., 2018; Kurukulasuriva & Mendelsohn, 2008). Faced with a growing population and increasing effects of climate change, West African agricultural systems are predicted to be able to meet only 13% of the region's food needs by 2050 without implementation of targeted measures to increase production, possibly through closing of yield gaps by increasing agricultural productivity (Montpellier Panel, 2013).

Although provision of crop insurance could mitigate some of these challenges by transferring agricultural production risks away from smallholder farmers, adverse selection and moral hazard undermine mechanisms for effective risk transfer under traditional credit and insurance schemes (Tadesse et al., 2015). Moving beyond crop insurance, other obstacles affect agricultural production in a more general sense. For example, weakly developed supply chains prevent sufficient access to inputs, and governance issues have hampered efforts to strengthen input value chains and improve input use among smallholder farmers (Kelly et al., 2003; Poku et al., 2018). Additionally, inputs such as fertiliser and other soil amendments are often applied inefficiently due to lack of farmer knowledge on how to optimise input use; this results in under or over-applications of inputs, reducing profitability for farmers and often creating negative production externalities such as nutrient or chemical pollution and excessive greenhouse gas emissions (Aune et al., 2017). Lack of farmer knowledge regarding good agricultural practices can be traced in part to insufficient or ineffective public interventions in the agricultural sector, including government agricultural extension services, which can disseminate up-to-date information on best practices for raising yields and improving household food security (Gebrehiwot, 2015). Commercialisation of agriculture produce is also low among many smallholder farmer communities; this is due in part due to suboptimal access to markets influenced by high transaction costs incurred at multiple points along agricultural value chains, and also due to underdeveloped market structure which prevents farmers from accessing a wider customer base to sell their produce (Awotide et al., 2016; Shiferaw et al., 2006).

5.2 Insurtech to protect against agricultural risks: *WorldCover*'s multi-technology insurance platform

Provision of weather index-based insurance against crop losses to smallholder farmers and agribusinesses through Insurtech is a potential solution to the numerous obstacles described above which affect traditional agricultural and crop insurance markets in SSA. Under weather-indexed based insurance systems, payments are initiated automatically when measurable rainfall at a representative weather station falls below a predefined threshold level during a given growing season. This simplified

structure for triggering insurance payments reduces moral hazard and monitoring costs for insurers, eliminates incentives to misreport crop production among farmers, and increases efficiency and timeliness of payments by eliminating the need to directly observe crop losses at the farm level (Tadesse et al., 2015). A leader in leveraging Insurtech for crop insurance in SSA is the firm *WorldCover*, founded in 2015 and based in Accra and New York City. The firm, which has since expanded to Kenya and Uganda, uses satellite data, on-ground sensors, mobile phone technology, and data analytics, including innovation risk modelling, as the backbone for creating and delivering its weather index-based insurance products to individual farmers and agribusinesses (Bright, 2019c; Oliver Wyman, 2019).

WorldCover currently uses a person-to-person (P2P) lending platform to connect social investors with farmers and agribusiness owners through a digital marketplace, enabling investors to add diversified returns and social impact to their investment portfolios. Farmers can access *WorldCover* insurance through simple mobile phone technology, and the insurance products or "smart contracts" are based on blockchain, a distributed ledger technology used to underpin cryptocurrencies such as bitcoin. Blockchain products are trustless (all contracts receive pay-outs as promised), time-stamped (policyholders can obtain proof that they hold a contract and stakeholders have the ability to view transaction information), and protective of digital identities (policyholders own their digital data and can thus choose to leave a network and control their financial transactions histories as they please). Indeed, blockchain technology is regarded as highly secure in its potential for guarding personally identifiable information, with many blockchain technologies using asymmetric cryptography for authentication, integrity verification, and permission enforcement.

Using blockchain simplifies the insurance underwriting process by automating policies once they are already in place and reducing operations costs. A parametric or index-based insurance scheme such as rainfall-based crop insurance is therefore a prime candidate for use of blockchain, because it requires only on-ground or remotely sensed rainfall data obtained from satellites to facilitate pay-outs, bypassing tedious manual assessments of losses and decision-making that characterize traditional crop insurance schemes. Once the rainfall amount has been assessed, payments are sent instantly to farmers through mobile money providers, including MTN Mobile Money in Ghana and M-Pesa in Kenya. Farmers also use mobile money to make their insurance premium payments and interface with *WorldCover* through its mobile app.

