Advancing firm digitalization in Sub-Saharan Africa

Contribution from the International Trade Centre

Abstract

The sub-Saharan Africa (SSA) region has witnessed notable progress in business digitalization over the past decade, yet part of its potential remains untapped. This chapter uses the International Trade Centre's Enterprise Digital Transformation Index (e-DTI) to examine how companies in SSA can fully reap the benefits of digitalisation.

Using a novel dataset comprising over 7000 enterprises across 78 countries, this chapter stresses how both firm-level actions, as well as policies and interventions at the business environment and national levels, are critical to advance digital transformation among firms, and economies, in SSA.

First, the creation of a digital-supportive environment is critical as SSA's digital readiness lags behind other regions of the world. The lower level of digital readiness in the region results in lower digital transformation for firms, compared to those in the rest of the world. Digital skills, a key driver of firm digital transformation, are particularly deficient in SSA.

Enhancing firm competitiveness can also help overcome country-level barriers to digitalization. Exporters tend to be the top performers in their country. Exporting firms in SSA demonstrate higher digital adoption than non-exporters in the region, as analysis in this chapter shows. These firms benefit from better devices, greater awareness of digital trends, a higher likelihood of having a digital strategy as well as a more digitally skilled workforce.

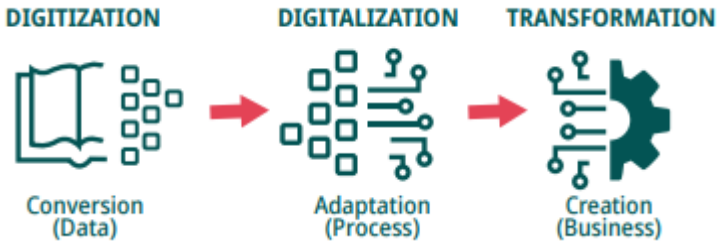
1. Introduction

In a world grappling with the aftermath of a global pandemic and the escalating climate crisis, enhancing business performance—especially among small firms—has become crucial for reigniting economic growth, improving living standards, and achieving the Sustainable Development Goals. This is particularly pertinent in Africa, where less than 6% of the 32 SDG targets are on track to be achieved by 2030.[1]

Digital technologies are pivotal to boosting firm productivity. They offer the potential to connect businesses to new markets, enhance efficiency, and drive innovation.[2] Despite significant efforts to leverage digital tools across African countries,[3] many businesses, especially smaller ones, continue to face obstacles in adopting and effectively using digital solutions.[4] This is a critical issue because greater efficiency and competitiveness gains come from digital deepening—moving beyond basic digital technology use to achieve comprehensive digital transformation.

Digital transformation represents the latest and most impactful wave of technological change. It involves two interrelated processes: digitization and digitalization.[5] Digitization entails converting analogue data and processes into a machine-readable format. It involves capturing information from a physical source, such as a customer order form, and storing it electronically in a computer system or database. Digitalization is a broader concept, referring to the use of digital technologies to enhance business processes. This results in new activities or changes to existing ones, such as when companies use customers' information to generate insights and target social media advertising to their tastes and buying patterns.[6]

Figure 1 Digitization, digitalisation and digital transformation



Source: *ILO, 2021.*[7]

[1] United Nations Development Programme, '2024 Africa Sustainable Development Report' (*UNDP*, 2024) <https://www.undp.org/africa/publications/2024-africa-sustainable-development-report> accessed 26 September 2024.

[2] Jieun Choi, Mark Dutz and Zainab Usman, *The Future of Work in Africa: Harnessing the Potential of Digital Technologies for All* (World Bank 2020) <https://openknowledge.worldbank.org/handle/10986/32124> accessed 25 October 2022.

[3] African Union (2020)

[4] ITC, 'SME Competitiveness in Francophone Africa 2022: Fostering Digital Transformation' (International Trade Centre 2022) <https://intracen.org/resources/publications/sme-competitiveness-in-francophone-africa-2022-fostering-digital> accessed 31 August 2023.

[5] Analysis and definitions from Accenture. See: IMF and others, 'Digital Trade for Development' (World Trade Organization 2023).https://www.accenture.com/us-en/insights/digital-transformation-index

[6] IMF and others, *Handbook on Measuring Digital Trade* (2023) <https://www.wto.org/english/res_e/booksp_e/digital_trade_2023_e.pdf> accessed 29 August 2023.

[7] International Labour Organization, 'Small Goes Digital' (2021) <https://www.ilo.org/publications/small-goes-digital> accessed 4 September 2024.

While digitization and digitalization can occur independently, digital transformation requires their concurrent implementation.[8] Whether firms can make advanced use of technologies and achieve digital transformation depends on several factors.

The sector in which a firm operates, for example, influences its technological needs and capabilities. Yet, the most critical factor is the presence and quality of digital enablers at the country level. These enablers include digital infrastructure, skills, and regulatory frameworks. When these are in place, countries become digitally ready, increasing their firms' capacity to adopt and effectively utilize digital technologies. However, small firms should not sit idle waiting for the environment to improve. They must take actions to enhance their competitiveness to – at least partially – make up for what the country lacks.

The remainder of the chapter is organized as follows. Section 2 introduces the International Trade Centre's Enterprise Digital Transformation Index (e-DTI) and demonstrates the intricate connection between country digital readiness and firm digital transformation. Section 3 focuses on SSA, showing that, despite the lower level of country digital readiness in the region, more competitive firms manage to digitally transform. This underscores the importance of firm-level competitiveness actions to partially make up for what the environment lacks. Lastly, Section 4 concludes with policy recommendations aimed at guiding stakeholders in establishing a digital framework for sustainable and inclusive growth in SSA.

2. Firms adopt digital technologies if countries are digitally ready

Digital transformation is redefining how we consume, produce, and interact with one another.[9] A wealth of literature confirms the positive and significant relationship between firm investment in digital technologies and productivity.[10]

But a firm's ability to integrate digital technologies depends on a multitude of factors. Externally, the business environment in which a firm operates crucially influences to what extent it has access to, and deploys, digital technologies. This section explores these external factors and proposes a novel index of firm-level digital transformation to demonstrate the intricate connection between country digital readiness and firm digital transformation

[8] Accenture, 'Digital Transformation' (2024) <https://www.accenture.com/us-en/insights/digital-transformation-index> accessed 30 May 2024.

[9] Klaus Schwab, 'The Fourth Industrial Revolution: What It Means and How to Respond' (*World Economic Forum*, 14 January 2016) <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/> accessed 16 May 2024.

[10] Martin Borowiecki and others, 'The Impact of Digitalisation on Productivity: Firm-Level Evidence from the Netherlands' (OECD Economics Department 2021) Working Paper 1680 <https://www.oecd.org/publications/the-impact-of-digitalisation-on-productivity-firm-level-evidence-from-the-netherlands-e800ee1d-en.htm> accessed 29 May 2024; Timothy DeStefano, Richard Kneller and Jonathan Timmis, 'Cloud Computing and Firm Growth' (University of Nottingham 2019) Research Paper 2019/09 <https://www.nottingham.ac.uk/gep/documents/papers/2019/2019-09.pdf> accessed 29 May 2024; Tomaso Duso and Alexander Schiersch, 'Let's Switch to the Cloud: Cloud Adoption and Its Effect on IT Investment and Productivity' (2022) CESifo Working Papers No. 9944 <https://papers.ssrn.com/abstract=4226411> accessed 29 May 2024; Peter Gal and others, 'Digitalisation and Productivity: In Search of the Holy Grail – Firm-Level Empirical Evidence from EU Countries' (OECD 2019) OECD Economics Department Working Papers No. 1533 <https://www.oecd-ilibrary.org/economics/digitalisation-and-productivity-in-search-of-the-holy-grail-firm-level-empirical-evidence-from-eu-countries_5080f4b6-en> accessed 29 May 2024.

