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Digitalization and Disruptive Technologies in the Middle East and North Africa (MENA) and Sub-Saharan Africa (SSA) Regions

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DIGITALIZATION AND DISRUPTIVE TECHNOLOGIES IN THE MIDDLE EAST AND NORTH AFRICA (MENA) AND SUB-SAHARAN AFRICA (SSA) REGIONS

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Abstract

This paper aims at investigating the role of digitalization and the so-called disruptive technologies (DTs) in Middle East North Africa (MENA) and Sub-Saharan Africa (SSA) regions. It builds on a number of studies that have been devoted to investigate the impact of digitalization on individual countries in both regions, as well as a couple of regional reports. The paper tackles two main aspects of digitalization and DTs in MENA and SSA. The two main aspects are readiness (determinants of the sets of the two regions, MENA and SSA, to adopt new technologies), and the effects of adopting digitalization and DTs, or the lack thereof, on different aspects of the economies of both regions. The study pinpoints the gap between MENA and SSA, both in terms of readiness indicators, as well as effects. The study concludes that digitalization, so far, has limited positive impact on both SSA and MENA regions. The positive impact can be larger provided that the determinants or preconditions for allowing it to play this role are present. Such preconditions include the required infrastructure (both physical and data), the appropriate institutional and legal framework, the needed human capital, etc.

JEL Classifications: O33. O53, O55

Keywords: Disruptive technology, Digitalization, MENA, SSA.

ملخص

تهدف هذه الورقة إلى البحث في دور الرقمنة وما يسمى بالتكنولوجيات التخريبية (DTs) في مناطق الشرق الأوسط وشمال إفريقيا (MENA) وأفريقيا جنوب الصحراء(SSA) . وهي تستند إلى عدد من الدراسات التي كُرست لدراسة أثر الرقمنة على فرادى البلدان في كلتا المنطقتين، فضلا عن تقريرين إقليميين. تتناول الورقة جانبين رئيسيين للرقمنة و DTs في منطقة الشرق الأوسط وشمال إفريقيا و وأفريقيا جنوب الصحراء (SSA) . ويتمثل الجانبان الرئيسيان في: الاستعداد (محددات مجموعتي المنطقتين، منطقة الشرق الأوسط وشمال أفريقيا، ومنطقة جنوب الصحراء الكبرى، لاعتماد تكنولوجيات جديدة)، وآثار اعتماد نظام الرقمنة والأشكال التفصيلية، أو عدم وجودها، على مختلف جوانب اقتصادات المنطقتين. تحدد الدراسة الفجوة بين منطقة الشرق الأوسط وشمال إفريقيا وأفريقيا جنوب الصحراء ، سواء من حيث مؤشرات الاستعداد أو الآثار. وخلصت الدراسة إلى أن الرقمنة، حتى الآن، لها تأثير إيجابي محدود على كل من المنطقتين. يمكن أن يكون التأثير الإيجابي أكبر بشرط وجود المحددات أو الشروط المسبقة للسماح له بأداء هذا الدور. وتشمل هذه الشروط المسبقة: البنية التحتية اللازمة (المادية والبيانات على السواء)، والإطار المؤسسي والقانوني المناسب، ورأس المال البشري اللازم، وما إلى ذلك.

Introduction

Digitalization is spreading all over the globe with different intensities, mainly depending on the ability to invest in it and its related aspects and on the readiness to accept it as a core element in all aspects of the social, economic, and political spheres. In many cases, it is becoming an integral element of life. This paper aims to investigate the role of digitalization and the so-called disruptive technologies (DTs) in the Middle East and North Africa (MENA) and Sub-Saharan Africa (SSA) regions. It builds on several studies that examine the impact of digitalization on individual countries in both regions, as well as some regional reports. We aim to synthesize such studies in a cohesive and consolidated context.