As of May 2019, *WorldCover* has insured over 30,000 farmers in Ghana, Uganda, and Kenya (Bright, 2019c). For the time being, *WorldCover* only provides insurance against drought or low rainfall events and only works in several select value chains, but there are plans to expand into new crops and insurance products. *WorldCover* is currently expanding to other emerging economy markets, including India, Mexico, Brazil, and Indonesia (Bright, 2019c).

5.3 Drone technology for optimising agricultural production – *Investiv Group*

Complementing *WorldCover*'s Insurtech weather index-based crop insurance described above, other firms across SSA are currently designing and implementing digital solutions to address other market imperfections affecting the region's agricultural sector at diverse points along agricultural value chains. For example, the Ivorian start-up *Investiv Group* has been using unmanned aerial vehicles (UAVs), otherwise known as drones, to optimize crop management and overcome underdeveloped market structure and informational asymmetries between producers, grower cooperatives, and clients. *Investiv Group* was co-founded in 2016 by Aboubacar Karim, an Ivorian entrepreneur who had recently completed graduate studies at Laval University in Quebec, Canada (Okafor, 2019). The firm uses drones along with cameras, sensors, and GPS devices in precision agricultural systems to allow farmers to optimize input use, conserve water, and reduce environmental impacts (Commodity Port, 2019). A UAV equipped with a camera and a GPS device can take aerial images of a crop field, identifying specific areas of the field affected by nutrient deficiencies, drought stress, crop diseases, or pest and weather damage (Commodity Port, 2019). This information can then be used to optimize applications of fertilizer, irrigation water, and inputs used for pest or disease management, targeting areas of the field in specific need of these inputs and avoiding wasteful overapplications. Application time is also greatly reduced through use of drones, with *Investiv Group* reporting that fertilizer can be applied by

drone over a two-hectare field in just fifteen minutes, a significant reduction over traditional application methods (Okafor, 2019). Drones can even be used to spread beneficial insects and replant forests through aerial seeding (Hill, 2018).

Investiv Group has also partnered with grower cooperatives and certification programs to implement aerial mapping of farmer plots, which is often required for enrolment and participation in cooperatives and fair trade, organic produce, or ecolabel certification programs (Karim, 2020). Enrolment in grower cooperatives, many of which facilitate exportation of agricultural produce, has the potential to increase a farmer's customer base, thus overcoming the market failures of moral hazard and adverse selection which prevent many farmer associations and customers from learning about the quality of a farmer's produce. Additionally, fair trade cooperatives and farmer organisations have exhibited a significantly higher level of transparency and democratic governance, which also has likely positive impacts on farmers and their profits (Balineau, 2011). Contract farming enforced by third parties, including fair trade certification programs, has also been shown to increase the quality of agricultural produce, potentially raising commodity values and expanding farmer access to value-added markets (Balineau, 2013). As of 2019, *Investiv Group* reported that it had already mapped and diagnosed approximately 8,000 hectares of farms and plantations and up over 30 off-ground farms with capacity for aerial mapping, diagnosis, and input applications (Okafor, 2019). The firm is currently partnering with KINEDEN, an organization that works in the cocoa bean exporting industry in Côte d'Ivoire, on certifying 9,467 farmers in 9 different cooperatives to facilitate their access to the cocoa bean export market. This involves collection of GPS data and aerial flyover mapping of a total of 28,744 hectares of cocoa farms (Karim, 2020). *Investiv Group* was recognized as one of the most promising start-ups in Côte d'Ivoire by the Ivorian Business Federation in 2017 (Flying Labs, 2020).

6 Electricity infrastructure

6.1 Obstacles to development

Poorly developed and inefficient electrical grids impact the quality of life of the over 940 million people that live without electricity across the planet, representing 13% of the world population in 2017. Of this total, 591 million were located in SSA, suggesting that inefficiencies in delivery of electricity to households and MSMEs is affecting both quality of life and market efficiency across the region (Berthelemy, 2019; Ritchie & Roser, 2019). This overall figure fails to capture the difficult realities of energy access in remote, rural communities in many regions of SSA, where often over 90% of a community does not have electricity (USAID, 2016). Rural households in such communities often rely on traditional lighting mechanisms such as candles, kerosene lamps, and diesel generators, which can be costly and hazardous (Orpaz, 2013), time-consuming to set up, and can create negative externalities such as noise and indoor air pollution (Berthelemy & Nossek, 2018; USAID, 2016).

