

### 3. Digitalization in Sub-Saharan Africa

Every second, the region has averaged one new internet users.<sup>1</sup> This fast-paced digital revolution holds the promise of transforming economies and people's lives. It takes on added importance as countries across the region grapple with the unprecedented health and socio-economic fallout of the COVID-19 pandemic. All policy levers are being deployed to protect lives and livelihoods. Digital solutions have helped to provide more resilience and allowed for rapid, flexible, and inclusive policy responses to the pandemic.

Looking ahead, the diffusion of digital technologies and knowledge will create new opportunities for progress and inclusion—greater resilience and efficiency, more access to global markets, improved public service delivery, increased transparency and accountability, and the creation of new jobs. However, digitalization also brings new challenges, including the risk of traditional job losses, the need to revisit policy design, and cybersecurity and data privacy concerns, among others.

It is extremely difficult to know ahead of time how such innovations will ultimately play out. The impact will likely vary across countries, economic sectors, and occupations. But digitalization does not happen by itself. Public policy has a crucial role to play in facilitating technological change, shaping its effects, and in mitigating the potential costs of transition.

Countries and policymakers need to adapt to this new environment. Crisis response and development strategies should aim to nurture emerging digital economies where feasible. In sub-Saharan Africa, there is a pressing need to provide health and economic support to address the immediate crisis. Beyond this, the need to create 20 million jobs per year over the next two decades to absorb the region's young and growing workforce is more pressing than ever. This underscores the importance of economic connectivity and integration as key pillars of successful growth strategies (IMF 2018a).

Against this backdrop, this chapter provides an initial glimpse of how digitalization is influencing economies and policies in sub-Saharan Africa, and how digitalization has aided the crisis response. It also seeks to provide a broad framework to help guide policymakers in devising their countries' digital strategies. The chapter explores the following questions:

- How can digitalization be measured?
- With an appropriate measure in hand, how is digitalization evolving in sub-Saharan Africa, how does this compare to other regions, and what are the main drivers?
- How might digitalization impact economic outcomes and macroeconomic policies?
- And finally, which policies should countries adopt to foster digitalization, capitalize on emerging opportunities, and manage associated risks?

Digitalization, of course, is a multidimensional and rapidly evolving concept. Assessing and tracking progress is therefore difficult, particularly as data is limited—both in terms of coverage and length. To help address these constraints, this chapter builds on a new Enhanced Digital Access Index (EDAI) that aims to better reflect the multifaceted nature of digitalization and provide a baseline for future analysis.

In many respects, sub-Saharan Africa is closing the digital gap with rest of the world. Internet penetration is expanding rapidly, especially through mobile connectivity. Indeed, some countries in the region—Cabo Verde, Ghana, Rwanda, and the Seychelles—are leaders in their income group. Yet, large differences remain across the region and within countries. Rural areas are less connected and the gender gap is widening.

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<sup>1</sup> The average number of new internet users during 2012–17 based on data from the International Telecommunication Union.

This chapter’s empirical analysis suggests that connectivity is associated with stronger economic growth, with an increasing share from the services sector. This analysis treats the phased arrival of submarine cables to the region as a natural experiment to examine the impact of digital connectivity on economic performance. At the firm level, businesses that use digital communications have higher sales and create more jobs—importantly, higher skilled and permanent jobs. Similar to growth, digital connectivity appears to shift the *composition* of employment from manufacturing to the services sector, with an apparently larger shift to the services sector for women.

Digitalization is also impacting macroeconomic policy tools and the transmission of those policies to the economy. Some countries are delivering cash transfers through mobile money to provide immediate and much needed support to those impacted by the pandemic. Yet, the adoption of digital fiscal tools is still in its early stages and offers significant upside potential through higher revenues, more efficient public spending, improved public financial management, and greater transparency. In contrast, digitalization is already well advanced in the financial sector, where some sub-Saharan African countries are global leaders in mobile money transactions.

Countries in the region have embraced digital tools to respond to the crisis, building on existing strategies. The future path for economies is incredibly uncertain, but as attention turns to policies for the recovery, it seems likely that the pandemic will have served to accelerate the digital transformation. As countries move in this direction, four broad pillars can help guide policy efforts: investing in infrastructure, policy frameworks, people and skills, and resilience to risks.

## TRENDS IN DIGITALIZATION: WHERE DOES SUB-SAHARAN AFRICA STAND?

### Measuring Digitalization

Digitalization is a broad concept. It refers to the spread and use of digital technologies—the internet, mobile phones, and other tools and processes—to collect, store, analyze, and exchange information digitally (World Bank 2016, Brookings 2017). This chapter focuses on two aspects of digitalization:

- *Digital connectivity*—the ability to access and use technologies to connect to the internet and share digital information.
- *Digital depth*—the extent to which economic activities, transactions, and policies are becoming digital, including through more online, interconnected, and automated systems.

The process of digitalization, like the technologies that enable it, is evolving rapidly. As such, most data to measure digitalization is only emerging. Time series tend to be short, with inconsistent coverage across countries. More readily available indicators tend to capture narrower concepts, such as internet penetration and mobile phone subscriptions.<sup>2</sup> Broader measures are emerging. For instance, the World Bank’s Digital Adoption Index captures digital adoption by businesses, individuals, and government, but generally consists of only two data points (2014 and 2016).

To help capture the multidimensional aspects of *digital connectivity*, IMF staff have developed a new EDAI (Alper and Miktus 2019). Building on an index developed by the International Telecommunication Union (ITU), the EDAI covers more variables and upgrades the ITU’s weighting methodology to capture five core aspects of digital access: information technology (IT) infrastructure,<sup>3</sup> affordability, education, quality, and internet usage. The EDAI includes 20 underlying variables across these five core metrics.<sup>4</sup>

<sup>2</sup> Measured as “internet users,” as produced by the UN’s ITU—which includes individuals, as a share of the population—who have used the internet in the last three months via a fixed or mobile network. Other organizations that have developed indicators include the Economist Intelligence Unit’s *Inclusive Internet Index*, Euler Hermes’ *Enabling Digitalization Index*, and Dell Technologies’ *Digital Transformation Index*.

<sup>3</sup> Infrastructure in the EDAI refers to IT infrastructure, including measures of mobile and fixed line connections. Access to electricity is considered a foundational layer of infrastructure.

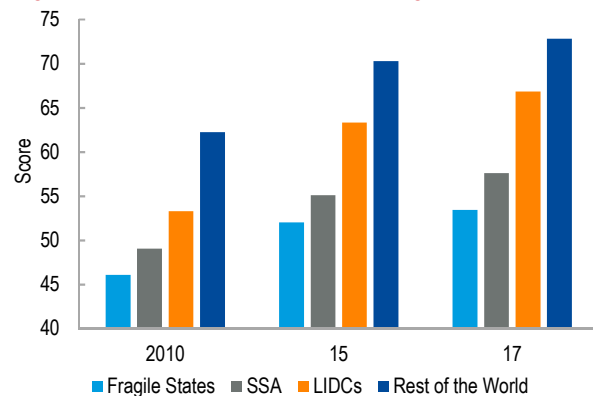
<sup>4</sup> Although the methodology for this chapter remains as described in Alper and Miktus (2019), the variables used to estimate EDAI and its subcomponents were updated to account for data availability. See Annex 3.1 for the list of variables and definitions.

Measures of *digital depth* are even more scarce. Measuring digital depth allows us to gauge the diffusion of digital transactions into private and public sector activities. For instance, e-commerce can help measure the depth of private digital activity, capturing the share of active online paying customers and mobile money transactions. Public sector indicators often seek to measure the extent to which government services are available online. For example, the United Nations' (UN) online service index (OSI) covers the availability and quality of online public services. In this context, there is ongoing debate about how to measure digital activities in countries' GDP. For example, the contribution of digital trade to GDP has likely been underestimated (IMF 2018b).

### Sub-Saharan Africa Is Rapidly Becoming Digitally Connected

Digital connectivity has increased rapidly in sub-Saharan Africa (Figure 3.1). While the global digital divide is still large, the gap with the rest of the world is narrowing fast.<sup>5</sup> Internet penetration in the region has increased tenfold since the early 2000s, compared with a threefold increase in the rest of the world.<sup>6</sup> The proliferation of mobile technologies has been particularly pronounced in sub-Saharan Africa, with most people accessing

**Figure 3.1. Enhanced Digital Access Index (EDAI)**  
*Digitalization has advanced across the region*



Source: Alper and Miktus (2019).

Note: SSA = sub-Saharan Africa; LIDCs = Low-Income Developing Countries.

the internet via mobile rather than fixed line broadband.