The report deals with two main aspects of digitalization and DTs in MENA and SSA: (1) readiness, i.e., the determinants of the two regions to adopt new technologies; and (2) the effects of adopting digitalization and DTs, or the lack thereof, on different aspects of the economies of both regions. Moreover, the paper pinpoints the different alternatives applied by the reviewed papers in the utilization of the terms 'digitalization' and 'DTs.' In addition, and with the aid of some international data, we highlight the gap between MENA and SSA in terms of readiness indicators as well as effects.

The paper starts by identifying the scope and definition of digitalization and DTs used in this report. In section two, different determinants of adopting digitalization are reviewed, whereas section three focuses on analyzing the effects of digitalization on the economies of both regions. We then conclude and provide some policy implications.

1. The definition and scope of digitalization used in the reviewed papers

The authors of the papers reviewed in this report have adopted different concepts and scopes of digitalization. The concepts share similar aspects, but there is an element of differentiation as well, so each definition might have different implications. It is important to highlight this issue and identify how this can potentially affect the results.

Although the literature has adopted many terms and details, the studies reviewed rely mainly on digitalization proxies depending on data availability and the nature of the sector studied in this regard. For example, the literature groups what is coined as "DTs" into five broad categories including: Artificial Intelligence (AI); digital technology, such as big data and the Internet of Things (IoT); 3D printing; biotechnology; and material/nanotechnology (de Melo and Solleder, 2022; Alemayehu, 2022). Atiyas and Dutz (2022) consider "digital technologies" to refer to all technologies that capture, generate, store, modify, and transmit data through binary digits. Digital technologies include the Internet, all types of software, computers and tablets, Internet-enabled

smartphones (3G, 4G, and 5G that combine computing and telephone functions into one unit, and progressively enable faster access to and processing of more data), digital cameras and video, geo-location, and digital platforms (software-based online marketplaces that intermediate by facilitating peer-to-peer transactions, matching buyers and sellers, and enabling crowd-based transactions). In addition to the linking of data collected by sensors on many different types of production and household goods through IoT, other productivity-enhancing DTs include cloud computing, namely the on-demand availability of data storage and computing power so that instead of buying the underlying expensive hardware, enterprises and households can buy the associated online services on a per-use basis and discontinue use when no longer needed. They also include AI offerings, typically supported by machine learning (ML), namely predictive analytic algorithms that improve over time with the use of increasingly large amounts of data. Other available DTs include: blockchains, namely decentralized, distributed digital records linked together using cryptography to be resistant to modification of the underlying data and to ensure that the underlying data is tamper-proof; cryptocurrencies, namely digital money based on decentralized ledger technologies; and 3D printing or additive manufacturing, which is the construction of objects from a digital 3D computer graphic. Zhu and Luo (2022) also provide an extensive literature review of the concept of digitalization.

In the Kenyan study by Onsomu et al. (2022), which focused on the agricultural sector, the authors identify a number of characteristics of DTs. They state that they are "characterized by fast Internet connectivity, information and communications technology (ICT) infrastructure investments, value-added services, mobile money, and mobile banking services, among others." In another context, they state: "Disruptive technologies are highly interdependent. They constitute a dynamic ecosystem which includes communication infrastructure, digital platforms, acquisition of appropriate digital skills, local ICT connectivity, and strong regulatory institutions." This implies that even in the case of DTs, the authors of different papers chose either a broad definition without identifying which type of DTs or selected a very narrow element of DTs due to data limitations.

In a study that focused on Egypt and Jordan (Zaki, 2022a), the term 'technology' is used instead of DTs and the author uses a number of proxies to elaborate on the usage of technology by different firms, including "whether the firm has a website or not, uses smartphones or not, online selling and buying, the Internet, is listed on an application and self-built sales website that enables online payment), and performance (sales and exports)." On the other hand, Ben Youssef (2022) adopts a narrow definition of digitalization and confines it to e-commerce.

To overcome the different definitions adopted in the different papers, and to ensure that a comprehensive and inclusive term is adopted, we follow the definition cited in Zhu and Luo (2022) as follows: "According to Gebre-Mariam and Bygstad (2019), digitalization refers to the development and implementation of ICT systems and concomitant organizational change, it

involves the transformation of socio-technical structures formerly mediated by non-digital artifacts into ones mediated by digitized artifact." This is a simple, non-technical, and broad definition that serves the aim of this report. Hence, digitalization is adopted in its broad sense, implying the use of digital technologies and digitized data.