Electricity services provided by electrical grids across SSA are underprovided in part due to lack of financial resources for expanding grids, and also due to informational asymmetries between utilities and consumers (Berthelemy, 2019). Lack of electricity access can cut workdays short for businesses and households alike, leading to lost revenues, lower educational achievement, and inflated household energy costs for tasks such as accessing light and charging phones (Tobias & Castro, 2020). Additionally, research has shown that unreliable electricity supply decreases firm sales, profits, and total factor productivity in SSA, with stronger effects for firms that do not own a generator (Berthelemy & Nossek, 2018; Berthelemy, 2019; Cole et al., 2018). Finally, lack of electricity access reduces access to Internet and mobile technologies, even where penetration of these technologies is sufficiently high.

6.2 Smart solar home systems – *Lumos Global*

Renewable energy sources such as solar energy can be provided at the individual household or business scale, and they require few to no variable costs after initial fixed costs related to purchasing materials. Solar technology can also be integrated with digital technology for remote monitoring and control of electricity use, and incremental payments for provision of electricity services can be made regularly via mobile money or airtime purchases until the client fully pays off their system. As such, individual solar

energy systems have the potential to leapfrog missing electricity infrastructures and bypass the financing issues that often prevent municipal, state, and national governments from expanding electrical grids. Solar energy provision can also be monitored through use of digital and Internet technology to enable precision use of electricity, optimising consumption, reducing waste, and lowering high electric bills that often create significant economic hardship for low-income clients (Berthelemy & Nossek, 2018).

Lumos Global is one such firm that provides off-grid electricity services to households and MSMEs in multiple SSA countries through provision of solar home systems (SHSs) to a variety of business and individual clients. The firm's off-grid solution to electricity access effectively leapfrogs missing or incomplete electricity infrastructure, increasing rates of electricity access in the communities where the firm operates. *Lumos Global*'s model combines solar energy technology with mobile payments and financing provided through existing cellular network providers, taking advantage of the relatively high rates of mobile penetration in many rural, off-grid communities where electricity demand is high. The SHS is small enough to fit in a box, making it easy to transport on foot or by bicycle, and includes a solar panel activated by text message with sufficient capacity to charge small appliances such as mobile phones, laptop computers, electric fans, radios, and lights for a household or a business (Orpaz, 2013; USAID, 2016). Customers are required to make a 40 USD initial down payment, a 12 USD installation fee, and incremental payments of 0.50 USD per day or 3 USD per week over a period of five years until they have completely paid off the package and the SHS is unlocked (Clowes, 2019; Orpaz, 2013). In this sense, *Lumos Global* uses a pay-as-you-go (PAYG), lease-to-own financial model (Roach & Cohen, 2016). The capacity of the SHS is sufficient to power homes, small businesses, hospitals, schools, mosques, and churches (Roach & Cohen, 2016). Lumos has opted to use airtime credit payments instead of traditional mobile money payments to increase its penetration into markets and communities where MM access is limited. This is a simple, easy-to-use payment mechanism for customers, but it requires a much more complex technology integration on the back end than does mobile money (Roach & Cohen, 2016). Customers top up their phones with sufficient funds to pay for the service bundle of their choosing.

As of 2019, Lumos had already fitted over 100,000 solar home systems in Nigeria (Clowes, 2019), provided electricity to over 250,000 people, and created over 1,100 jobs in the country (Lumos Global, 2017). A CDC Group report published in 202 found positive results of Lumos SHS on client quality of life, with 63% of respondents stating services were a "very good" or "good" value for their money (Lumos Global, 2020b; Tobias & Castro, 2020). Additional findings from the study illustrate the potential of solar energy for increasing productivity and raising incomes. Nineteen percent of Lumos customers reported using electricity provided by their SHS for income-generating activities, with 80 percent of this group reporting increased incomes through improved electricity access (Tobias & Castro, 2020). Sixteen percent of Lumos customers reported using the SHS at their workplace; 60% of this group were shop owners and 25% owned a barbershop or a salon. The majority were small business owners with an average of only two employees. Eight percent of business customers reported launching a new business after subscribing to the Lumos SHS service. Six months after purchase, 96 % of Lumos' business customers reported that the business where they were using the SHS was their main source of income, an increase of 9 percentage points over the baseline (Tobias & Castro, 2020). Follow-up surveys with business customers also revealed that 77% of clients reported their business had progressed through using the Lumos SHS, with 14% reporting that their opening hours had increased as a result (Tobias & Castro, 2020). These results show the potential of off-grid solar energy systems to leapfrog missing electricity infrastructure and raise productivity and revenues for MSMEs and entrepreneurs.