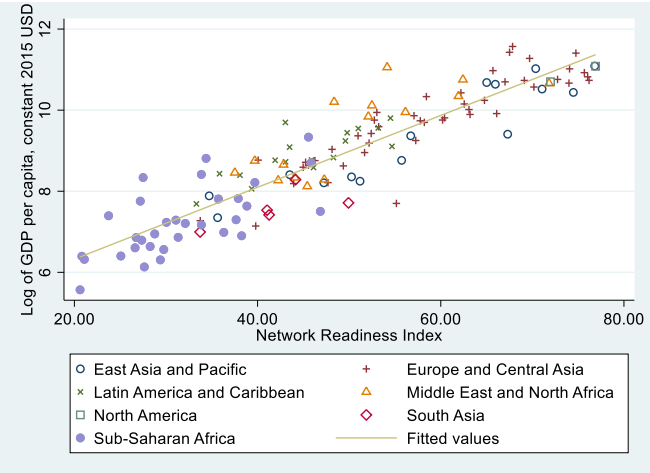
Digital readiness is uneven across countries and regions

One way to measure a country's digital readiness is to assess the extent to which certain digital enablers are present or functioning. The Network Readiness Index (NRI), developed by the Portulans Institute, provides an aggregate measure of a country's level of digital preparedness, as well as disaggregated indicators for the most fundamental dimensions of digital readiness at the country level: access (infrastructure), individuals (skills) and regulations.[11] 'Access' evaluates the technological infrastructure that a country needs to engage in the global economy. 'Individuals' captures the proficiency, inclusivity and adeptness of a nation's population and entities in using technological assets. 'Regulations' assesses whether there are the right structures in place to invigorate the networked economy and how far they reach.

Using the aggregate NRI, Figure 2 shows that countries in SSA exhibit comparatively low digital readiness, and are concentrated at the lower end of the NRI's distribution. On average, the NRI has a value of 32 in SSA, followed by South Asia with an average score of 42. In contrast, countries in North America and Europe and Central Asia exhibit higher average NRI scores of 74 and 59, respectively.

Country digital readiness is largely correlated with income, with a few exceptions, as shown in Box 1. As Figure 2 indicates, countries in the high-income bracket tend to display high digital readiness, while low-income countries exhibit lower readiness. This is not surprising, as a country's level of income partially determines its ability to invest in a digitally-supportive environment.[12]

Figure 2 Country digital readiness and income are related



***Source**: ITC, based on World Bank World Development Indicators and NRI from Portulans Institute.*

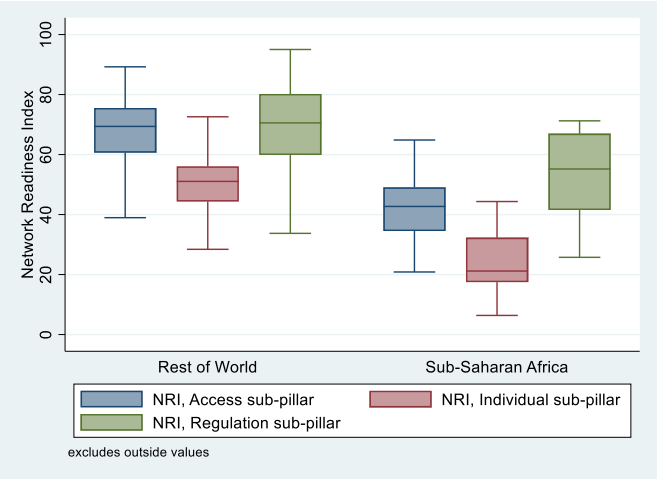
Divides between countries also exist within the individual sub-pillars of the NRI – Access, Individuals and Regulations. SSA displays lower scores than the rest of the world (RoW) in all three sub-pillars (Figure 3). The most significant disparity is observed in the Individuals sub-pillar, indicating that SSA falls behind other regions, particularly when it comes to the digital competency of its labour force.[13]

[11] Portulans Institute, 2023. https://networkreadinessindex.org/. NRI ranges between 0 and 100, with higher values denoting better outcomes. For additional information on the NRI, its pillar and sub-pillars see Appendix.

[12] Bhim Jyoti and Ajay Kumar Singh, 'Does Digitalization Have a Causal Relationship With Economic Development?: An Experience From a Country-Wise Panel Data Statistical Analysis', *Handbook of Research on Perspectives on Society and Technology Addiction* (IGI Global 2023) <https://www.igi-global.com/chapter/does-digitalization-have-a-causal-relationship-with-economic-development/www.igi-global.com/chapter/does-digitalization-have-a-causal-relationship-with-economic-development/325180> accessed 23 August 2024.

[13] The difference is statistically significant in regressions controlling for GDP per capita.

Figure 3 SSA lag in digital infrastructure, skills and regulation



***Source**: ITC, based on NRI from Portulans Institute.*

Engaging in digital deepening, and initiating the deployment of digital technologies in general, requires digital skills. Unless individuals have the skills required to take advantage of digital access, connectivity is meaningless.[14]

In SSA, the current landscape of digital skills reveals significant gaps when compared with other regions. In 2021, SSA countries scored between 1.8 and 5 on the Digital Skills Gap Index - below the global average of 6.[15] Despite this, the demand for digital skills in the labour market is high: according to the World Bank, around 87% of African business leaders say that digital skills development is a priority area in need of further investment.[16]

Box 1 - Digital transformation in Rwanda: a success story

Rwanda stands out as success story of digital transformation among low-income countries, defying the observed correlation between digital readiness and income level (Figure 1). The NRI score ranks Rwanda well above its income peers and as top performer in Africa, demonstrating how deliberate government action and innovation can drive digital transformation.

Recognizing ICT as crucial for growth, especially for a landlocked country with few natural resources, Rwanda has extensively invested in digital infrastructure and skills training over the past 20 years as part of its Vision 2020 strategy. These efforts aimed at shifting the economy from agrarian to knowledge-based, establishing Rwanda as a technological hub in Africa.

As of 2021, mobile phone penetration in Rwanda had reached 73%, more than double the share of 2011. The 4G network now covers 96% of the country, and international bandwidth access increased

[14] ITC, 'SME Competitiveness in Francophone Africa 2022' (n 4).
[15] Wiley, 'Global Rankings for Digital Skills | Wiley Gap Index' (*Wiley*, 2021) <https://dsgi.wiley.com/global-rankings/> accessed 22 August 2024.
[16] World Bank, 'Digital Skills to Accelerate Human Capital for Youth in Africa' (2023) <https://thedocs.worldbank.org/en/doc/3eb99d2c0a89888a7d1292898cce4651-0010012023/original/004-Digital-Skills-to-Accelerate-Human-Capital-for-Youth-in-Africa.pdf> accessed 22 August 2024.

tenfold between 2014 and 2019, driven by the Government's roll-out of a fibre-optic broadband network.

Rwanda's digital readiness stems from decades of government initiatives, public-private partnerships and investments across multiple sectors of the economy. From the deployment of the first National Information and Communication Infrastructure plan in 2000 to the current Smart Rwanda Master Plan and 2018-2024 ICT Sector Strategic Plan, the Government has strived to leverage ICT in all sectors of its economy.

Public-private partnerships have been key, especially in digital infrastructure. For example, a 2,300 km fibre-optic backbone was built with World Bank's support, and Korea Telecom facilitated the roll-out of 4G infrastructure, now covering over 95% of the country's territory.