2. Determinants of adopting new technologies (readiness)

This section compares the MENA and SSA regions in terms of specific determinants of adopting new technologies. It focuses on the comparison of readiness and the prerequisites needed to intensify it in the two regions in light of the case studies covered by this report. This would involve investigating several issues, such as regulatory aspects, human capital, the characteristics of firms…etc. We begin with Fardoust and Nabli (2022), who identify several gaps including gender, age, geography (between and within countries), skills…etc.

Human capital

All the studies reviewed in this report highlight the fact that to ensure that digitalization plays an important positive role in the economies of both MENA and SSA, several aspects need to be catered for, including human capital. Both regions, to different extents, lack the human skills needed to allow them to reap the benefits of digitalization.

SSA country case studies pinpoint the vital role of human capital. Alemayehu (2022) identifies that the Government of Ethiopia has highlighted that the lack of human capital is a major challenge as per the National Digitalization Strategy (NDS) published in 2020, which had negative spillover effects on the ability to utilize technology in the banking sector. The same has been repeated in Kenya, where high ICT illiteracy in the agricultural sector hindered its ability to harness technology (Onsomu et al., 2022). In fact, the agricultural sector in Kenya is of vital importance for the economy and the population, constituting more than 60 percent of employment and 65 percent of export earnings. The number of technological applications introduced to enhance the productivity of the sector and the farmers is impressive and includes applications to adjust irrigation, applications for the purchase of inputs in a timely manner with affordable prices, and applications for marketing. Yet, the inability to harness such technological applications in a significant way implied that they remained short in achieving their ultimate objective of enhancing the productivity of the sector. Similar results were also found in the case of Senegal, where Diallo et al. (2022) find that gender, age, education level, and proficiency in languages are the main factors determining the adoption of digital technologies for job search purposes. They also find that the job search increases with the increase in age. Education and skills (language proficiency) have a determinable role in adopting technology. Atiyas and Dutz (2022) confirm the issue of human capital in SSA when they identify four determinants of mobile uptake: (1) affordability as captured by low incomes and high data prices; (2) capabilities as reflected by low levels of

education and skills; (3) the availability of other complementary assets (especially electricity); and (4) attractiveness as reflected by the perceptions of useful content.

When investigating the case of MENA countries, specifically Egyptian and Jordanian firms, Zaki (2022a) shows that education, among other factors, plays an important role in determining the adoption of technology by firms. Similar findings are found by Zaki (2022b) when investigating the case of firms in Egypt and Jordan. The same has been the case for Ben Youssef (2022), who reveals that Moroccan firms with more educated staff adopt e-commerce more frequently than firms with staff who are less educated.

Hence, it is confirmed by all country and regional case studies that human capital (proxied by education and/or skills) is an important determinant of technology adoption.

Gender

The role of gender as a key determinant of readiness has been debatable when comparing SSA with MENA, and also within regions. For example, within MENA, Zaki (2022b) finds that women-led firms are more likely to be digitized than those led by men in Egypt and Jordan. Yet, Ben Youssef (2022) believes that gender plays no role in Moroccan firms' adoption of e-commerce.

In the case of SSA, Diallo et al., (2022) stipulate that there is a male bias in terms of adopting digital technologies for job search purposes. Hence, the role of gender bias does not seem to have been resolved based on the studies included in this report.