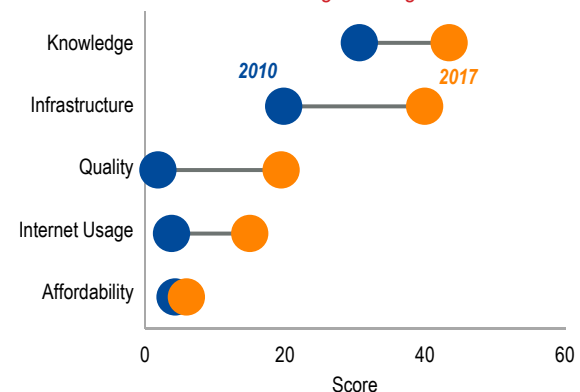
Since 2010, the EDAI shows broad improvements in sub-Saharan Africa in IT infrastructure, internet usage, quality, and knowledge (Figure 3.2). But gaps remain compared to the rest of the world (Figure 3.3). Affordability is a lingering obstacle to adoption, given the high overall cost relative to income. The quality of mobile connection remains poor—the average mobile download speed in the region is 7.4 Mbps, more than three times slower than the rest of the world.<sup>7</sup>

### Large Differences in Connectivity within the Region

There are large differences among countries *within* the region, with higher-income countries experiencing greater connectivity.

- IT infrastructure appears to be a main driver of variation, as indicated by differences in the amount of fixed-line connections and share of population covered by higher speed mobile services (at least 3G).
- Differences in knowledge and quality—EDAI sub-indices—also play a role, but to a lesser extent.

**Figure 3.2. Sub-Saharan Africa: Enhanced Digital Access Index—Evolution of Sub-Indices**  
*With infrastructure and knowledge driving better connectivity*



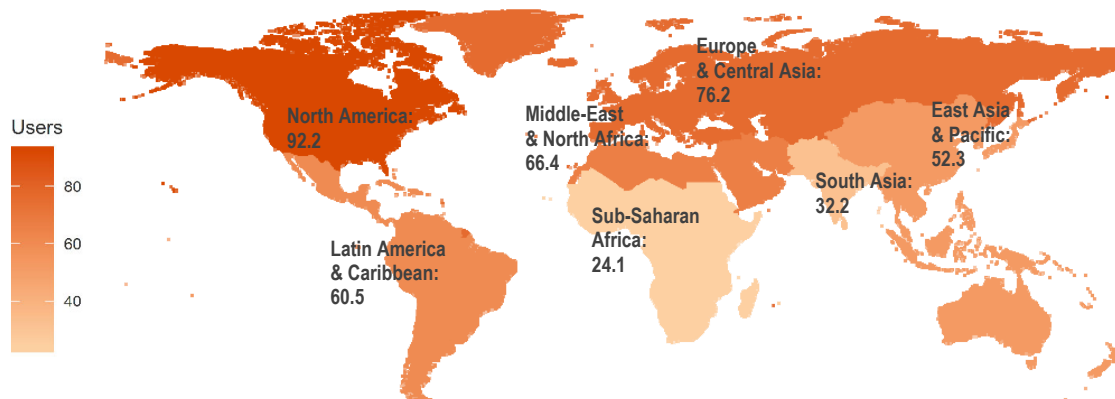
Source: Alper and Miktus (2019).

<sup>5</sup> For an overview of digitalization in Asia see, “The Digital Revolution in Asia: Disruptor or New Growth Engine (or Both)?” in the Regional Economic Outlook: Asia and Pacific, IMF, October 2018.

<sup>6</sup> Internet penetration is measured as a percentage of the population that uses the internet. In 2017, it was about 24 percent for sub-Saharan Africa and 64 percent in the rest of the world.

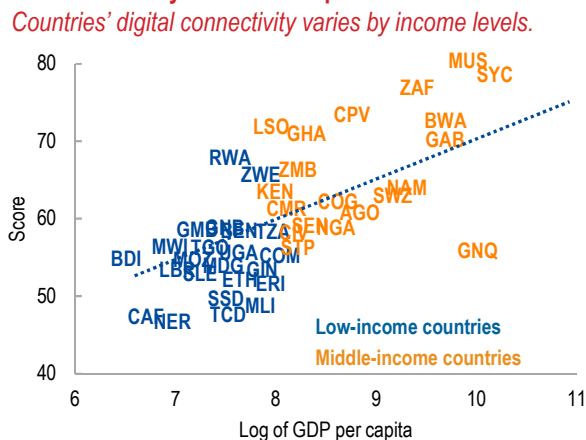
<sup>7</sup> Download speeds vary widely across sub-Saharan Africa, with speeds in Botswana and South Africa ranging from 14 to 20 Mbps, while speeds in the Democratic Republic of Congo and Liberia are about 2.5 Mbps.

**Figure 3.3. World: Internet Penetration, 2017** (percent of population)  
*Sub-Saharan Africa continues to lag other regions in internet penetration.*



Source: International Telecommunication Union.

**Figure 3.4. Sub-Saharan Africa: Enhanced Digital Access Index by Income Group**  
*Countries' digital connectivity varies by income levels.*



Source: Alper and Miktus (2019).

- Similarly, a lower cost of doing business, higher urbanization, and more financial access also tend to be associated with greater digital connectivity (Figure 3.4). Leveling the playing field for female entrepreneurs is particularly important among the business environment factors associated with higher levels of digitalization (Alper and Miktus 2019).

There are also considerable differences *within* countries. Most rural communities do not have access to the internet (even through mobile devices). There is a significant gender gap, with just 23 percent of women in sub-Saharan Africa having access to the internet compared to about 34 percent of men. The regional gender gap of 33 percent in

2019 appears to be widening, up from 21 percent in 2013,<sup>8</sup> and is much larger than the global gender gap of 17 percent.

### Digital Depth in Sub-Saharan Africa is Still Relatively Low

The overall level of e-commerce remains low compared to other regions, but is growing rapidly. In 2019, e-commerce revenues grew by an average of 24 percent in sub-Saharan Africa. About one-quarter of the region's population were active, online-paying customers in 2019, compared with at least half the population in all other regions and 90 percent in advanced economies.

Here, too, there is a wide variation across the region. More than half the population is engaged in e-commerce in some countries (Botswana, Gabon, Nigeria, South Africa), whereas the share in other countries remains below 15 percent (Chad, the Democratic Republic of Congo, Malawi, Niger, Sierra Leone).

A similar pattern exists with social media. While average use of social networks puts the region below the world average, sub-Saharan Africa experienced the most rapid growth in social network use (Facebook, Twitter, etc.) during 2012–16.<sup>9</sup>

One area where sub-Saharan Africa is leading digital depth is the financial sector. Mobile money transactions as a share of GDP are close to

<sup>8</sup> The gender gap is the difference between internet penetration rates for males and females relative to the rate for males.

<sup>9</sup> See *The Global Information Technology Report 2016* by the World Economic Forum. Use of virtual social networks is an index based on a scale of 1-7. A higher number indicates a better position.

25 percent of GDP, compared with just 5 percent in the rest of the world. The region has also been advancing digital innovation in fintech, resulting in the development of new services and apps.

More broadly, there is a growing field of digital innovators in the region, spanning areas such as health, education, commerce and agriculture.<sup>10</sup> There are currently an estimated 600 active tech hubs in Africa—40 percent more than the previous year—providing facilities and support for tech and digital entrepreneurs (GSMA 2019). Broader measures of digital innovation, such as mobile app creation or information and communication technology innovation, are increasingly available for countries in the region and will enable better monitoring of the region’s role in driving innovation.

Digitalization in the public sector is also advancing, with the UN’s average OSI for the region increasing by 45 percent between 2012 and 2018. Yet, this remains low relative to the rest of the world, with the gap widening slightly between 2014 and 2018.<sup>11</sup>

## THE IMPACT OF DIGITALIZATION ON ECONOMIC PERFORMANCE

Digitalization has the potential to influence productivity, employment, and growth. Greater digital connectivity enables specialization of production and economies of scale, both of which can raise productivity and growth. Moreover, it has provided more resilience by enabling firms and workers to maintain some operations through the COVID-19 pandemic. Connectivity can also support structural transformation through the diffusion of knowledge and the development of

new products and services (IMF 2016). At the same time, like trade integration, connectivity may result in winners and losers, with risks for particular sectors or jobs (Rodrik 2018).

### Macroeconomic Performance<sup>12</sup>

Analysis suggests that countries with higher levels of digital connectivity (measured by internet penetration) tend to have higher levels of economic growth. But, *ex ante*, the direction of causation is not always clear. Connectivity may help growth. And growth may facilitate greater connectivity. Untangling these effects is important, particularly if we want to understand the extent to which economic growth in sub-Saharan Africa might benefit from greater digitalization, and how this may impact employment.