With the digital infrastructure in place, the Government launched the e-portal *Irembo* in 2017, an online platform aimed at delivering government services to businesses and citizens. The portal currently hosts 96 government services across six government agencies.

As investments in digital infrastructure reach maturity, initiatives like Kigali Innovation City assert Rwanda's status as an ICT hub. The Government is now focusing on skills training and cyber security, adopting Africa's first national strategy for the responsible and inclusive use of AI.

Rwanda's experience underscores the importance of aligning national development goals with digital strategies, and ensuring that policies, public-private partnerships, and investments are consistently implemented and supported by the Government.

Sources: (CNBC Africa, 2024; GIZ, 2023; Government of Rwanda, n.d.; 2010; 2015; Harguth, 2022; Portulans Institute, 2023; Razavi, 2018; UNDP, 2024).

Country digital readiness shapes firm-level digital transformation

What does country digital readiness imply for firm-level digital transformation? To understand to what extent firms adopt digital technologies, ITC conducted a Digital Transformation Survey across 78 countries, between May 2022 and March 2024.[17] The survey includes over 7000 companies, across all sectors and firm-size categories (listed in Table A1 of the Appendix).

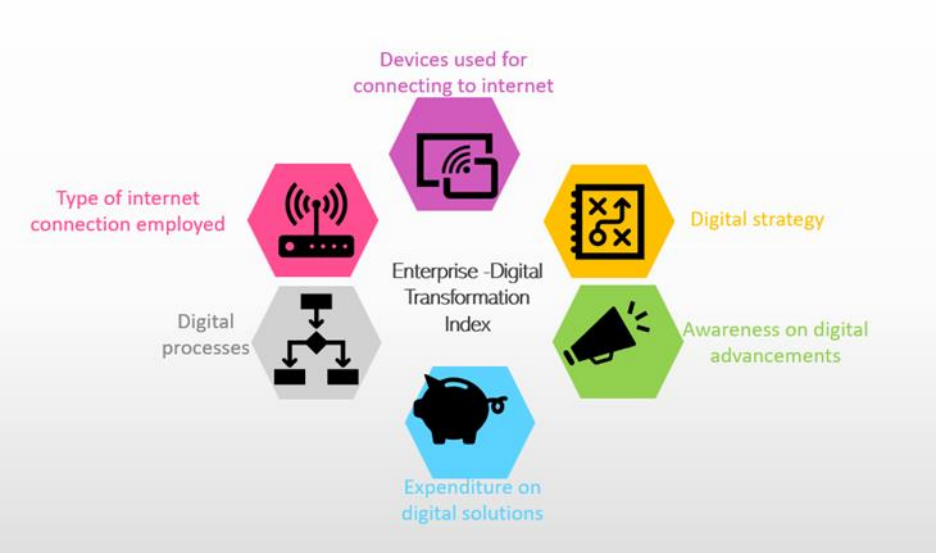
Based on firms' responses, ITC developed an index of firm-level digital transformation, the Enterprise Digital Transformation Index (e-DTI). The score ranges from 0 to 100, with higher values indicating that firms are further ahead in their digital transformation path.[18]

To build the e-DTI, six variables from the ITC Digital Transformation Survey were selected through confirmatory factor analysis (see the Appendix for further details). These variables include the type of devices and internet connection used, uses of digital technologies, level of expenditure on digital tools, management awareness of digital advancements and existence of a firm digital strategy (Figure 4).

[17] The data collection occurred in two rounds. The first round took place in Francophone Africa from May to August 2022. The second round was conducted globally from July 2023 to March 2024.

[18] The e-DTI is constructed for the subset of firms that use digital technologies for business operations and for whom full and comparable data are available. This results in a sample of 4651 firms across 67 countries, varying in size and sector.

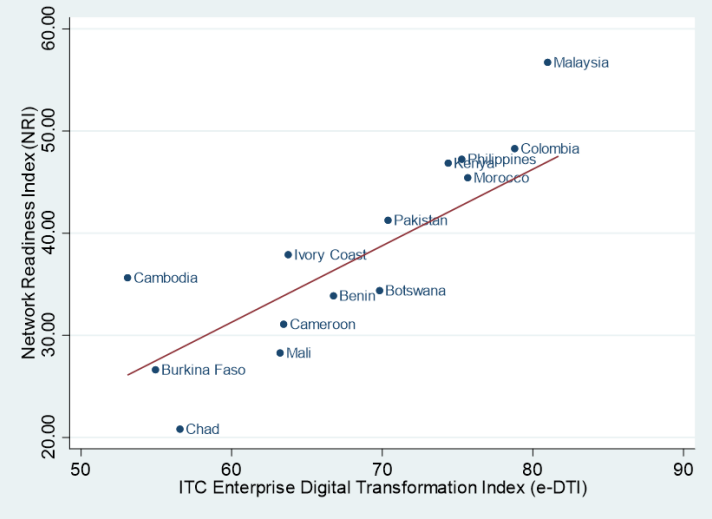
Figure 4 ITC Enterprise Digital Transformation Index



Source: *ITC*

Figure 5 shows the correlation between the NRI and the ITC e-DTI and illustrates that companies operating in more digitally ready countries, as per the NRI, exhibit higher levels of digital adoption, as per the e-DTI. Simply put, the higher the country's digital readiness, the higher the average firms' level of digital adoption.

Figure 5 Country digital readiness essential for firm digital transformation



Notes*: The vertical axis measures the Network Readiness Index at the country level. The horizontal axis measures the ITC Enterprise Digital Transformation Index at the firm level. Values range from 0-100, with higher scores denoting better performance in the respective indices. This figure includes only countries with more than 20 firms with e-DTI.*

Source*: ITC, based on NRI for Portulans Institute and ITC Digital Transformation Survey.*

Digital transformation lags among companies in Sub-Saharan Africa

African enterprises lag in digital technologies use. [19] Previous research has shown that most African companies are still using largely nondigital technologies for most business functions, with the biggest gap in technological sophistication across countries observed in the agricultural sector. [20]

Findings from the ITC Digital Transformation Survey confirm this trend, revealing that companies in SSA have a lower e-DTI compared to other regions. Analysing the various components of the e-DTI provides key insights into the main factors driving the digital transformation gap between companies in SSA and those in other regions (Table 1).

Firstly, connectivity remains a challenge in SSA. The majority (55%) of companies in the region report accessing the internet through mobile-broadband or public connections, such as internet cafés and libraries, while only a third of firms (36%) surveyed in the RoW do so (Table 1). In contrast, only 45% of firms in SSA report connecting through fixed-broadband, compared with 65% of firms in the RoW.[21]

The preference for mobile-broadband over fixed-broadband connections among SSA companies largely relates to the relatively higher cost of fixed-broadband services in the region. While fixed-broadband penetration has continuously increased in recent years in urban areas, subscription charges are still higher than in middle-income countries.[22] In SSA, monthly subscriptions were more than twice as costly as those in North Africa in 2019.[23]

While mobile-broadband is more affordable than fixed-broadband, the region also has the highest price relative to income for mobile broadband services.[24] In 2023, for example, more than half of SSA countries had yet to meet the UN Broadband Commission's target of 1GB at less than 2% of average monthly income.[25] ITC's survey results also reveal that more than two-thirds (69%) of firms in SSA report high cost of internet services, compared to 53% of firms in non-SSA countries. Increasing connectivity and making it affordable require measures from several stakeholders - as discussed in Box 2 - and the integration of digital priorities in national development strategies (as highlighted in the case of Rwanda in Box 1).