7 Tax collection and public service provision

7.1 Obstacles to development

It is estimated that corporate tax avoidance provokes losses of up to 2 percent of GDP on average throughout countries in SSA (Thibault, 2020). Informational asymmetries are at the heart of the tax evasion problem, with hiring of tax inspectors complicated by issues of adverse selection and attempts

to identify concrete evidence of tax evasion plagued by moral hazard problems (Allingham & Sandmo, 1972; Chen & Cyrus Chu, 2005). Because of these market failures as well as inadequate public intervention in the tax collection sphere, traditional methods of tax enforcement and tax payment often involve high transaction costs (Crocker & Slemrod, 2005). As a result, many municipal governments in SSA are faced with a shortage of funds for investing in delivery of public services such as educational and healthcare systems, roads and other transport infrastructures, streetlights, waste collection, and provision of water and other utilities.

Outstanding unpaid bills and large numbers of disconnected subscribers affect the ability of many public service providers to supply reliable services to communities throughout SSA (Cowell & Gordon, 1988). Additionally, sending personnel to issue and write off bills, collect payments, and disconnect subscribers adds to transaction costs (Gridley, 2020). For instance, in water markets, wasteful usage, high water losses, billing inaccuracies, and inefficient monitoring of water use due to informational asymmetries and high transaction costs further exacerbate financial difficulties for water utilities across the region (Andres, 2016; Kore, 2020). This leads to significant costs for both public service providers and consumers. Marginalized urban populations throughout SSA pay high monetary, time, and health costs as a result of inefficient public service provision, and these costs stand to increase with high rates of urban population growth in many SSA countries (Kore, 2020).

7.2 Digital tax payments and monitoring – *Sudpay*

Fintech is increasingly proposed as an innovative means to leverage mobile and digital technologies to digitalise municipal tax collection (Sy et al., 2019). Among the fintech start-ups proposing innovative tax collection solutions is the Senegalese firm *Sudpay*. Its digital tax payments platform, TownPay, enables local governments to track and collect taxes from MSMEs and other businesses through its B2G payments platform. The platform enables municipal governments to geolocate tax payment activities for all payees registered in their jurisdictions, addressing issues of adverse selection and moral hazard described above and reducing transaction costs (Shi, 2018). MSMEs are provided with proprietary mobile terminals and municipalities are given digital dashboards to use for tax collection (Bayen, 2019). Clients can pay their taxes through simple cash payment, through the Senegalese mobile money (MM) platform Tigo Cash, or through the *Société Générale*'s electronic wallet platform, Yup (Gorwitz, 2018). To facilitate MM payments, *Sudpay* provides MSME taxpayers with SIM cards linked to their MM accounts (Sudpay, 2019). For clients without MM accounts opting to pay in cash, the TownPay platform is principally used to confirm and geolocate tax payments. To finance the service, *Sudpay* deducts a 2% commission from all tax payments received by tax authorities, which it shares with its mobile operator and financial services partners (Gorwitz, 2018; Shi, 2018), and it collects additional commissions on digital credit and retirement savings products provided by its partners (Jackson, 2018). This system allows municipalities to increase tax collection rates, reduce fraud, and increase their budgets for provision of basic public services including healthcare, education, infrastructure, waste collection, public lighting, and more (Bayen, 2019).

As of June of 2019, at the close of a grant funding program sponsored by GSMA Ecosystem Accelerator, *Sudpay* had already enrolled 18,000 Senegalese MSMEs on the TownPay platform and was collecting approximately 40,000 USD in taxes per month (Bayen, 2019). The *Sudpay* platform is currently being used by nine different municipalities throughout Senegal, with plans to expand to more municipalities in Senegal, Côte d'Ivoire, and Guinea in the near future (Bayen, 2019).