The arrival of submarine cables delivering internet to the continent provides a rare natural experiment that helps answer this question. The timing and capacity of these cables was independent of the macroeconomic circumstances in any particular country. It, therefore, provides a valuable and exogenous source of variation in internet penetration that can help us estimate the *causal* impact of that penetration on economic growth and other macroeconomic outcomes.<sup>13</sup>

As countries were connected to the submarine cables, they experienced faster and cheaper internet access, which was associated with a faster uptick in internet penetration compared to countries not directly connected (Figures 3.5 and 3.6).<sup>14</sup>

Using this *de facto* experiment, we find that a 1 percentage point increase in the share of the population using the internet leads, on average, to a 0.37 percentage point increase in the growth of

<sup>10</sup> For example, see the publication series *Digital Innovation Made in Africa*, developed by Make-IT in Africa which showcases selected innovations and entrepreneurs.

<sup>11</sup> The OSI is part of the UN’s E-Government Development Index (EGDI) composite indicator. The OSI is based on an expert assessment of each country’s national website—including the e-services and e-participation portal—and the websites of ministries such as education, health, and finance, as applicable (UN 2018).

<sup>12</sup> This section is based on a forthcoming IMF working paper, “Macroeconomic Impacts of Internet Penetration in SSA: Evidence from Submarine Cables” by Felix Simione and Yiruo Li. Also see online Annex 3.2 for more details.

<sup>13</sup> Submarine cables are a network of fiber cables, placed under the sea, which connect countries and continents. They provide faster internet speed and lower cost compared to satellite networks that prevailed in the past. The analysis builds on the assumptions that (i) the difference in internet penetration rates between coastal and landlocked countries would have remained broadly unchanged absent the arrival of submarine cables, and (ii) the timing of the arrival and capacity of the cables depend little on macroeconomic conditions (see online Annex 3.2 for details). This country-level analysis complements the work by Hjort and Poulsen (2019), who explore a related experiment at the firm level to assess the impact on employment.

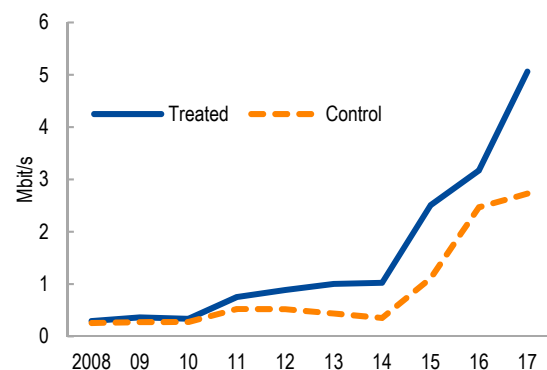
<sup>14</sup> Based on this, we explore two instrumental variables for internet penetration that capture (i) being directly connected to a submarine cable after 2009 and (ii) the data capacity of the submarine cables (see online Annex 3.2 for details).



real per capita income. This is slightly higher than other studies that are based on a broader sample of countries, possibly suggesting a higher marginal return from connectivity for countries in the region.<sup>15</sup>

### Figure 3.5. Sub-Saharan Africa: Fixed (Wired)-Broadband Speed

*Countries' directly connected to submarine cables experience faster increases in internet speed*

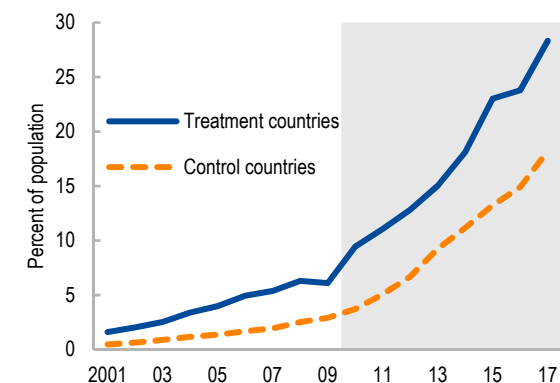


Sources: International Telecommunication Union; and IMF staff estimates.

Note: Treatment countries are defined as those directly connected to a submarine cable (mostly coastal, with the exception of Rwanda and Uganda). Control countries are those not directly connected (landlocked).

### Figure 3.6. Sub-Saharan Africa: Individuals Using Internet

*And in internet penetration*



Sources: International Telecommunications Union; and IMF staff estimates.

Note: Treatment countries are defined as those directly connected to a submarine cable (mostly coastal, with the exception of Rwanda and Uganda). Control countries are those not directly connected (landlocked).

Moreover, we find that internet penetration leads to a possible shift in the sources of growth. Higher penetration increases the share of services in total value-added, while reducing the share of industry. The impact on agriculture, however, is not statistically significant.

Notably, a similar pattern emerges in the labor market. While there does not appear to be an impact on overall employment, the share of employment in the services sector increases. There is also a sizable gender impact. Increased internet penetration is associated with a larger share of women working in the services sector—the shift to more employment in services is two and half times larger for women than men.

### Firm-level Performance<sup>16</sup>

Observing the behavior of firms also provides insights into the potential payoffs of connectivity. The World Bank's Enterprise Surveys (WBES) provide data on the use of email for firms operating in the formal manufacturing and service sectors. This serves as a proxy for firms' digital connectivity, as email use forms an important—if not dominant—feature of most firms' digital connectivity.

The majority of firms in sub-Saharan Africa use email to communicate with clients or suppliers (57 percent)—the lowest among regions and well below the world average of 71 percent (Figure 3.7). Moreover, email use tends to be most common among large and experienced firms, as well as foreign-owned firms and those that export to international markets (Figure 3.8).

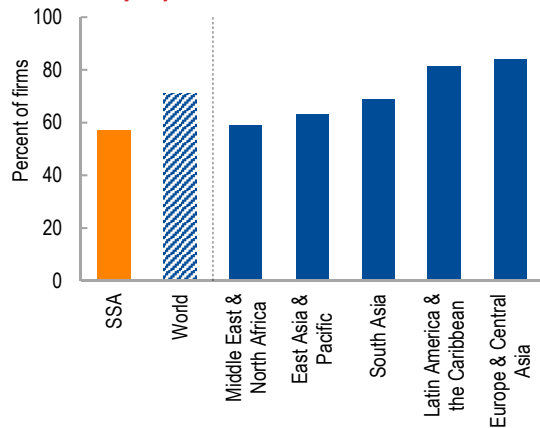
To assess how firm performance might benefit from digital connectivity (email use), the analysis again exploits an implicit natural experiment provided by the submarine cable network. In this case, internet access via submarine cables is periodically interrupted by seismic events on the sea floor; interruptions that are clearly not influenced by firm characteristics.

<sup>15</sup> Several studies estimate the relationship between growth and broadband internet penetration. The estimated coefficients range between 0.05 and 0.2, with very few exceptions of negative coefficients. However, most of the studies rely on broader country samples (mostly non-sub-Saharan Africa), and do not address the endogeneity between income and internet penetration. The ITU (2012) and World Bank (2016) provide an extensive review of the empirical work.

<sup>16</sup> This section is based on a forthcoming IMF working paper, "Digital Connectivity and Firm Performance in sub-Saharan Africa," by Joël Cariolle (FERDI), Maëlan Legoff (Banque de France), and Sampawende Jules Tapsoba and Martha Tesfaye Woldemichael (both IMF). This section also benefited from collaboration with Olivier Santoni (FERDI).

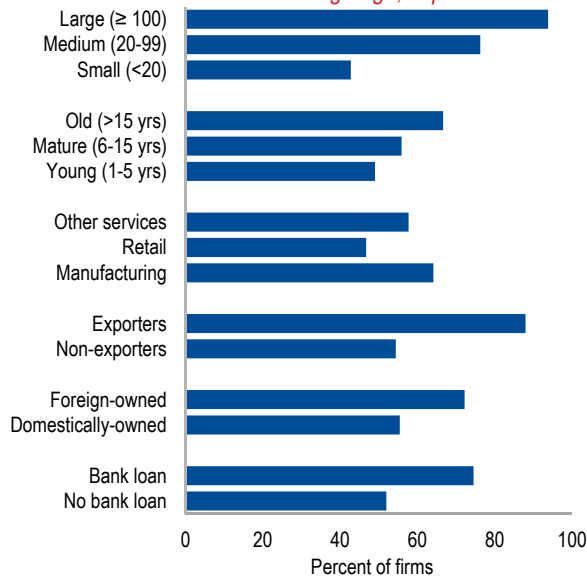
By looking at variations in connectivity across firms—combining each submarine cable network’s exposure to seismic risk with the firm’s exposure to that risk, as gauged by its distance to its nearest international telecommunications node—we can

**Figure 3.7. Selected Regions: Email Use by Firms**  
*While the majority of firms in SSA use email for business*



Sources: World Bank Enterprise Surveys; and IMF staff calculations.