Box 2 - Policies for more affordable broadband

The cost of internet connection is high in Africa with respect to average income, rendering it unaffordable for many individuals and businesses. Yet recent developments in digital infrastructure, as well as innovative policies and initiatives, have allowed network operators in Africa to reduce costs

[19] Begazo, Tania, Moussa P. Blimpo, and Mark A. Dutz., 'Digital Africa: Technological Transformation for Jobs' (World Bank 2023) <978-1-4648-1737-3>..

[20] ibid. The study found that the average African enterprise with five or more full-time employees in Ghana, Kenya, Malawi, and Senegal lags in the use of computers relative to Brazil and in the use of smartphones for most enterprise size groupings.

[21] Companies were asked "What is the main type of internet connections your company uses?" The response options, which are mutually exclusive, included: fixed broadband subscriptions, mobile broadband subscriptions, public WiFi.

[22] Broadband Commission, 'Connecting Africa Through Broadband : A Strategy for Doubling Connectivity by 2021 and Reaching Universal Access by 2030' (2019) <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/131521594177485720/Connecting-Africa-Through-Broadband-A-Strategy-for-Doubling-Connectivity-by-2021-and-Reaching-Universal-Access-by-2030> accessed 8 August 2023.

[23] ibid.

[24] ITU, 'The Affordability of ICT Services 2023' (2024).

[25] GSMA, 'The State of Mobile Internet Connectivity 2023 Sub-Saharan Africa Key Trends' (2023) <https://www.gsma.com/r/wp-content/uploads/2023/10/State-of-Mobile-Internet-Connectivity-2023-Sub-Saharan-Africa.pdf>.

significantly, resulting in cheaper internet connectivity. The most successful examples exploit new technologies and business models, bring together public and private sectors, and align regulation with policy objectives.

Infrastructure sharing

Infrastructure sharing involves multiple operators pooling resources and collaboration on the deployment and maintenance of physical infrastructure components, such as towers, fibre optic cables and data centres. The benefit of this model is that operators can spread the expenses related to infrastructure among multiple stakeholders. This, in turn, allows operators to extend network coverage to previously unconnected areas – without incurring prohibitive expenses.

In Nigeria, tower sharing agreements have become increasingly popular as a cost-effective means to expand mobile network coverage. Thousands of shared towers have been positioned across the country by companies such as IHS Nigeria Limited, enabling multiple mobile operators to co-locate their equipment. This model has improved network coverage and quality of service, particularly in rural and underserved areas.

Public-Private Partnerships

Public-private partnerships hold significant potential to bridge the substantial investment gap required for infrastructure projects. This joint effort reduces the risks to private operators in financing and constructing telecoms infrastructure, while also freeing up government resources to achieve other pressing policy objectives.

For example, the Ghana Investment Fund for Electronic Communications, an agency of the Ministry of Communications and Digitalisation of Ghana, partnered with Ascend Digital Solutions, a private company, to build shared 4G-enabled networks in rural areas. Thanks to this collaborative model, around 1.1 million subscribers had connected to the shared network as of June 2023.

Greater competition in the telecoms market

Improving competition at various stages of the broadband value chain can have a significant impact on broadband price. Regulatory reforms may seek to increase competition between facility operators (tower companies and wholesale broadband operators); reduce barriers to entry for global digital platforms (for example Whatsapp); boost foreign participation in fixed broadband markets and foster competition in international gateways, leased lines and mandated infrastructure sharing.

For example, the Comoros increased competition by issuing a second telecom operating license in 2015, ending the state-owned telecom monopoly. This was associated with significant price drops for broadband—from 76% of Gross National Income per capita in 2014, before entry of the second operator, to 33% in 2019, four years after entry, for fixed broadband, and from 31% to 9% of Gross National Income per capita over the same period, for mobile broadband.

Source: (GSMA, 2023a; 2023b; ITU, 2022; 2024a; Telecom Review Africa, 2024; World Bank, 2024; World Bank Group, 2018).

The adoption of digital technologies in a firm is as dependent on affordable, high-quality internet access as it is on access to affordable and high-quality internet-enabled devices. ITC survey data

reveals that in SSA, most companies use smartphones (79%) in their operations, almost equivalent to the proportion in the RoW (83%) (Table 1 Access and use digital technologies lower in SSA). Comparing the share of firms using PCs, however, reveals a greater disparity: only 32% of SSA firms report using PCs, compared to almost double (61%) in the RoW. The limited use of PC among SSA companies can have implications on their growth perspectives. While a basic, inexpensive smartphone may be sufficient for starting a business, it often lacks the computational power and memory to support a business effectively as it grows.

As in the case of internet services, digital equipment and software cost more in SSA than in other regions.[26] According to a 2023 analysis, for example, digital and analog machinery and equipment are 13-15% more expensive in SSA, in absolute terms, than in the United States.[27] This helps explain the present analysis' finding that SSA firms tend to spend a higher proportion of total expenditure on digital solutions, compared with RoW firms (Table 1), and still reach lower levels of digital transformation.

The high cost of digital technologies in the region does not necessarily impede digitalization, but it does constrain firms from engaging in more sophisticated activities with digital technologies. ITC data shows that the share of firms using digital technologies for advanced purposes is significantly lower in SSA, compared to the RoW. For example, only 13% access government services electronically versus 41% in the RoW, 25% make digital payments against 54% in the RoW, and 25% use cloud-based data storage, compared to 40% in the RoW (Table 1).

This more basic use of digital technologies among SSA companies is concerning, as greater efficiency and competitiveness gains come with the use of more advanced digital tools. ITC survey in Francophone Africa, for example, reveals that companies using intermediate or advanced digital technologies – such as cloud-based data storage, digital accounting or computerized inventory management – are twice as likely to report improved production efficiency than firms that only used e-mail or social media. They are also 40 percentage points more likely to reduce operating costs, thereby highlighting the benefits of deeper digitalization.[28]

Firms in SSA are also 13 percentage points less likely than those in other regions to have a digital strategy, which hampers their digital economic potential (Table 1).

[26] World Bank, 'Digital Opportunities in African Businesses' (World Bank 2024).
[27] ibid.
[28] ITC, 'SME Competitiveness in Francophone Africa 2022' (n 4).

Table 1 Access and use digital technologies lower in SSA

		Total	SSA	RoW
Devices used to connect:				
	PCs	43%	32%	61%
	Tablet	54%	60%	44%
	Smartphones	80%	79%	83%
Type of internet connection:				
	Fixed-broadband subscriptions	52%	45%	65%
	Mobile-broadband subscriptions	39%	43%	32%
	Public WiFi (i.e., internet's café, library)	9%	12%	4%
Use of digital technologies:				
Advanced	Sell on e-commerce platforms or social marketplaces	27%	27%	26%
	Store data on the cloud	31%	25%	40%
	Make digital payments and finance	36%	25%	54%
	Access government services provided electronically	24%	13%	41%
Intermediate	Research new ideas for products or services	50%	40%	55%
	Do accounting, keep financial records and manage inventory	37%	32%	45%
	Track and analyse customer information	47%	30%	55%
	Create and maintain company website	30%	25%	39%
Basic	Communicate with customers/suppliers through email	72%	71%	75%
	Telework or communicate with staff	33%	25%	48%
	Advertise on social media	61%	60%	63%
Firm's expenditure on digital solutions:				
	More than 50%	6%	7%	5%
	Between 25% and 50%	25%	30%	19%
	Less than 25%	62%	61%	64%
	0%	6%	3%	12%
Manager stays up to date on new developments in digital technology				
	Yes, always	52%	51%	54%
	Sometimes	39%	42%	35%
	No, never	8%	7%	11%
Company has digital strategy				
	Yes	67%	62%	75%

***Source**: ITC Digital Transformation Survey.*

3. Competitive firms are better able to leverage digital technologies

While a weak enabling environment hinders firms' digital adoption in the SSA region, certain firms in the region are nevertheless able to digitalize to a considerable extent.[29] More competitive firms are better able to compensate for the lack of enablers in their surroundings.