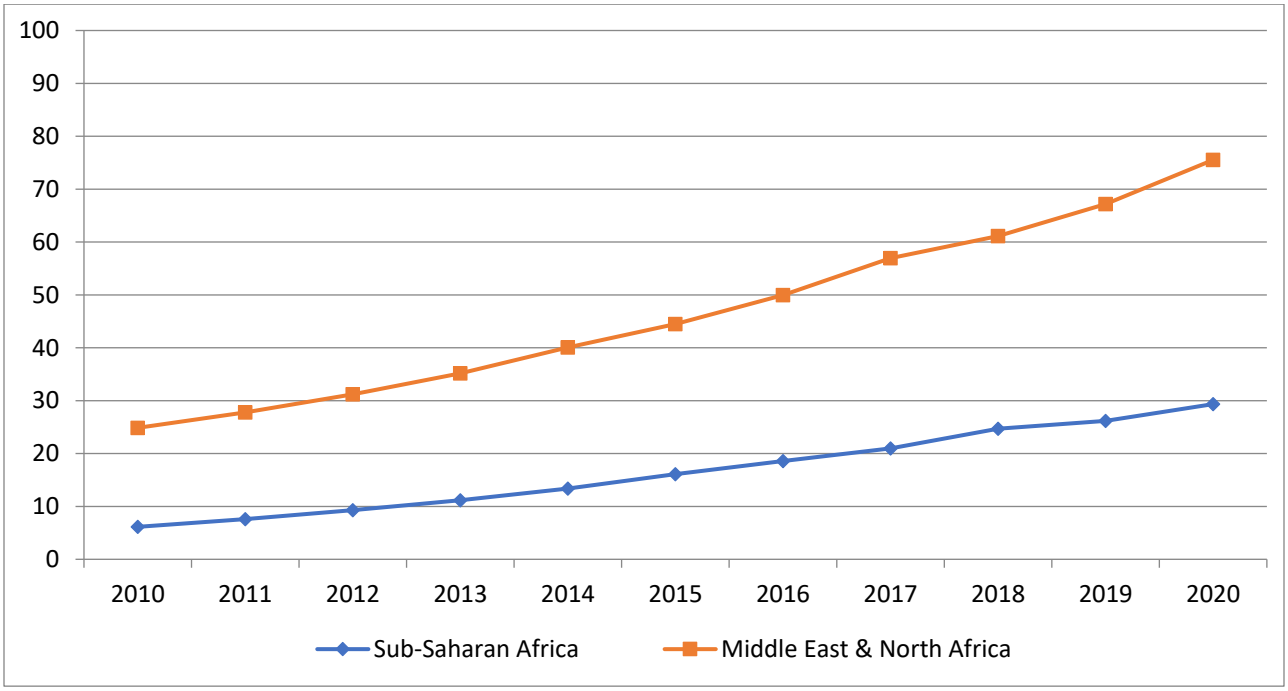
Status of national data infrastructure[3]

In terms of Internet coverage, the world average for Internet coverage reached 92 percent in 2018 (de Melo and Solleder, 2022). MENA's coverage reached 94 percent, slightly higher than the world average, whereas SSA had 71 percent coverage, placing it as the least region in the world in terms of coverage (de Melo and Solleder, 2022). Internet usage reached 49 percent of the population in SSA (the least after South Asia with a rate of 46 percent) and 64 percent in MENA (which is comparable to other regions) (de Melo, and Solleder, 2022). Figure 1 depicts the significant increase in the ratio of the percentage of individuals using the Internet as a percentage of the total population in both regions, yet with a widening divergence. Comparing Internet usage with coverage percentages shows that there is a considerable coverage-usage gap, where individuals are covered by the Internet but are not using it due to a lack of affordability, skills, or meaningful/quality access (Zhu and Luo, 2022). This is a crucial issue (coverage versus usage)

[3] National data infrastructure includes submarine cables and broadband lines, i.e., Internet exchange points; colocation data centers; and network readiness (national data ecosystems, see de Melo and Solleder, 2022).

that should be focused on when analyzing the status of the adoption of new technologies in SSA and MENA.