**Figure 3.8. Sub-Saharan Africa: Email Use by Firm Characteristics**  
*Email use is most common among large, experienced firms.*



Sources: World Bank Enterprise Surveys; and IMF staff calculations.

estimate the impact of connectivity on different outcomes (Cariolle, Le Goff, and Santoni 2019).<sup>17</sup> In this instance, we estimate the impact of email use on firms’ sales and their number and type of workers.<sup>18</sup>

Even accounting for firm size, the results suggest that firms using email for business perform better in sales and in creating jobs—importantly, higher-quality jobs. Firms using email have real annual sales that are 2.6 times higher than non users and employ eight times more workers than non users. These firms also tend to hire more permanent, full-time employees rather than temporary workers. Attesting to the quality of job creation, the results also show that email use shifts the composition of the manufacturing workforce in favor of higher-skilled jobs (administration, sales, and skilled production workers).

## THE IMPACT OF DIGITALIZATION ON MACROECONOMIC POLICIES

Digitalization has provided additional tools to respond to the COVID-19 pandemic. Digital platforms have enabled the rapid deployment of social protection programs and enabled some essential government services to continue to operate (Box 3.1). Beyond these immediate benefits, digitalization can support better policy design, improve public sector accountability, and support further financial inclusion and deepening. Yet, the changing nature of economic and financial transactions can complicate policymaking and introduce more uncertainty and risks.

### Tool for More Efficient and Effective Fiscal Policy

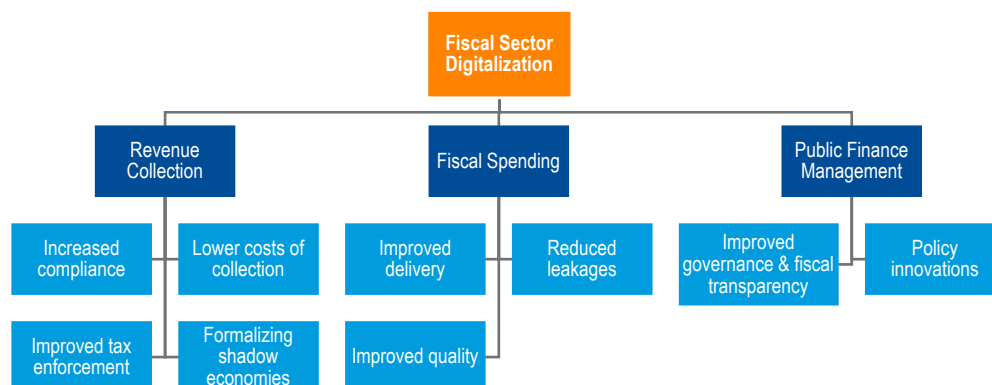
Digital tools have the potential to improve the efficiency, transparency, and impact of fiscal policy by strengthening how governments collect and

<sup>17</sup> The identification strategy is built on the assumption that (i) firms’ digital connectivity via the internet is directly affected by the exposure of the country’s submarine cable network to seismic risks and that (ii) firms are heterogeneously affected by such vulnerability to internet disruptions based on their distance to international telecommunications infrastructure nodes. Therefore, the variable used to instrument email use is the interaction between the annual frequency of earthquakes and the firm’s distance to the closest connectivity infrastructure. While firms in the same location share the same nodes, each WBES round is administered to a nationally representative sample of firms, usually covering businesses operating in different cities within the same country, and thus provides sufficient variation for running regressions. The empirical approach is discussed more fully in online Annex 3.3.

<sup>18</sup> The analysis covers some 18,000 observations from 39 countries in sub-Saharan Africa. It controls for country, time, sector, location-specific effects, and other determinants of firm performance, including firm age, firm size (measured by the number of full-time permanent employees when the firm started operations), foreign ownership, exporting status, experience of the top manager, access to bank financing, and distance to the closest submarine cable landing station or Internet Exchange Point.

**Figure 3.9. Transmission Channels in Digitalizing the Fiscal Sector**

*Digitalization helps to improve the efficiency and impact of fiscal policy*



Source: IMF staff.

analyze data, as well as how effectively they deliver public services and raise revenues (Figure 3.9). This does not make digitalization a silver bullet to achieving better fiscal outcomes. It can, however, complement and reinforce underlying structural fiscal reforms.

So far, the adoption of digital tools by the public sector in sub-Saharan Africa remains low compared with other regions. For instance, only about 30 percent of countries in sub-Saharan Africa provide e-filing services and none use e-procurement processes other than for ex-post information sharing. Half of the countries in the region do not have a website or one that is easy to navigate to share information on public finances (Figure 3.10).

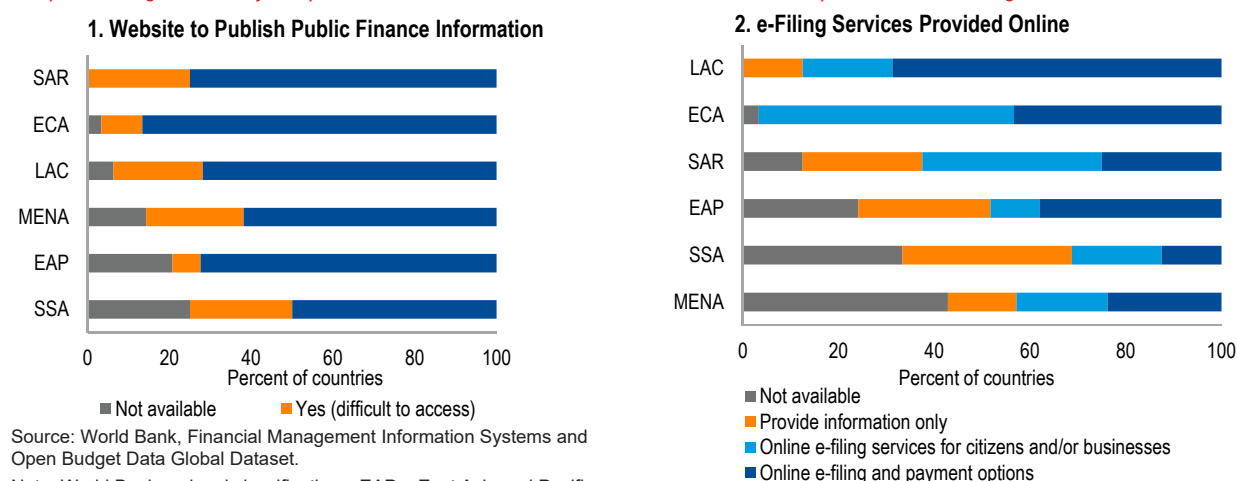
Adoption is more advanced in the area of debt management, where 94 percent of countries in the region have an operational digital platform.

### Improving Public Financial Management

By providing opportunities to strengthen public financial management, digitalization can facilitate better planning, execution, and monitoring of government budgets. Access to more accurate and timely information via digital platforms supports improved policy analysis, forecasting, and budget formulation. Digitalized processes can reduce delays, streamline procedures, and reduce the potential for human error, improving budget execution. Together with more accessible online information,

**Figure 3.10. Open Budget Score and e-Services**

*Adoption of digital tools by the public sector in sub-Saharan Africa remains low compared with other regions.*



Source: World Bank, Financial Management Information Systems and Open Budget Data Global Dataset.

Note: World Bank regional classifications. EAP = East Asia and Pacific; LAC = Latin America and Caribbean; MENA = Middle East and North Africa; ECA = Europe and Central Asia; SAR = South Asia; and SSA = sub-Saharan Africa.

Source: World Bank, Public Financial Management Systems and Eservices Global Dataset.



these factors provide an additional vehicle of transparency. And, by helping key stakeholders hold governments more accountable, digitalization can improve governance and reduce incentives for corruption (see Box 3.2).

### Optimizing Fiscal Spending

Spending efficiency, as measured by the Public Expenditure and Financial Accountability (PEFA) framework, is higher in countries that have adopted e-payment systems.<sup>19</sup> In this regard, digital systems can allow for:

- *Better targeting* of public benefits and services (Dubois and Ludwinek 2015). Digital technology allows for better identification and verification of beneficiaries, reporting, and information management. It also enables governments to limit leakages related to fraud, corruption, and over subscription of public programs (Lund and others 2017). Similarly, biometric technology or digital IDs (as being introduced in Burkina Faso, Côte d’Ivoire, and Ghana) can help governments ensure that public programs are well targeted (Muralidharan and others 2016). For example, by requiring biometric registration, South Africa eliminated 850,000 ghost and ineligible public-program beneficiaries in 2014 and halved administrative costs (IMF 2018c).
- *Better coverage* of eligible recipients of public payments, with conservative estimates of a non-take-up rate of about 40 percent (IMF 2018c). Using digital tools to simplify application processes and raise awareness of social benefits can help reduce barriers to program uptake. Mobile payment systems can also help governments provide support to difficult-to-reach households. For example, during the 2014–16 Ebola crisis, e-transfers delivered much needed cash support in Liberia and Sierra Leone for isolated rural households (Dumas and others 2017).