Exporters lead in digital transformation

Firm performance varies widely within each country.[30] Companies differ greatly in terms of size, cost structure, profitability, and productivity. A major observation supported by extensive literature is that,

[29] The analysis of this section is focusing only on firms in SSA. The sample is composed of 4,791 companies in 31 SSA countries.
[30] Eric J Bartelsman and Mark Doms, 'Understanding Productivity: Lessons from Longitudinal Microdata' (2000) 38 Journal of Economic Literature 569; Chad Syverson, 'What Determines Productivity?' (2011) 49 Journal of Economic Literature 326.

once firms become sufficiently productive to cover the high costs of entering foreign markets, they start exporting.[31]

Exporters are therefore used in this section as a proxy for more competitive firms, in line with previous literature.[32] To study the degree of digital transformation of these more competitive firms, the following estimation is used on the sample of firms located in SSA:

$$y_i = \beta_0 + \beta_1 Exporter_i + \beta_4 NRI_c + \sum \gamma_{IND} \delta_i^{IND} + \sum \gamma_{SIZE} \delta_i^{SIZE} + \varepsilon_i \quad (1)$$

For firm i, y_i is the outcome variable, the enterprise Digital Transformation Index (e-DTI) or the individual sub-pillars of the index. $Exporter_i$ is an indicator that the firm exports internationally. Industry and size fixed effects are controlled for, shown as $\delta_i^{IND}, \delta_i^{SIZE}$ respectively, as is the level of digital readiness of a country, using the Portulans Institute's Network Readiness Index from 2023, shown as NRI_c.

Table 2 presents the results of the analysis. In column 1, the coefficients firstly indicate that exporters score on average 12.53 points higher in the e-DTI than non-exporters in the region, revealing deeper digitalization among exporting firms compared with their non-exporting counterparts.[33] Specifically, a representative non-exporter has an e-DTI score of 62. If the same firm were to export, it would have a score of 75.

Columns 2 through 7 of Table 2 present the variables composing the e-DTI and provide key insights into the factors driving the digital disparity observed between exporters and non-exporters in SSA. While all coefficients are positive and statistically significant, certain variables exhibit a greater magnitude than others, indicating relevance in explaining differences in digital adoption.

Firstly, exporting firms are more likely than non-exporters to deploy more advanced devices to connect to the internet, by 10.67 percentage points (column 2). This is in large part because exporting firms tend to have a great level of resources available to invest in digital technologies and are better able to spread the costs of these technologies by using them efficiently.[34] Other research has also shown that exporters also have the capabilities to exploit more advanced digital technologies, which non-exporting counterparts often lack.[35]

Second, managers in exporting companies are 14.62 percentage points more likely than those in non-exporting firms to be up to date with new developments in digital technologies that could be relevant for their business (column 6). Indeed, the literature confirms that exposure to globally competitive companies allows firms to benefit from knowledge and technology spillovers, which they can, in turn,

[31] Marc J Melitz, 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity' (2003) 71 Econometrica 1695.

[32] Justine Falciola and others, 'Identifying the Drivers of SME Resilience: Evidence From Developing Countries During the COVID-19 Pandemic'; Areti Gkypali, James H Love and Stephen Roper, 'Export Status and SME Productivity: Learning-to-Export versus Learning-by-Exporting' (2021) 128 Journal of Business Research 486; Mahmut Yasar, Carl H Nelson and Roderick Rejesus, 'Productivity and Exporting Status of Manufacturing Firms: Evidence from Quantile Regressions' (2006) 142 Review of World Economics 675.

[33] Firm size and NRI controls are statistically significant and of the expected sign, as shown in Table 2.

[34] OECD, *OECD Economic Surveys: New Zealand 2022* (OECD 2022) <https://www.oecd-ilibrary.org/economics/oecd-economic-surveys-new-zealand-2022_a4fd214c-en> accessed 23 August 2024.

[35] ibid.

incorporate in their own value chains.[36] Studies have also indicated that exporting firms often assign higher importance to technology than non-exporting firms, which contributes to a higher commitment to technology adoption.[37]

Exporters in SSA are also more likely to have a digital strategy in place. Specifically, exporters have a substantially higher propensity than non-exporters to have a clear digital strategy detailing priorities to invest in digital technologies and skills, with a difference of 19.10 percentage points (column 7). This is not surprising as exporting firms tend to be more aware that they can capitalize on digital technologies, which present them with numerous opportunities to extend their reach, connect with stakeholders and streamline operations[38]. This, in turn, encourages a more proactive and organized approach to digital transformation, compared with firms less aware of and less able to capitalize on the potential dividends from adopting digital technologies.

[36] Arkady Trachuk and others, 'Knowledge Spillover Effects: Impact of Export Learning Effects on Companies' Innovative Activities', *Current Issues in Knowledge Management* (IntechOpen 2019) <https://www.intechopen.com/chapters/67384> accessed 23 August 2024.

[37] Ramiro Albrieu and others, 'The Adoption of Digital Technologies in Developing Countries: Insights from Firmlevel Surveys in Argentina and Brazil' [2020] Industria;Tecnología <https://www.researchgate.net/publication/339912060_THE_ADOPTION_OF_DIGITAL_TECHNOLOGIES_IN_DEVELOPING_COUNTRIES_INSIGHTS_FROM_FIRM-_LEVEL_SURVEYS_IN_The_adoption_of_digital_technologies_in_developing_countries_Insights_from_firm-level_surveys_in_Argen>; Dianne Tipping, 'Australian Exporters: Gaining a Competitive Advantage through Digital Trade Innovation' <https://www.dfat.gov.au/about-us/publications/trade-and-investment/business-envoy-april-2021-digital-trade-edition/australian-exporters-gaining-competitive-advantage-through-digital-trade-innovation>; Dimitris Gavalas, Theodoros Syriopoulos and Efthimios Roumpis, 'Digital Adoption and Efficiency in the Maritime Industry' (2022) 7 Journal of Shipping and Trade 11; Mercedes Teruel and others, 'The Birth of New HGEs: Internationalization through New Digital Technologies' (2022) 47 The Journal of Technology Transfer 804; Xavier Cirera and others, 'Understanding Firm-Level Adoption of Technology in Ethiopia'.

[38] Amoin Bernadine N'Dri and Zhan Su, 'Successful Configurations of Technology–Organization–Environment Factors in Digital Transformation: Evidence from Exporting Small and Medium-Sized Enterprises in the Manufacturing Industry' [2024] Information & Management 104030.