Figure 1. Individuals using the Internet (% of population) in MENA and SSA (2010-20)



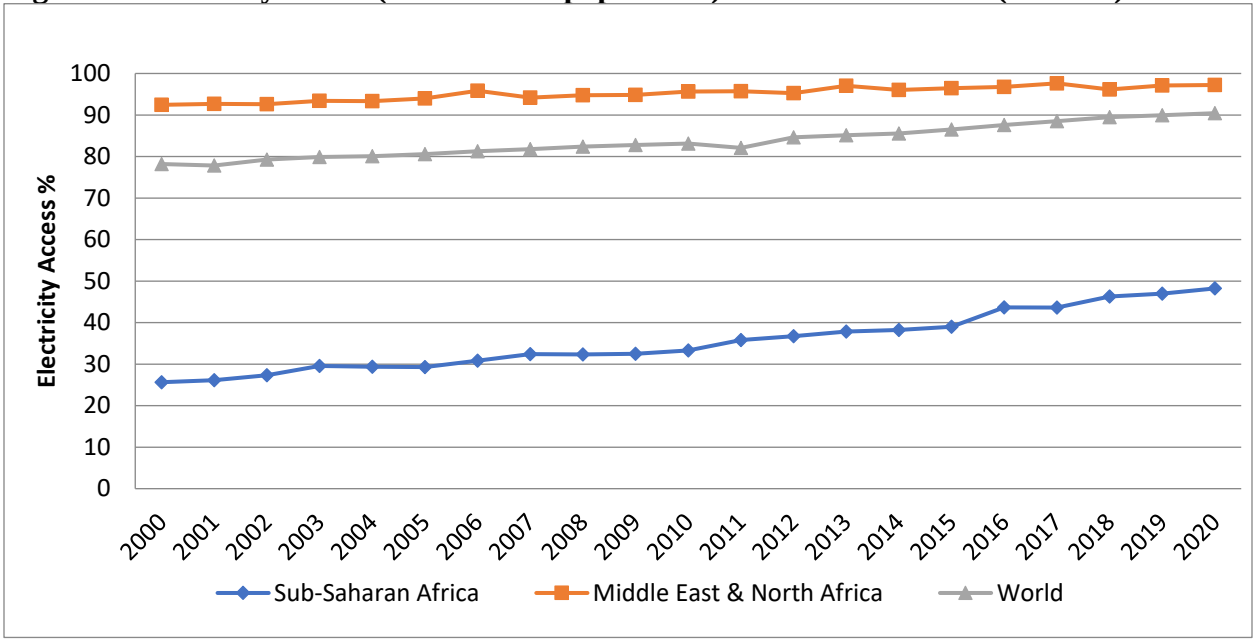
Source: World Bank (2022).

The closure of such a gap entails that countries upgrade the fiber backbone infrastructure, which requires massive investments, and combine it with retail competition from service providers, where the small geographical size of many countries makes it unprofitable. The relatively slow penetration of the Internet in SSA could be due to the slow deployment of submarine coverage (SMC) cables, or of usage (once coverage is secured). Several political, geographical, and economic factors could be also behind the low adoption rate. The arrival of the EASSY/SEACOM cables in 2008-09 was an exogenous technological shift in the capacity to carry out international communications and, therefore, facilitated Internet usage in SSA, despite the aforementioned factors. The percentage of the population covered by Internet-enabled mobile telecommunications networks varied among the SSA and MENA regions, with MENA taking the lead. Yet, in the last few years and due to COVID-19, SSA governments invested heavily in such aspects and, consequently, there is a high extent of convergence.

de Melo and Solleder (2022) explain that the state of national data infrastructure is modest in both regions, signaling an inability to harness an effective digital transformation process and specifically cross-border e-commerce. They provide evidence based on firm-level data showing that the modest performance of exports of software-intensive export services is highly caused by humble data infrastructure. In another context, Atiyas and Dutz (2022) argue that national data

infrastructure (coverage aspect) is not the main constraint and that it is the uptake aspect that represents the main binding constraint (where affordability is the main culprit). They find that the most important binding constraint preventing countries from benefiting from digitalization lies in too little uptake and use of the Internet as well as the range of productive technologies enabled by the Internet. In their explanation for the low uptake, they argue that low affordability is the main reason, which encompasses many issues, including low education and skill levels, low income levels, low levels of complementarity assets such as electricity, and high relative prices associated with technology usage (which includes issues associated with physical infrastructure as well as a lack of competition, as explained below). They also find that the largest gap is in SSA, followed by non-rich MENA countries and North African MENA countries. Figure 2 shows the discrepancy in access to electricity between MENA and SSA.