7.3 Smart utilities provision – *CityTaps*

Informational asymmetries such as moral hazard and resulting high transaction costs can be solved through digital or "smart" provision of water and other utilities. Pay-as-you-go (PAYG) business models, which have been employed by *Lumos Global* to provide its solar home systems to low-resource clients as described in section 6.2, have also shown promise in increasing pre-paid access to clean water (Sharma, 2017). One example is the firm *CityTaps*, which is harnessing digital technologies to create innovative solutions to inefficiencies in water utilities markets in SSA through its CTSuite platform. This technology consists of a prepaid smart water meter installed at subscriber households and an integrated cloud-based software (CTCloud) that provides financial and operational data to utilities

companies and consumers (Gridley, 2020; Kore, 2020). The smart water meters, called CTMeters, ensure that customers do not receive unexpectedly high water bills by providing a transparent, simple mechanism for water services provision purchased with PAYG micropayments (Haushofer, 2019).

The PAYG model lowers costs and increases transparency for customers, with payments made upfront through mobile money platforms such as Orange Money. Customers can top up their water balance at any time over phone, and water access is unlocked automatically via long range (LoRA) connectivity (Kore, 2020). New customers can subscribe at lower risk to the utility due to the prepaid payment model, and previously disconnected users can reconnect to the service while paying off their debts via small, daily micropayments (Kore, 2020). Utilities enjoy better financial health through real-time transfer of digital payments, and they pay a per-meter monthly subscription to *CityTaps* for the service (Gridley, 2020; Kore, 2020). Another advantage is the CTSuite cloud-based data system, which provides transparency for potential investors (Gridley, 2020).

During its pilot phase in Niamey, *CityTaps* installed 1,325 CTMeters in households throughout the city connected to Niger's water sector, the *Societé d'exploitation des eaux du Niger* (SEEN), and reaching over 10,500 beneficiaries (Kore, 2020). An evaluation of the firm's pilot phase found that the service had helped households save 94 percent on water costs per cubic meter consumed, and SEEN's water price of 0.21 USD per cubic meter was 16 times cheaper than water sourced from traditional pushcart vendors (Kore, 2020). Customers also reported time savings of 1.5 hours per day, taking only 7 minutes to top up their mobile water account and leaving 86 more minutes for other activities (Kore, 2020). Survey respondents also reported perceived health improvements from using the service (Gridley, 2020). There were also significant benefits for the utility, as the evaluation revealed bill payments were received on average 18 days in advance when using the CTSuite system, a significant improvement over the traditional system in which payments would sometimes be collected over 6 months after the service delivery date. SEEN also reported a revenue collection efficiency of 125 percent during the pilot phase (Kore, 2020).

The SEEN evaluation endline survey also found significant effects on mobile money take-up, with 43 percent of customers becoming new mobile money users, 15 percent becoming new Orange Money users, and 95.5 percent of previous mobile money users reporting using mobile money more frequently since subscribing to the CTSuite system (Kore, 2020). *CityTaps* was also able to negotiate a reduced transaction fee of 50 CFA francs for water balance top-ups of 500-1,000 CFA francs, a reduction from the typical 100 CFA franc transaction fee for other Orange Niger transactions (Kore, 2020). After successful installation of the first 1,325 meters, SEEN has recently ordered 10,000 additional CTMeters, with a goal of providing clean water to 100,000 urban residents by 2020 (Haushofer, 2019).

8 Conclusion – lessons learned

While the ventures described in this paper have all experienced success in securing investment funds and addressing obstacles to development within the digitalisation space in their respective sectors of intervention, there have also been challenges. For example, firms must often work with a clientele base that is unfamiliar with the specific technologies being deployed or the products and services being offered. This has been the case with *WorldCover*, which has experienced difficulties satisfying its farmer customers who are often unaccustomed to the nature of weather index-based crop insurance and how the pay-out system works, or to crop insurance in general, and are thus less likely to take up the service (Hight, 2019; Patt et al., 2010). Working with rural populations with limited literacy and numeracy rates can also be a challenge for firms operating in the digitalisation space and relying on their customers having a basic level of technological aptitude (Hight, 2019). These challenges highlight the utility of digital solutions that take advantage of the most basic mobile and Internet technologies, which are able to be taken up and used by rural populations with limited formal education and experience using technology. Some programs have also chosen to integrate digital literacy and numeracy training into their framework in order to increase demand for their services.