Table 2 Enterprise Digital Transformation Index higher for exporters

VARIABLES	(1) Enterprise Digital Transformation Index (e-DTI)	(2) Devices used for connecting to internet	(3) Type of internet connection employed	(4) Digital processes	(5) Expenditure on digital solutions	(6) Awareness on digital advancements	(7) Has digital strategy
Exporter	12.53***	10.67***	7.743***	7.108***	4.948***	14.62***	19.10***
	(1.278)	(1.417)	(1.726)	(1.704)	(1.481)	(1.774)	(2.738)
Micro	-8.787***	-8.826***	-14.26***	-13.83***	-4.307***	-7.937***	-2.745
	(1.232)	(1.249)	(1.547)	(1.609)	(1.273)	(1.669)	(2.656)
Sector= Manufacturing	0.724	0.433	3.865	6.996*	-2.266	-3.543	4.739
	(3.061)	(3.234)	(3.353)	(3.961)	(3.058)	(4.063)	(6.740)
Sector = Services	5.286**	1.191	8.569***	5.270	-0.650	4.380	11.90**
	(2.689)	(2.897)	(2.940)	(3.592)	(2.799)	(3.562)	(6.061)
Women-led	-0.704	2.206	-4.402***	-0.209	-0.0669	-2.603	1.037
	(1.436)	(1.543)	(1.664)	(1.854)	(1.468)	(1.951)	(2.940)
Youth-led	0.760	-3.261**	-2.560	2.973	-2.107	2.424	1.486
	(1.398)	(1.479)	(1.671)	(1.821)	(1.405)	(1.838)	(2.959)
NRI	0.756***	1.098***	0.986***	0.528***	-0.313**	0.929***	1.295***
	(0.124)	(0.133)	(0.151)	(0.162)	(0.131)	(0.168)	(0.264)
Constant	35.40***	31.94***	37.14***	55.01***	57.88***	37.86***	7.416
	(4.717)	(5.123)	(5.587)	(6.461)	(5.050)	(6.337)	(10.23)
Observations	1,177	1,607	1,582	1,541	1,392	1,539	1,407
R-squared	0.150	0.131	0.109	0.074	0.028	0.084	0.054

Source: ITC Digital Transformation Survey
*Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*

Exporters have better skills

Skills are a requirement for firms to fully realize the gains of digital transformation. Without the necessary skills to capitalize on digital access, connectivity remains ineffective. However, as section 2 shows, digital skills are deficient in SSA, as indicated by the lower scores in the NRI Individuals sub-pillar. This highlights the critical need for improved digital competency in the region's labour force. Therefore, providing support to SSA firms to identify and retain digital talent is a priority.

ITC analysis reveals that exporting firms have a better digitally skilled workforce (Table 3). As column 1 shows, exporters in SSA are more likely than non-exporters to report a good match between the digital skills of their employees with the needs of their business, by almost 16 percentage points. This is in large part because exporters tend to have a greater level of resources than those that are not engaged in international trade to pay for digital talent.[39]

Yet columns 2 and 3 reveal additional channels explaining this finding. As column 2 shows, exporters are almost 20 percentage points more likely than non-exporters to assess digital skills in their recruitment processes compared to non-exporters. Similarly, exporters have a 14 percentage points higher likelihood of training employees to improve their digital skills vis-à-vis non-exporters (Table 3, column 3).

Table 3 Exporters have better skill match than non-exporters

VARIABLES	(1) Good digital skill match	(2) Do you assess digital skills in your recruitment process?	(3) Do you train your employees to improve their digital skills?
Exporter	0.159***	0.194***	0.142***
	(0.0227)	(0.0282)	(0.0289)
Micro	-0.103***	-0.0831***	-0.0217
	(0.0233)	(0.0262)	(0.0264)
Sector= Manufacturing	-0.105*	-0.129**	-0.0121
	(0.0561)	(0.0630)	(0.0650)
Sector = Services	0.0282	-0.0217	0.0849
	(0.0488)	(0.0558)	(0.0578)
Women-led	-0.00732	-0.00834	-0.00553
	(0.0269)	(0.0298)	(0.0301)
Youth-led	0.0535**	0.00785	-0.0565*
	(0.0254)	(0.0297)	(0.0301)
NRI	0.00933***	0.00322	0.0158***
	(0.00230)	(0.00269)	(0.00265)
Constant	0.438***	0.504***	-0.000797
	(0.0877)	(0.102)	(0.102)
Observations	1,465	1,485	1,469
R-squared	0.065	0.046	0.047

Source: ITC Digital Transformation Survey
*Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*

[39] Tien Dung Luu, 'Digital Transformation and Export Performance: A Process Mechanism of Firm Digital Capabilities' (2023) 29 Business Process Management Journal 1436.

Other research indeed demonstrates that strong human resource management practices, including robust recruitment processes and on-the-job training, can play an important role in ensuring firms have adequately skilled workforces, fit for their business' needs.[40]

Research in SSA also shows that improving the digital skills assessment capabilities of hiring managers as well as leveraging either in-house or externally-secured training can fill gaps in employees' digital skills.[41] This is particularly important as the demand for digital skills grows and the need for more advanced and specialized digital skills expands in the region.[42]

Given the importance digital skills play for digital transformation, it is essential to lower the barriers small businesses typically face. Box 3 highlights the importance for small African businesses to have access to and awareness of digital services providers. Creating platforms and networks for collaboration and cooperation can accelerate the adoption of digital skills and technologies.

Box 3: Supporting small businesses' digital transformation

Lack of digital skills in the workforce, constrained resources to invest in digital solutions and unsupportive digital infrastructure stymie the digital transformation of the many SMEs. Alone, they cannot overcome these challenges. A system of support, beyond the government, is needed to foster their digital transformation. Small businesses that provide digital services and innovations, as well as larger, more established companies, can play a key role in providing this support.

First, small businesses can offer a selection of digital services across a firm's value chain. Take ChapChap, a fintech from Uganda that enables SMEs in the country to manage cash flow, make or receive digital payments and improve record-keeping, through mobile-based solutions. Despite low digital literacy and the reticence of some business-owners to abandon cash in Uganda, ChapChap's services have helped them understand, and capitalize on, the value of digital solutions. Currently, ChapChap serves 43,000 MSME business owners, in an ever-growing network.

Similarly, in Ethiopia, Lersha is a digital platform through which smallholder farmers can purchase farming inputs, hire mechanization services, receive agro-climate advisory and fertilizer recommendations, acquire financial services, and more. To overcome limitations arising from low levels of digital skills, as well as hesitancy among farmers, Lersha employs digitally skilled youth – 'Lersha Agents' – to create digital profiles for their farmers so they can access the platform's services, and start seeing the benefits.

Large companies can also build the capacity of small businesses to deploy and effectively use digital technologies. Since 2013, for example, Microsoft's 4Afrika initiative has worked alongside local governments, partners, start-ups, SMEs and youth to provide affordable internet access, boost digital skills training to address the shortage of talented IT employees, and help private and public organizations invest in technology solutions. In the four years after the initiative was launched,

[40] Ian Stone, 'Upgrading Workforce Skills in Small Businesses: Reviewing International Policy and Experience' (2012).
[41] International Finance Corporation (IFC), 'Digital Skills in Sub-Saharan Africa: Spotlight on Ghana' (IFC 2019).
[42] Choi, Dutz and Usman (n 2); Jonas Hjort and Jonas Poulsen, 'The Arrival of Fast Internet and Employment in Africa' (2019) 109 American Economic Review 1032.

Microsoft 4Afrika had trained 775,000 Africans through the Microsoft Virtual Academy, brought over 500,000 SMEs online and helped 17,000 grow their businesses on Biz4Afrika.

In the same vein, in 2021, Google announced it would invest $1billion in Africa over the next five years to support a range of initiatives to help boost Africa's digital transformation. As of 2023, it has provided support to over one million businesses in the region, through the Hustle Academy and Google Business Profiles, and has helped numerous job-seekers learn and develop skills through Developer Scholarships and Career Certifications.

Engaging digitally advanced companies, both small and large, can have a profound impact in accelerating small businesses' efforts to digitalize. For this to occur, however, increasing the awareness of small African businesses regarding these services and creating platforms and networks for them to collaborate and cooperate will be essential.