Figure 2. Electricity access (% of overall population) in MENA and SSA (2000-20)



Source: World Bank (2022).

Atiyas and Dutz (2022) believe that there is a country-specific disparity within the two regions, with some countries in a relatively backward composition compared to their peers. For example, Comoros and South Sudan have relatively low coverage rates and mobile uptake compared to the rest of SSA, whereas Yemen and Iraq have low coverage rates and mobile uptake compared to the rest of the MENA region. The time of adoption of technologies also plays a role, where some countries have been lagging but managed to catch up. For example, mobile cellular subscriptions have grown rapidly in MENA and globally over the past two decades. The level in Jordan and Morocco has exceeded the average regional level, while Egypt started with a relatively low level that has grown rapidly since 2010 and is close to the regional average (Zhu and Luo, 2022).

Country-specific evidence was provided in the case of Morocco, where Ben Youssef (2022) shows that the listing of Moroccan firms on digital platforms increases the probability of adopting e-commerce. Fardoust and Nabli (2022) pinpoint the importance of improving cyberspace coverage as a key determinant, in addition to privacy and data protection.

Therefore, the data infrastructure gap seems to be an important determinant of adopting technology. However, the gap seems to be larger in SSA when compared to MENA. The data infrastructure gap is not only confined to physical infrastructure; it is also associated with the ability to utilize it, which depends on a number of factors, some of which are associated with affordability while others are associated with issues like cyberspace coverage, quality of coverage, and privacy. Hence, differentiating between the coverage and uptake aspects is a key issue here, where the evidence in the studies covered in this report identifies that, coverage is the key determinant in some cases while uptake is the key determinant in others, where the key barrier to accelerated progress is the lack of meaningful and affordable connectivity.

Business models and innovation

Alemayehu (2022) observes that although the banking sector in Ethiopia seems to have the necessary investment and infrastructure for adopting digitalization, the business model adopted does not seem to be in the same vein. For example, almost all the banks in Ethiopia have an information technology (IT) department, but they do not seem to have adopted digitalization as the main strategy for transforming their current business model. Ethiopian banks still follow the traditional business model aiming at branch expansion and targeting big customers and foreign exchange generators. Plans for using digitalization as a main business strategy that can help expand banking services seem to be lagging. Part of this neglect, including digitalization as a main aspect, is the absence of indicators aiming at measuring the impact of digitalization on banking services.

In an alternative way of investigating the role of business models, Zaki (2022b) finds that firms that devote more funds to research and development (R&D) (innovation aspect) in the services sector tend to adopt and use different digital platforms more than others that do not spend on R&D and do not operate in the services sector. A similar result is reached by Zaki (2022a), who points out that R&D plays an important role in firms' adoption of technology. The same result is obtained by Ben Youssef (2022), who reveals that innovation plays an important role in the performance of firms adopting e-commerce. According to his argument, firms operating in the secondary and tertiary sectors and newer firms are more likely to adopt e-commerce since they are more open to innovations and changes. Moreover, innovation activities positively impact the adoption of e-commerce in Moroccan firms. Tables 1 and 2 show the relative advancement of the MENA region over the SSA region in both the Network Readiness Index and the Digital Adoption Index. Hence, the case studies in both SSA and MENA pinpoint the important role played by business models and innovation in adopting technology on both the sector and firm levels.

Table 1. Overall Network Readiness Index scores for 2022 in select MENA and SSA countries in ascending order[4]

Countries	Scores
Israel	72.20
United Arab Emirates	65.64
Saudi Arabia	61.09
Qatar	57.87
Oman	54.72
Bahrain	54.34
Kuwait	51.04
South Africa	48.90
Jordan	48.31
Egypt, Arab Rep.	47.76
Kenya	46.90
Morocco	46.50
Iran, Islamic Rep.	46.07
Tunisia	45.46
Lebanon	42.30
Cabo Verde	41.68
Algeria	39.48
Rwanda	39.48
Botswana	37.72
Nigeria	36.67
Benin	36.05
Cameroon	33.72
Malawi	31.30
Burkina Faso	29.76
Burundi	21.11