### Strengthening Revenue Collection

Evidence suggests that countries with higher levels of internet penetration and mobile subscriptions also have higher revenues.<sup>20</sup> An increase in digitalization in sub-Saharan Africa from the 25<sup>th</sup> to the 75<sup>th</sup> percentile (measured as a proportion of households with internet access) is associated with an increase in domestic revenue by up to 2.1 percentage points of GDP (see online Annex 3.4). Countries adopting e-filing also tend to have higher value-added tax collection efficiency, and nearly half of the countries in the region experienced a statistically significant boost in collection efficiency after implementing e-filing.

- *Simplifying tax administration.* Moving from paper and cash-based tax payments can reduce transportation, labor, and transaction costs. For example, in 2014, the Kenya Revenue Authority (KRA) introduced iTax, a fully integrated and automated domestic tax administration that allows taxpayers to pay via mobile devices. This allowed the KRA to establish real-time revenue and audit monitoring, and progressively reduced the cost of revenue collection (Ndung’u 2017). Since 2016, digitalized tax services in South Africa—automated processing and risk management—have significantly reduced the time and red tape associated with tax assessments and customs evaluations. Today, most personal income tax assessments (95 percent) are made within 3 seconds, compared to 180 days in 2006 (IMF 2018c).
- *Increasing tax compliance.* Digital tools such as e-filing and prepopulated tax return forms can streamline the process of paying taxes, reducing compliance costs (Artana and Templado 2018). For example, attitudes toward tax compliance among small business owners improved after Uganda enabled e-filing of tax returns in 2012 (Night and Bananuka 2018). While digitalization can create the risk of new ways to evade taxes, it can also enhance the breadth and quality of taxpayer information. Enabling third-party verification (for example, financial

<sup>19</sup> The PEFA measures the extent to which a country’s public financial management practices contribute toward their “aggregate fiscal discipline, strategic allocation of resources, and efficient service delivery.” The PEFA is 23 percent higher on average in countries with e-payment systems.

<sup>20</sup> The control variables include GDP per capita, economic growth, trade openness, terms of trade, the size of the agriculture sector, measures of corruption, inflation and education. These variables are from the IMF’s *World Economic Outlook* and the World Bank’s World Development Indicators.

sector data) or using e-invoices to track business transactions can help reduce tax evasion, including at the border (Pomeranz 2015; Bellon and others 2019). Further, digital cadasters<sup>21</sup> can help mobilize revenue from property taxes—Ghana and Niger have introduced GPS-based digital-address initiatives to reduce tax evasion.

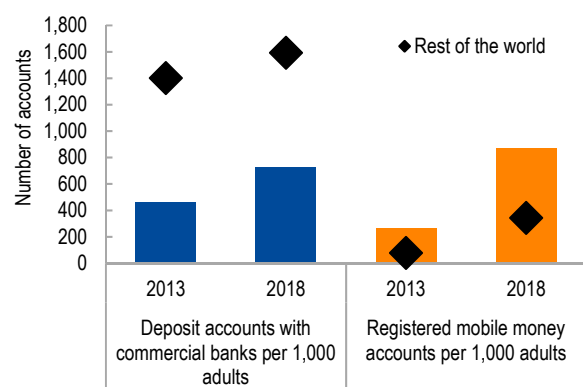
- *Broadening the tax base.* Adopting digital platforms may encourage formalization by reducing barriers to acquiring information (Aslam and Shah 2017) and making it easier to make payments. However, such initiatives need to be implemented carefully, with an appropriate mix of incentives, so as not to deter economic agents in the initial stages. In Benin, for example, offering training with online bank accounts increased registration of informal businesses by 16.3 percentage points (Klapper and others 2019).

### Monetary and Financial Sector Policies<sup>22</sup>

Over the past decade, technological innovation has accelerated the pace of financial sector development and inclusion in sub-Saharan Africa. The early and rapid spread of mobile money, in particular, opened

**Figure 3.11. Sub-Saharan Africa: Deposit Accounts and Mobile Money Accounts (average)**

*Penetration of mobile banking in SSA is outpacing traditional banking*



Source: IMF, Financial Access Survey.

Note: Data availability covers 31 and 23 sub-Saharan countries in 2013 and 2018 respectively.

<sup>21</sup> A digital cadaster is a computerized map or “spatial” location showing property boundaries.

<sup>22</sup> This section is based on a forthcoming IMF working paper, “Beyond Fintech: The Implications of Digitalization on Monetary and Financial Sector Policies” by Mame Astou Diouf, Pranav Kumar Gupta, and Franck Ouattara.

<sup>23</sup> See online Annex 3.5, “Mobile Phone Ownership and Welfare: Evidence from South Africa’s Household Surveys”.

<sup>24</sup> Data from the IMF’s Financial Access Survey.

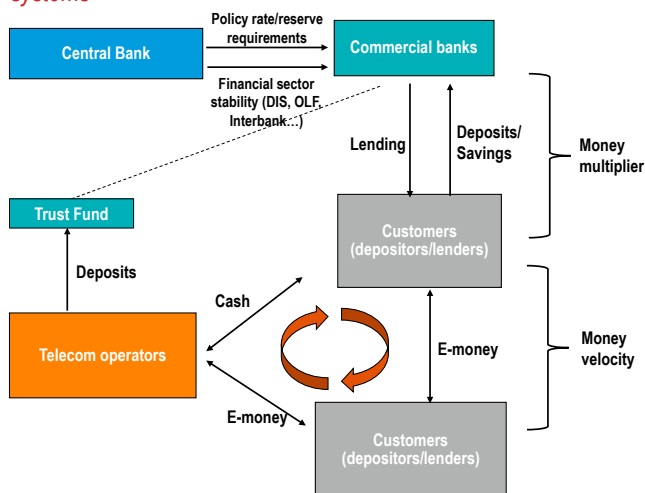
up the financial sector to previously excluded populations and proved to be a valuable tool amidst the COVID-19 pandemic. Evidence suggests that the spread of mobile money can help reduce poverty and raise growth (Jack and Suri 2016 and Khera and others 2019).<sup>23</sup>

In sub-Saharan Africa, the number of mobile money agent outlets has increased significantly, from almost zero in 2008 to more than 38,000, on average, in each country in 2018. Moreover, the number of mobile money accounts now exceeds the number of traditional deposit accounts, with 21 percent of adults in the region having a mobile money account (IMF 2019) (Figure 3.11).

The region is also leading the world in mobile transactions. Mobile-money transactions more than tripled from an average of 8 percent of GDP in 2014 to 25 percent in 2018. This compares with an increase from 3 percent to 5 percent for the rest of the world. By 2018, the volume of transactions among new frontier countries (Burkina Faso, Côte d’Ivoire, Ghana) had caught up with the region’s early adopters (including Kenya, Tanzania and Uganda).<sup>24</sup> As financial inclusion has increased, mobile money has provided a robust—and safe—alternative to physical transactions during

**Figure 3.12. Evolving Structure of the Financial Sector**

*The growth of mobile banking adds complexity to payment systems*



Source: IMF staff.

the COVID-19 pandemic. More broadly, it has increasingly become a platform for other financial services, such as the provision of credit, savings, and cross-border payments.

### Changing the Pattern of Monetary and Financial Relationships

The rise of mobile money, or e-money more broadly,<sup>25</sup> and the entrance of mobile network operators (MNOs) has the potential to reshape traditional financial relationships, with attendant implications for financial stability and monetary policy. Under current practices, the key role of an MNO is to issue e-money, manage trust funds,<sup>26</sup> operate a mobile money platform, and manage an agent distribution system (Figure 3.12).

Despite its growing prominence, literature on the impact of e-money on monetary policy remains thin.<sup>27</sup> A study using data of 33 countries in sub-Saharan Africa over 2011–18 suggests that an increase in registered mobile money accounts is associated with an increase in velocity; most likely due to increased financial inclusion and depth.<sup>28</sup> Consequently, central banks that target monetary aggregates may face increased uncertainty in forecasting velocity. For those central banks that instead focus on the policy rate as an operational instrument, increased use of e-money should strengthen the transmission mechanism, because of higher financial inclusion and reduced informality. Furthermore, a few MNOs have begun to provide short-term credit to customers, which could further impact monetary policy transmission.<sup>29</sup> Hence, it is important for central banks to remain attentive to the growing prominence of e-money and adopt

statistical reporting methods to account for e-money developments.