Source: (ChapChap, 2023; Gajria, 2022; Karikkandathil, 2017; Lersha, n.d.; TechAfrica News, 2024; World Bank, 2024b).

4. Policy Implications: Advancing firm digitalization in Sub-Saharan Africa

This chapter demonstrates that firm digital transformation is lower in countries that do not provide a conducive environment for businesses. This means that, to really move the needle on digital transformation, interventions at the macro level are needed. This is the first order of business. Digital infrastructure, digitally competent populations and supportive regulatory frameworks are the key elements needed to lay the foundation for a digital economy.

The analysis in this chapter shows that the lag in the uptake of digital technologies among SSA firms is largely due to costly 'basics', including internet services and devices. No entity alone has the means to close this **digital infrastructure** gap. Investments must come from public sources such as national budgets, the private sector, through public-private partnerships, and external sources, including foreign direct investment and concessional development financing. The Aid for Trade initiative, for example, supports developing countries, especially Least Developed Countries, in building infrastructure and productive capacity to integrate in global trade, with a growing focus on digitalisation.

Increasing, first and foremost, the coverage and quality of electricity connections is vital to provide a groundwork for internet infrastructure. Once this is in place, initiatives and policies that aim to increase access, affordability and quality of internet services (see Box 2) and internet-enabled devices will be needed to ensure equitable access to the internet and digital devices for all.

For example, stakeholders can influence affordability of devices through targeted fiscal and non-fiscal incentives. Governments, for instance, can facilitate access by lowering or eliminating duties on telecommunication and ICT equipment, as called for in the WTO Information Technology Agreement (ITA). Along with import duties, taxes can represent 30 to 40 percent of total device cost, according to the World Bank.[43] Several countries have implemented tax exemptions to make digital devices more

[43] Ramin Amin and Doyle Gallegos, 'Affordable Devices for All Innovative Financing Solutions and Policy Options to Bridge Global Digital Divides' (World Bank Group 2023) <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099080723143031193/P1737510ac79240b90aaa10618d282c1780> accessed 29 May 2024.

affordable. In 2022, the Government of Chad for example introduced a 5-year tax exemption on the import of electronic devices, aiming to increase affordability and adoption of digital technologies.

Digital skills are a requirement for firms to fully realize the gains of digital technology application. As this chapter shows, digital skills are the most critical constraint for digital adoption among SSA firms.

As highlighted in Box 3, both small and large companies play a crucial role to play in fostering digital skills and promoting the use of digital technologies among small African businesses. Granting financial support for businesses to offer digital skills training to workers will also allow businesses to develop the digitally competent workforces they need for digital transformation.[44] Online resources, such as the Skills Academy, launched by MTN, Africa's largest mobile network operator in 2023, are valuable, cost-effective tools that can facilitate access to digital skills training, among others.[45] At the educational level, improving IT preparedness within schools and integrating digital skills learning within educational curricula is fundamental to equip future workers with the latest skills required in the digital age.[46]

Finally, **regulation**, too much or too little, can impact to what degree firms and countries are able to digitalize. Updating a country's policy and regulatory toolkit for the digital age requires adopting a whole-of-society approach. Regulatory reforms that increase access to digital technologies and foster cross-border technology diffusion can be instrumental to boosting digital technology adoption across firms in the region.[47]

But small businesses must have a voice in crafting digital economy regulations, with business support organizations and agencies such as the International Trade Centre playing a critical advocacy role. Regulations can help business succeed, but they can also create costs, which SMEs can feel more keenly than larger firms.

Different approaches and ad hoc responses jeopardize the interconnected nature of the digital economy. Strengthening multilateralism and related governance structures**,** while ensuring the participation of all countries, prevents the kind of fragmentation, with conflicting standards and methods, that is so damaging to small businesses.

While a multitude of stakeholders work to improve the business environment and put in place the enablers of digital transformation, companies do not sit idle. They can and must **take actions** to make up – at least partially – for what the environment lacks. This chapter shows that competitive firms in SSA, as proxied by their export status, are able to digitalize to a higher degree. Hence, SMEs need to strengthen their competitiveness.

ITC's competitiveness framework helps understand the determinants of firm competitiveness. The framework is built around three pillars – compete, connect and change. In order to compete in the day-to-day, firms need to deliver output of appropriate quantity, quality and cost. To connect with its business environment, a company needs to be able to exploit information to underpin strategy and

[44] International Finance Corporation (IFC) (n 41).
[45] MTN, 'MTN Skills Academy' (2023) <https://skillsacademy.mtn.com/about> accessed 30 May 2024.
[46] World Bank (n 16).
[47] African Union Commission and OECD, 'Africa's Development Dynamics 2021: Digital Transformation for Quality Jobs' (OECD 2021) <https://www.oecd-ilibrary.org/development/africa-s-development-dynamics-2021_34fe3890-en> accessed 19 August 2024.

operations. And to be able to change in response to, or in anticipation of, dynamic market forces, companies need to be able to mobilize financial resources, capital and skills and invest them in innovation.[48]

Investing in fundamental aspects of firms' competitiveness can yield dividends for digital transformation. For example, analysis in this chapter shows that assessing digital skills during the recruitment process and training employees to improve their digital capabilities can help businesses build a more skilled workforce, which, in turn, can boost digital adoption.[49]

The odds may be stacked against firms when operating in less-than-ideal conditions, but competitiveness may help them succeed nonetheless. This chapter has shown that Sub-Saharan African firms can and must act when the business ecosystem is not supportive. Simultaneously, continuous investment in the critical enablers is imperative to advance the digital transformation of businesses and economies in Sub-Saharan Africa.

References

Accenture, 'Digital Transformation' (2024) <https://www.accenture.com/us-en/insights/digital-transformation-index> accessed 30 May 2024

African Union (AU), 'The Digital Transformation Strategy for Africa (2020-2030)' (2020) <https://au.int/en/documents/20200518/digital-transformation-strategy-africa-2020-2030> accessed 26 October 2022

African Union Commission and OECD, 'Africa's Development Dynamics 2021: Digital Transformation for Quality Jobs' (OECD 2021) <https://www.oecd-ilibrary.org/development/africa-s-development-dynamics-2021_34fe3890-en> accessed 19 August 2024

Albrieu R and others, 'The Adoption of Digital Technologies in Developing Countries: Insights from Firmlevel Surveys in Argentina and Brazil' [2020] Industria; Tecnología <https://www.researchgate.net/publication/339912060_THE_ADOPTION_OF_DIGITAL_TECHNOLOGIES_IN_DEVELOPING_COUNTRIES_INSIGHTS_FROM_FIRM-_LEVEL_SURVEYS_IN_The_adoption_of_digital_technologies_in_developing_countries_Insights_from_firm-level_surveys_in_Argen>

Amin R and Gallegos D, 'Affordable Devices for All Innovative Financing Solutions and Policy Options to Bridge Global Digital Divides' (World Bank Group 2023) <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099080723143031193/P1737510ac79240b90aaa10618d282c1780> accessed 29 May 2024

Bartelsman EJ and Doms M, 'Understanding Productivity: Lessons from Longitudinal Microdata' (2000) 38 Journal of Economic Literature 569

Begazo, Tania, Moussa P. Blimpo, and Mark A. Dutz., 'Digital Africa: Technological Transformation for Jobs' (World Bank 2023) <978-1-4648-1737-3>

Borowiecki M and others, 'The Impact of Digitalisation on Productivity: Firm-Level Evidence from the Netherlands' (OECD Economics Department 2021) Working Paper 1680

[48] ITC, 'SME Competitiveness Outlook 2021: Empowering the Green Recovery' (22 June 2021) <https://www.intracen.org/resources/publications/sme-competitiveness-outlook-2021-empowering-the-green-recovery> accessed 23 September 2024.