Some firms, such as *Zipline*, have also experienced challenges convincing national governments and investors to finance an innovative model, which may seem novel and untested, instead of focusing on

more traditional methods of service provision (Pothering, 2019). Other firms, such as *Investiv Group*, *Lumos Global*, and *CityTaps*, have had to grapple with making their products and services accessible to low-income clients, as the relatively high fixed costs associated with uptake of these products are often prohibitive for many households and MSMEs in SSA. In such cases, implementing pay-as-you-go models has often proven to be an effective solution (Kore, 2020). Other firms have had issues with government regulations that complicate their business activities; for example, *Investiv Group* must comply with the Ivorian government's regulations related to operation of UAVs in Ivorian airspace (Suy, 2019), and *Kobo360*'s logistics operations in Nigeria have been significantly hampered by restrictions on movement enacted in the context of the global Covid-19 pandemic (Garretsen, 2020; Onaleye, 2020). Firms facing such legal and bureaucratic challenges may need to invest time in diversifying their revenue base or improving productivity to make up for productivity losses associated with complying with government regulations.

Despite these challenges, many digital firms in SSA have continued to make progress. For example, since the onset of the Covid-19 pandemic, *Jumia* has expanded its logistics service to external clients (Henry, 2020). *WorldCover* is expanding into additional crops such as cashews, coffee, and cocoa (Towett, 2019) and into additional markets in Latin America and Asia, including India, Mexico, Brazil, and Indonesia (Bright, 2019c). The firm is also using blockchain to develop a premium sharing scheme wherein smallholder farmers can spread insurance costs to include other actors in the value chain, including larger commercial-scale producers and multinational corporations (Bird, 2018). Despite the current difficulties related to the pandemic, *Kobo360* is planning to expand into 10 new SSA countries (Bright, 2019b). The firm is also working on developing its blockchain-enabled platform, the Global Logistics Operating System (GLOS), which will enable the company to further increase the efficiency and security of the value chain services it offers to its customers. *Kobo360* is also launching the Kobo Wealth Investment Network (KoboWIN), a crowd-invest vehicle financing platform to fill a gap in availability of vehicle financing in Nigeria (Bright, 2018).

Other firms have taken advantage of increased demand for new products during the Covid-19 pandemic, developing new products or services to fill gaps in supply chains. For example, since the start of the pandemic in 2020, *Zipline* has delivered Covid-19 tests throughout Rwanda and Ghana (Baker, 2020; De León, 2020), and talks are currently underway to expand the firm's services into multiple countries in sub-Saharan Africa, South America, and Southeast Asia (Glauser, 2018). *Investiv Group* is also seeking to diversify its revenue base, partnering with SECO, a subsidiary of the Ivorian cotton agribusiness OLAM (Investiv Group, 2019), and with the sugarcane agribusiness Sucrivoire to provide drone-based aerial fertilizer applications for these firms (Investiv Group, 2020). *Lumos Global* has secured funding from FMO, the Dutch entrepreneurial bank, to expand into Côte d'Ivoire (Lumos Global, 2020a), and the firm is making improvements to its call centre to more efficiently address customer concerns (Tobias & Castro, 2020). *Sudpay* is rolling out its financial services to MSME taxpayer clients via TownPay, exploring a partnership with the Senegalese firm Fintech to integrate banking services into the *Sudpay* platform (Gorwitz, 2018), and looking to expand into Côte d'Ivoire, Guinea, and Mali (Bayen, 2019). *CityTaps* plans to expand its services into Kenya (Kore, 2020), Burkina Faso, (Gridley, 2020), and Mali (Kore, 2020).

One of the key underlying messages from this paper is the potential of digital technologies to leapfrog missing infrastructures and processes, make up for inadequate public interventions in program service and delivery, and strengthen institutions that have been put in place in industrialized countries but which are often missing, incomplete, or inefficient in SSA countries. However, despite the potential of these technologies for leapfrogging missing infrastructures and institutions, progress can only effectively be made when there is a sufficient degree of adoption and diffusion of digital technologies within the population. In West Africa as in other countries throughout sub-Saharan Africa, many of the populations excluded from public service provision also have low rates of access to digital technologies in general, making it challenging for firms to adopt these leapfrogging technologies in the markets and communities where they are needed most. Disparities in mobile and Internet penetration persist both between countries and between urban centres and rural areas within countries (Cariolle, 2020). As a result, isolated rural communities are less likely to have seen the benefits of digitalisation efforts to date. However, despite these challenges in digital technologies diffusion and adoption, many firms are

bringing their innovative solutions even to remote rural areas and working to positively impact the most vulnerable sectors of the population. Although many firms are still in the start-up phase and there is much work left to do in the digitalisation space, the ongoing digital revolution and growth of the middle class in SSA will both likely continue into the foreseeable future. As such, the potential for employing digital solutions to create jobs and improve market efficiency throughout the region will continue to grow.

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