### Financial Sector Challenges and Risks

The success of mobile money, a growing user base, and continued innovation has helped boost the introduction of new financial products, including credit and savings products and cross-border payments (Sy and others 2019). The physical and economic barriers posed by the COVID-19 pandemic are expected to accelerate these trends.

At the same time, digitalization exposes the financial sector to new risks. Mobile money issuers face operational challenges that give rise to credit and liquidity risks from e-money issuance, risks in managing customer deposits and a widely dispersed agent network, and risks to mobile money platforms and telecommunication networks (including cyber risks). Existing risks related to consumer protection could also be exacerbated, as it may become easier for online firms to bypass financial regulations.

Similarly, digitalization will likely require amendments to legal and regulatory frameworks, and supervisory practices.<sup>30</sup> Increasingly central banks may need to regulate private-sector cryptocurrencies, and are exploring central bank digital currencies. While some of these challenges could be overcome by considering a synthetic central bank digital currency, central banks will need to carefully weigh the pros and cons, while being cognizant of the infrastructure and resources available and the potential impact on financial stability and monetary policy (Mancini-Griffoli and others 2018).<sup>31</sup>

<sup>25</sup> Mobile money refers to a range of financial transactions offered across mobile phones and is generally considered as a sub-category of electronic or e-money

<sup>26</sup> In some countries, regulations stipulate that the stock of e-money must be backed one-for-one by cash deposits in a trust fund or liquid investments. In some, including in the West African Economic Monetary Union, the stock of e-money must be backed one-for-one by deposits in bank accounts in the form of term deposits (at least 75 percent of the float) and investments in the regional stock market.

<sup>27</sup> For example, Weil, Mbiti, and Mwega (2012) and Ndirangu and Nyamongo (2015) have found no significant impact of mobile money on monetary aggregates, whereas Adam and Walker (2015) using a dynamic stochastic general equilibrium model, found the impact of mobile money likely to be positive to enhance the efficacy of monetary policy implementation.

<sup>28</sup> Estimates suggest that a 10-percentage point increase in registered mobile money accounts leads to a 0.2-point increase in velocity. The results are robust, controlling for the number of ATMs and nominal GDP growth (see forthcoming IMF working paper, “Beyond Fintech: The Implications of Digitalization on Monetary and Financial Sector Policies” by Mame Astou Diouf, Pranav Kumar Gupta, and Franck Ouattara).

<sup>29</sup> Estimates show that mobile money does not seem to have a significant impact on the money multiplier yet, possibly as the issuance of e-money is typically backed one-for-one by cash deposits in a trust fund, and so does not lead to an increase in the monetary base.

<sup>30</sup> See “The Bali Fintech Agenda” (International Monetary Fund and World Bank Group 2018), which brings together the key considerations for policymakers to support the fintech sector while managing risks to financial stability and integrity.

<sup>31</sup> Also see online Annex 3.6.

## POLICIES TO REAP THE REWARDS OF DIGITALIZATION AND MANAGE RISKS

Countries across sub-Saharan Africa are embracing digitalization, developing policies to improve connectivity and leverage digital opportunities to boost growth and inclusion.<sup>32</sup> The COVID-19 pandemic is bringing the potential benefits of digitalization into sharper view.

While not a substitute for broader reforms, policies to promote digital tools and services that are more efficient and resilient, and less damaging to the environment, take on new importance in a post-pandemic world. However, digitalization does not happen by itself. It will be shaped by the policies and actions that each country adopts, and each country's priorities will depend on its relative digital strengths and weaknesses. Emerging from the pandemic with more resilient digital-based economies will, therefore, depend on integrating digital strategies within each country's broader development agenda.

Efforts to support digital connectivity and raise digital depth will require developing a digital-friendly policy framework anchored around four broad policy pillars: investing in infrastructure; investing in policies for a supportive business environment; investing in skills; and investing in risk management frameworks. In light of the real-time lessons from the pandemic, countries can benefit from an adaptive, peer-learning approach to guide these policy efforts.

### Investing in Infrastructure

Large upfront fixed costs and rapid technological change can make it difficult to prioritize a country's most important investment. But digitalization requires two critical infrastructure layers:

- *A foundation of traditional, but digital-friendly infrastructure.* Reliable electricity is critical. But access to electricity in sub-Saharan Africa is one of the lowest in the world, with a sizable urban-

rural divide within countries. Expanding access to electricity is therefore a priority.

- *A layer of digital-ready IT infrastructure.* Ensuring connectivity involves (i) connecting each country to the global network; (ii) national and intercity networks within each country; and (iii) connecting end users (fixed-line and mobile connections). Almost all countries in sub-Saharan Africa, except for the Central African Republic, Eritrea, and South Sudan, are connected through submarine cables or via cross-border terrestrial links. Progress is needed on building networks within countries and connecting end users. This also involves investing in supporting data storage and management, and content-hosting infrastructure, such as data centers (Broadband Commission 2019).

The traditional infrastructure costs are substantial. According to the African Development Bank (2018), achieving near full electrification in sub-Saharan Africa by 2025 would cost about \$35–50 billion annually.<sup>33,34</sup> Arguably, technologies could, over time, help to lower upfront investment costs (for example, solar mini grids).

In terms of IT infrastructure, the Broadband Commission (2019) puts the cost of achieving the Sustainable Development Goal of universal, affordable, and quality access to broadband connectivity in sub-Saharan Africa at about \$90 billion.<sup>35</sup> This estimate comprises 30 percent for capital investment in infrastructure, 50 percent for maintenance and operation, and 17 percent for investment in user skills and local content to ensure that the deployed infrastructure is used adequately. The remaining 3 percent is associated with regulation and building policy frameworks.

### Investing in Policy Frameworks

Financing IT infrastructure investments should rely primarily on funds from the private sector, with supportive public policies. As with the private sector

<sup>32</sup> See online Annex 3.7 on selected country experiences with digital reform.

<sup>33</sup> Other estimates have been broadly similar. In 2017, the Netherlands Environmental Assessment Agency put the costs of universal access to electricity in sub-Saharan Africa at \$24–49 billion per year by 2030.

<sup>34</sup> Beyond electricity, other complementary investments are also needed (for example, education). See IMF 2019 Working Paper “The Spending Challenge for Reaching the SDGs in Sub-Saharan Africa: Lessons Learned from Benin and Rwanda,” for cost estimates.

<sup>35</sup> The estimated cost of achieving high speed universal internet ranges from about \$57–90 billion depending on the estimation technique (Alper and Miktus 2019).

more broadly, investment in the digital economy requires a supportive business environment (IMF 2019). Moreover, given high fixed costs and the limited market in many countries, a broad regional approach would offer economies of scale, as was the case with investments in submarine cables.

Governments have a vital role to play in ensuring an appropriate business and regulatory environment for digitally enabled businesses and new entrants. Putting in place digital strategies is another key step to ensure equal access to critical digital infrastructure for all market players (competition policy) and individuals (mainstreaming gender policies), and lowering barriers to entry (cost, information asymmetries, licensing, etc.).

Support from governments—both regulatory and financial—and development partners would also be needed to ensure universal access and inclusion, such as connecting vulnerable or rural users (Broadband Commission 2019). Digitalization policies should seek to incorporate approaches to counter the widening gender gap and ensure that girls and women are not left behind.

Finally, governments can demonstrate leadership. Adoption of digital policy tools and providing e-government services can help make fiscal policy more effective and introduce citizens and businesses to the benefits and culture of digitalization. Governments can also encourage public-private sector dialogue by establishing points of contact and exchange between policymakers and digital service providers, through designated innovation hubs, offices, or digital sandboxes (a framework to allow innovators to conduct live experiments in a controlled environment under a regulator's supervision).

### Investing in People and Skills

Reaping the benefits from digital-supporting infrastructure and policies also requires investing in education. That includes improvements in core education as a basis for continued learning as well as focused investments in digital skills. This is vital to: (i) ensure that people and businesses can successfully leverage technology, while providing some assurance of a viable market for investors; and (ii) adequately equip the workforce of the future.

Despite a 40-percent improvement in EDAI knowledge indicators over the past decade, a gap remains between sub-Saharan Africa and other regions.

To this end, countries across the region are investing in human capital:

- Countries are *leveraging digital technology to enhance core education*. For instance, Côte d'Ivoire and Kenya have launched e-education services, and Sierra Leone is using digitalization to upgrade teacher recruitment processes and evaluate student progress.
- Increased focus on *promoting basic digital and financial literacy* is also a key tenet of many countries' digital strategies, as in Kenya and Rwanda.
- Other countries are focused on *building more advanced technical skills*, such as the coding academy at Niger's tech center and more options for tertiary training in software development and entrepreneurship in Kenya.
- Innovation hubs and similar vehicles can also *facilitate on-the-job or peer learning* to support entrepreneurs in building skills to develop new businesses.