[49] ITC, 'Promoting SME Competitiveness in Argentina' (International Trade Centre forthcoming).

<https://www.oecd.org/publications/the-impact-of-digitalisation-on-productivity-firm-level-evidence-from-the-netherlands-e800ee1d-en.htm> accessed 29 May 2024

Broadband Commission, 'Connecting Africa Through Broadband : A Strategy for Doubling Connectivity by 2021 and Reaching Universal Access by 2030' (2019) <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/131521594177485720/Connecting-Africa-Through-Broadband-A-Strategy-for-Doubling-Connectivity-by-2021-and-Reaching-Universal-Access-by-2030> accessed 8 August 2023

Choi J, Dutz M and Usman Z, *The Future of Work in Africa: Harnessing the Potential of Digital Technologies for All* (World Bank 2020) <https://openknowledge.worldbank.org/handle/10986/32124> accessed 25 October 2022

Cirera X and others, 'Understanding Firm-Level Adoption of Technology in Ethiopia'

DeStefano T, Kneller R and Timmis J, 'Cloud Computing and Firm Growth' (University of Nottingham 2019) Research Paper 2019/09 <https://www.nottingham.ac.uk/gep/documents/papers/2019/2019-09.pdf> accessed 29 May 2024

Duso T and Schiersch A, 'Let's Switch to the Cloud: Cloud Adoption and Its Effect on IT Investment and Productivity' (2022) CESifo Working Papers No. 9944 <https://papers.ssrn.com/abstract=4226411> accessed 29 May 2024

Falciola J and others, 'Identifying the Drivers of SME Resilience: Evidence From Developing Countries During the COVID-19 Pandemic'

Gal P and others, 'Digitalisation and Productivity: In Search of the Holy Grail – Firm-Level Empirical Evidence from EU Countries' (OECD 2019) OECD Economics Department Working Papers No. 1533 <https://www.oecd-ilibrary.org/economics/digitalisation-and-productivity-in-search-of-the-holy-grail-firm-level-empirical-evidence-from-eu-countries_5080f4b6-en> accessed 29 May 2024

Gavalas D, Syriopoulos T and Roumpis E, 'Digital Adoption and Efficiency in the Maritime Industry' (2022) 7 Journal of Shipping and Trade 11

Gkypali A, Love JH and Roper S, 'Export Status and SME Productivity: Learning-to-Export versus Learning-by-Exporting' (2021) 128 Journal of Business Research 486

GSMA, 'The State of Mobile Internet Connectivity 2023 Sub-Saharan Africa Key Trends' (2023) <https://www.gsma.com/r/wp-content/uploads/2023/10/State-of-Mobile-Internet-Connectivity-2023-Sub-Saharan-Africa.pdf>

Hjort J and Poulsen J, 'The Arrival of Fast Internet and Employment in Africa' (2019) 109 American Economic Review 1032

IMF and others, 'Digital Trade for Development' (World Trade Organization 2023)

——, *Handbook on Measuring Digital Trade* (2023) <https://www.wto.org/english/res_e/booksp_e/digital_trade_2023_e.pdf> accessed 29 August 2023

International Finance Corporation (IFC), 'Digital Skills in Sub-Saharan Africa: Spotlight on Ghana' (IFC 2019)

International Labour Organization, 'Small Goes Digital' (2021) <https://www.ilo.org/publications/small-goes-digital> accessed 4 September 2024

ITC, 'SME Competitiveness Outlook 2021: Empowering the Green Recovery' (22 June 2021) <https://www.intracen.org/resources/publications/sme-competitiveness-outlook-2021-empowering-the-green-recovery> accessed 23 September 2024

——, 'SME Competitiveness in Francophone Africa 2022: Fostering Digital Transformation' (International Trade Centre 2022) <https://intracen.org/resources/publications/sme-competitiveness-in-francophone-africa-2022-fostering-digital> accessed 31 August 2023

——, 'Promoting SME Competitiveness in Argentina' (International Trade Centre forthcoming)

ITU, 'The Affordability of ICT Services 2023' (2024)

Jyoti B and Singh AK, 'Does Digitalization Have a Causal Relationship With Economic Development?: An Experience From a Country-Wise Panel Data Statistical Analysis', *Handbook of Research on Perspectives on Society and Technology Addiction* (IGI Global 2023) <https://www.igi-global.com/chapter/does-digitalization-have-a-causal-relationship-with-economic-development/www.igi-global.com/chapter/does-digitalization-have-a-causal-relationship-with-economic-development/325180> accessed 23 August 2024

Luu TD, 'Digital Transformation and Export Performance: A Process Mechanism of Firm Digital Capabilities' (2023) 29 Business Process Management Journal 1436

Melitz MJ, 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity' (2003) 71 Econometrica 1695

MTN, 'MTN Skills Academy' (2023) <https://skillsacademy.mtn.com/about> accessed 30 May 2024

N'Dri AB and Su Z, 'Successful Configurations of Technology–Organization–Environment Factors in Digital Transformation: Evidence from Exporting Small and Medium-Sized Enterprises in the Manufacturing Industry' [2024] Information & Management 104030

OECD, *OECD Economic Surveys: New Zealand 2022* (OECD 2022) <https://www.oecd-ilibrary.org/economics/oecd-economic-surveys-new-zealand-2022_a4fd214c-en> accessed 23 August 2024

Schwab K, 'The Fourth Industrial Revolution: What It Means and How to Respond' (*World Economic Forum*, 14 January 2016) <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/> accessed 16 May 2024

Stone I, 'Upgrading Workforce Skills in Small Businesses: Reviewing International Policy and Experience' (2012)

Syverson C, 'What Determines Productivity?' (2011) 49 Journal of Economic Literature 326

Teruel M and others, 'The Birth of New HGEs: Internationalization through New Digital Technologies' (2022) 47 The Journal of Technology Transfer 804

Tipping D, 'Australian Exporters: Gaining a Competitive Advantage through Digital Trade Innovation' <https://www.dfat.gov.au/about-us/publications/trade-and-investment/business-envoy-april-2021-

digital-trade-edition/australian-exporters-gaining-competitive-advantage-through-digital-trade-innovation>

Trachuk A and others, 'Knowledge Spillover Effects: Impact of Export Learning Effects on Companies' Innovative Activities', *Current Issues in Knowledge Management* (IntechOpen 2019) <https://www.intechopen.com/chapters/67384> accessed 23 August 2024

United Nations Development Programme, '2024 Africa Sustainable Development Report' (*UNDP*, 2024) <https://www.undp.org/africa/publications/2024-africa-sustainable-development-report> accessed 26 September 2024

Wiley, 'Global Rankings for Digital Skills | Wiley Gap Index' (*Wiley*, 2021) <https://dsgi.wiley.com/global-rankings/> accessed 22 August 2024

World Bank, 'Digital Skills to Accelerate Human Capital for Youth in Africa' (2023) <https://thedocs.worldbank.org/en/doc/3eb99d2c0a89888a7d1292898cce4651-0010012023/original/004-Digital-Skills-to-Accelerate-Human-Capital-for-Youth-in-Africa.pdf> accessed 22 August 2024

——, 'Digital Opportunities in African Businesses' (World Bank 2024)

Yasar M, Nelson CH and Rejesus R, 'Productivity and Exporting Status of Manufacturing Firms: Evidence from Quantile Regressions' (2006) 142 Review of World Economics 675