### Investing in Resilience Against Digital Risks

As countries become more digitally connected, they also become more vulnerable to a range of unintended consequences and emerging risks, including internet shutdowns or misuse of technologies. It is important to complement pro-digital policies with risk-management frameworks to enable early and preemptive action. Risk frameworks would also need to evolve as rapidly as the underlying technology. Business continuity and cyber-risks have become more acute during the COVID-19 crisis as increased use of digital technology has intensified vulnerability to data and privacy risks and cyber-attacks. There are three broad categories of digital risk against which policymakers should aim to build resilience:



- *Cybersecurity resilience.* Maintaining an appropriate cybersecurity stance ensures that digital technologies are protected from threats that could cause disruptions for users. Sub-Saharan Africa's reliance on outsourced infrastructure services, such as data centers, makes it vulnerable to supply chain risks (for example, data breaches or communication interruptions). The ITU's framework to assess cybersecurity focuses on countries' legal, technical, and operational institutions and frameworks to deal with cybersecurity and cybercrimes. Cross-border cooperation and information sharing are also important.
- *Economic resilience.* Economic risks from digital technologies can evolve rapidly, such as money laundering and terrorist financing (ML/FT) risks or threats to consumer protection and data privacy. Other economic risks—workers facing job dislocation, tech firms weakening the tax base, or monopolies dominating some sectors due to network externalities—may be slower moving. Policymakers need to develop tools to respond. Regulations can protect consumers from monopolies, investment in skills can support job transitions, and better data can help increase tax efficiency.
- *Operational resilience.* As economies become more reliant on digital technologies, they also become more vulnerable to loss of connectivity. This means that individuals, businesses, and the public sector need to build skills and capacity for business continuity (including disaster recovery and contingency plans) in the event of unforeseen shocks.

Reflecting growing awareness of digital risks, countries across the region are adopting legislative and other frameworks to address these risks. About half of the countries in sub-Saharan Africa have passed laws on cyber-crimes and other cyber risks. According to the ITU framework, Mauritius, Kenya, and Rwanda are the top three performers in sub-Saharan Africa (ITU 2018). Many countries have also passed laws dealing with electronic transactions, consumer protection, and privacy and data protection. In some cases, legislation is being implemented at the regional level (for example, the Economic Community of West African States and the West African Economic and Monetary Union).

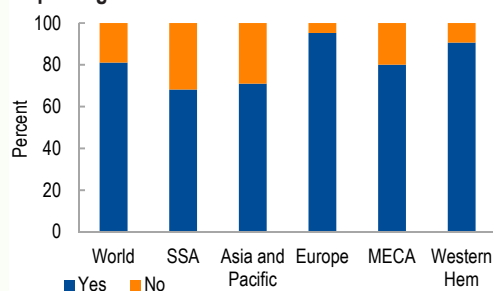
### Box 3.1. Digitalization and Responding to the COVID-19 Pandemic in Sub-Saharan Africa

Many sub-Saharan African countries are deploying digital policy responses to cope with, and cushion the effects of, the COVID-19 pandemic. This early experience offers some insights into how digitalization can help build more resilient economies for the future. For instance, mobile money, where the region is already a global leader, has been used to effectively deliver much-needed support while promoting social distancing. Yet, the connectivity gap between sub-Saharan Africa and the rest of the world also suggests that greater digital readiness could have allowed the region to do even more.

**While digitalization allowed businesses in the region to continue partial operations amid COVID-19, gaps in connectivity have limited the extent to which countries are benefiting from online activities.**

- *The switch to partial telework arrangements occurred in most countries, but has been less pronounced in sub-Saharan Africa than in other regions (Figure 3.1.1).* In countries where telework has been possible, it has generally been limited to a fraction of companies and services operating in the small formal sector, and has also been vulnerable to the region's less reliable internet connectivity and electricity supply. An IMF survey of policy responses to the pandemic suggests that countries in the region that were able to switch to partial telework by mid-May 2020 had more access to the internet (28 percent of the population) than non telework countries (17 percent).
- *While levels of e-commerce remain low, it has helped maintain business operations in some*

**Figure 3.1.1. Selected Regions: Percent of Countries Reporting Remote Work**



Source: IMF Strategy, Policy, and Review Department, Survey of Policy Responses to COVID-19 and Related Shocks (2020).  
Note: SSA = sub-Saharan Africa; MECA = Middle East and Central Asia; Western Hem = Western Hemisphere.

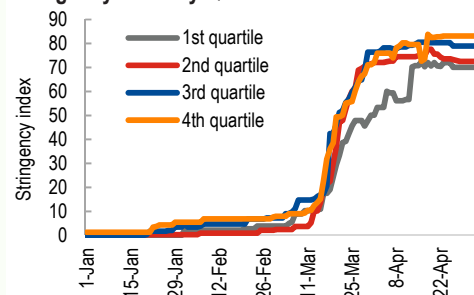
countries. Online orders picked up in Kenya and Nigeria, and the Senegalese authorities set up an e-commerce platform to provide easy access to the websites of small-and medium-sized enterprises that sell essential goods. In Uganda and Kenya, authorities are using social media to share information on where consumers can purchase food with mobile money, and have it delivered through ride-hailing apps.

**Some governments found new technologies to be useful to maintain public services.**

- *Telework has allowed some countries to minimize disruptions in some public services.* In Rwanda, the judiciary is increasingly using videoconferencing for court proceedings. In Côte d'Ivoire, a new ePassport agency manages the service online from application to appointment booking and payments. Kenya's eCitizen portal is witnessing increased usage for services, such as civil and vehicle registration.
- *Countries are leveraging e-learning tools for remote education.* Although access to schooling lags behind and fewer classes have moved online compared to other regions, virtual campus apps and websites have provided free study materials during school and university closures (Côte d'Ivoire, Ghana, Kenya, Liberia, and Uganda). Educational television and radio programs have also been launched, including in Angola, Burkina Faso, Cameroon, Madagascar, Malawi, and Sierra Leone.

**As governments in the region moved quickly to adopt containment measures (Figure 3.1.2), many also turned to digital tools to support these efforts and raise public awareness.**

- *Digital technology is supporting the public health response in unprecedented ways.* The South African and Kenyan authorities engaged tech companies to develop contact tracing apps. In Nigeria and Niger, free e-consultation tools allow users to self-assess infection risk and get tested based on symptoms. International experts shared experiences on hospital management, emergency response and staff medical training via webinars with Mozambique's frontline doctors.

**Figure 3.1.2. Sub-Saharan Africa: COVID-19 Policy Stringency Index by Quartiles of Internet Access**

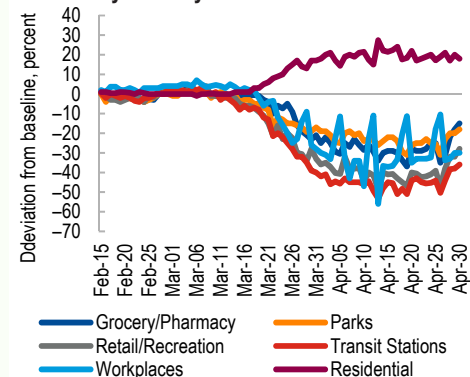
Source: Oxford COVID-19 Tracker.

Anti-epidemic robots in Rwanda are monitoring patients, delivering food and medication, and keeping medical records.

- *Digital tools are being used to raise public awareness and monitor lockdowns.* In Niger and South Africa, interactive WhatsApp- and Facebook based platforms provide local language automated responses to COVID-related questions. In Rwanda, drones fitted with megaphones are used to raise awareness and enforce lockdown measures and, in Botswana, people can request passes for domestic movements via an online platform. Countries are using mobile-based applications and location technology to monitor the effectiveness of lockdowns, revealing a sharp decrease in mobility in April 2020 (Figure 3.1.3).

**Many governments have actively turned to digital policy solutions to cushion the socio-economic impact of the pandemic, taking advantage of the region's leadership in mobile money.**

- *Central banks have relaxed regulations, while telecom operators have eased terms of service to encourage greater use of mobile money.* This aims to support retail transactions while limiting the spread of the COVID-19 virus through bank notes (Cameroon, Democratic Republic of Congo, Ghana, Kenya, Liberia, Mozambique, Rwanda, Uganda, Zambia, WAEMU). These measures include waiving fees for transactions below certain amounts (including transfers from bank accounts to electronic wallets and

**Figure 3.1.3. Sub-Saharan Africa: COVID-19 Community Mobility**

Source: Google LLC "Google COVID-19 Community Mobility Reports." Note: The baseline is the median value, for the corresponding day of the week, during the 5-week period Jan 3–Feb 6, 2020.

vice-versa), increasing the balance limits, and relaxing interoperability rules.

- *Countries are deploying and targeting social protection programs to vulnerable households and businesses through mobile money, electronic cash transfers, and virtual engagement* (Benin, Côte d'Ivoire, The Gambia, Lesotho, Madagascar, Namibia, Togo, Uganda, Zambia, Zimbabwe). Togo's "NOVISSI" cash transfer scheme uses mobile phone solutions to manage and target payments for the most vulnerable groups, mostly in the informal sector. Mobile money transfers are also being used to deliver emergency income support (Namibia) and benefits to people who have lost their jobs due to COVID-19 (Zambia). In Uganda, the "Girls Empowering Girls" urban social protection program for adolescent girls successfully transitioned to virtual mentoring. In Gabon and Senegal, the government will provide utility bills relief by digitally crediting the beneficiaries' accounts with utility companies.
- *Tax authorities in some countries are encouraging the use of e-tax services.* In Kenya, Namibia, and Nigeria, taxpayers have been encouraged to use existing online platforms for filling tax returns, making tax registrations, applying for tax refunds, and communicating with tax officers during the lockdown.

This box was prepared by Félix Simone, Martha Tesfaye Woldemichael, and Franck Ouattara.

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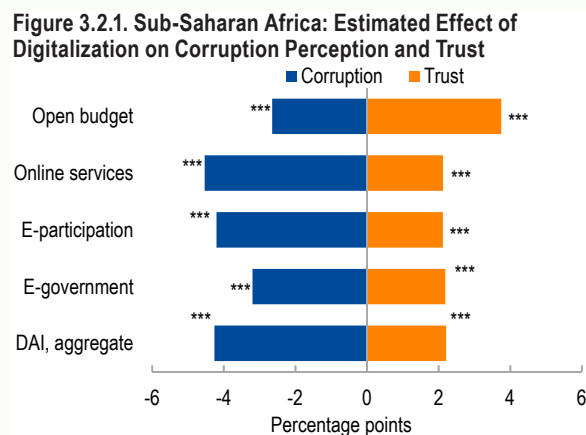
### Box 3.2. Digitalization, Corruption, and Trust in Africa

**Digitalization offers the opportunity to fight corruption more efficiently.** Several studies demonstrate that digitalization can improve prevention, detection, reporting, and prosecution of corruption (IMF 2018), notably by promoting transparency, accountability, and citizen participation. In this regard, countries in the region—Kenya, Tanzania, and Senegal—have adopted in recent years digital tax administration tools that reduce bureaucracy and help combat corruption of tax officials by reducing the opportunities for bribes.

**Digitalization can also enhance ties between the government and citizens, reinforcing trust in public officials.** Digitalization can help disseminate information in a cost-effective way, reducing search costs and moral hazard. The use of digital tools by governments (such as e-participation) facilitates advocacy and greater involvement by citizens in decision making, policy setting, problem solving and services design. This improves service quality, promotes

transparency, and helps enhance public trust in the government, which strengthens integrity and openness of the policy process to the participation of citizens (OECD 2018).

**Empirical analysis suggests that digital adoption is associated with lower corruption perceptions and improved trust in tax officials.** The study (Ouedraogo and Sy 2020) uses individual-level data (covering 23,000 individuals and 26 countries in sub-Saharan Africa) from the sixth wave of Afrobarometer surveys to analyze the impact of digitalization—proxied by several indicators including the World Bank’s Digital Adoption Index, Open Budget Index, and the United Nations’ E-government Index—on corruption.<sup>1</sup> The analysis finds that an increase in the index of digital adoption from the 25<sup>th</sup> percentile to the 75<sup>th</sup> percentile: (i) is associated with a decline in the perception of corruption of tax officials by up to 4.2 percentage points; and (ii) would boost trust in tax officials by around 2.5 percentage points (Figure 3.2.1).



Source: IMF staff calculations.

Note: Based on increase in digital adoption from 25th to 75th percentile. DAI = Digital Adoption Index. \*\*\*, \*\*, and \* indicate statistical significance at the 1, 5, and 10 percent level, respectively.

This box was prepared by Rasmane Ouedraogo.

<sup>1</sup> The analysis controls for characteristics such as the respondents’ socio-economic and demographic conditions and satisfaction with politicians, government performance in terms of public service delivery, and media availability. It also uses variations in the deployment of submarine cables at the subnational level as an exogenous instrument for digitalization.

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### Annex 3.1. Variables Used in the Enhanced Digital Access Index (EDAI)

Definition	Source
<b>Affordability</b>	
Fixed (wired)-broadband monthly subscription refers to the monthly charge for fixed (wired)-broadband internet service (i.e., any dedicated connection to the internet at speeds equal to, or greater than, 256 kbit/s) (% GNI per capita).	ICT
Mobile-cellular prepaid price of a short-message service (SMS) refers to the price of sending a message from a mobile-cellular telephone with a prepaid subscription to a mobile-cellular number of a competing network (% GNI per capita).	ICT
The price per minute of a peak rate call from a mobile cellular prepaid telephone to a mobile cellular subscriber of another (competing) network. Taxes should be included. If not included; it should be specified in a note including the applicable tax rate. (% GNI per capita).	ICT
Mobile-cellular prepaid connection charge is the initial, one-time charge for a new prepaid mobile-cellular subscription (but not refundable deposits); usually corresponds to the price of a subscriber identity module (SIM) card, but may include other fees (% GNI per capita).	ICT
Price of the plan, in local currency, mobile-broadband USB/dongle-based prepaid tariffs with 1GB volume of data (% GNI per capita).	ICT
<b>Infrastructure</b>	
Fixed-telephone subscriptions 100 inhabitants	ICT
Mobile-cellular subscriptions per 100 inhabitants	ICT
Percentage of population covered by mobile-cellular network refers to the percentage of inhabitants within range of a mobile-cellular signal, irrespective of whether or not they are subscribers or users. Calculated by dividing the number of inhabitants within range of a mobile-cellular signal by the total population and multiplying by 100.	ICT
Percentage of the population covered by at least a 3G mobile network refers to the percentage of inhabitants that are within range of at least a 3G mobile-cellular signal, irrespective of whether or not they are subscribers. Calculated by dividing the number of inhabitants covered by at least a 3G mobile-cellular signal by the total population and multiplying by 100.	ICT
Percentage of population covered by at least an LTE/WiMAX mobile network refers to the percentage of inhabitants that live within range of LTE/LTE-Advanced, mobile WiMAX/Wireless MAN or other more advanced mobile-cellular networks, irrespective of whether or not they are subscribers. Calculated by dividing the number of inhabitants covered by the mentioned mobile-cellular technologies by the total population and multiplying by 100.	ICT
<b>Internet Usage</b>	
Active mobile-broadband subscriptions per 100 inhabitants.	ICT
Fixed broadband subscribers divided by population and multiplied by 100.	ICT
Internet users (% population) can include both estimates and survey data corresponding to the proportion of individuals using the internet, based on national households surveys. The number should reflect the country's total population or at least individuals of 5 years and older.	ICT
<b>Knowledge</b>	
Adult literacy is measured as the percentage of people aged 15 years and above who can both read and write a short simple statement on their everyday life.	UNESCO (UIS)
Expected years of schooling is the total number of years of schooling that a child of a certain age can expect to receive, assuming the probability of his or her being in school at any particular age is equal to the current enrolment ratio age.	UNESCO (UIS)
Mean years of schooling provides the average number of years of education completed by a country's adult population (25 years and older), excluding years spent repeating grades.	UNESCO (UIS)
Gross enrolment ratio is measured as the total number of students enrolled at the primary, secondary and tertiary level, regardless of age, as a percentage of the population of school age for that level.	UNESCO (UIS)
<b>Quality</b>	
Fixed (wired)-broadband speed; in Mbit/s refers to the advertised maximum theoretical download speed; and not speeds; guaranteed to users associated with a fixed (wired)-broadband internet monthly subscription.	ICT
International Internet bandwidth per Internet user (bit/s).	ICT
Advertised maximum theoretical download speed; speeds not guaranteed to users associated with a 1GB USB/dongle-based postpaid plan.	ICT

Note: Variables were selected based on the following criterion: at least one observation for each variable is available during one of the previous three years leading up to the year for which the index is being calculated. When a given economy has more than one observation for a given variable, the latest data point is selected. The variable "Percentage of the population covered by at least an LTE/WiMAX mobile network" was dropped for 2010 as LTE/WiMAX was still an emerging technology. The indicators are aggregated using the Adjusted Mazziotta-Pareto Index (AMPI) methodology.



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