Source: https://networkreadinessindex.org/

[4] The Network Readiness Index is an index published annually by the World Economic Forum in collaboration with INSEAD as part of its annual Global Information Technology Report. It aims to measure the degree of readiness of countries to exploit opportunities offered by information and communications technology (Wikipedia). Network readiness depends on whether a country possesses the drivers necessary for digital technologies to meet their potential, and on whether these technologies actually have an impact on the economy and society. The drivers are grouped within three sub-indexes: the overall environment, readiness (which includes infrastructure, affordability, and skills), and usage (which is made up of individuals, business, and government). Impact is measured in terms of both economic and social impact (https://www.weforum.org/agenda/2016/07/what-is-networked-readiness-and-why-does-it-matter/).

Table 2. Overall Digital Adoption Index scores for 2016 in select MENA and SSA countries in ascending order[5]

Countries	Scores
United Arab Emirates	0.822969
Israel	0.787858
Bahrain	0.786019
Qatar	0.707999
Saudi Arabia	0.669529
Oman	0.653574
South Africa	0.638084
Kuwait	0.634642
Lebanon	0.572988
Tunisia	0.555916
Morocco	0.55537
Jordan	0.549759
Egypt, Arab Rep.	0.525825
Iran, Islamic Rep.	0.509145
Botswana	0.472318
Kenya	0.454194
Cabo Verde	0.434231
Algeria	0.431103
Rwanda	0.427687
Nigeria	0.418749
Angola	0.334767
Syrian Arab Republic	0.317156
Iraq	0.303694
Cameroon	0.295594
Burundi	0.261421
Malawi	0.258931
Yemen, Rep.	0.255398
Burkina Faso	0.236155
Benin	0.224117
Central African Republic	0.147107

Source: https://www.worldbank.org/en/publication/wdr2016/Digital-Adoption-Index#:~:text=The%20DAI%20is%20a%20worldwide,coverage%20and%20simplify%20theoretical%20linkages

[5] The Digital Adoption Index (DAI) is a worldwide index published by the World Bank that measures countries' digital adoption across three dimensions of the economy: people, government, and business. The index covers 180 countries on a 0-1 scale and emphasizes the "supply side" of digital adoption to maximize coverage and simplify theoretical linkages. The overall DAI is the simple average of three sub-indexes. Each sub-index comprises the technologies necessary for the respective agent to promote development in the digital era: increasing productivity and accelerating broad-based growth for *business*, expanding opportunities and improving welfare for *people*, and increasing the efficiency and accountability of service delivery for *government*. (https://www.worldbank.org/en/publication/wdr2016/Digital-Adoption-Index#:~:text=The%20DAI%20is%20a%20worldwide,coverage%20and%20simplify%20theoretical%20linkages.).

Institutional and regulatory infrastructure

In his study tackling digitalization, or lack thereof, in the Ethiopian banking sector, Alemayehu (2022) finds that the reasons behind the weak adoption of digitalization in this sector include the modest role played by the National Bank of Ethiopia as a regulator, which is accompanied by a lack of institutional framework represented by the absence of a national identity card. This institutional weakness led the National Bank of Ethiopia to adopt a conservative strategy in approving the process of embarking on digitalization, partially due to the fear of issues associated with cybersecurity, consumer protection…etc.

Zaki (2022b) believes that the institutional setup has an important role to play in firms' adoption of digitalization. He finds that Egypt suffers from institutional loopholes compared to Jordan, including the overlapping jurisdictions among the different agencies in charge of digital and finance-related issues.

The institutional and regulatory infrastructures seem to be overlooked when investigating the determinants of technology. It remains an important factor as revealed by the studies both in SSA and MENA. Moreover, the studies reveal that such aspects are not only confined to ICT-related sectors but to other sectors as well, such as the case of the Ethiopian banking sector. Table 3 reveals the ICT regulatory index for both MENA and SSA. The two regions are relatively similar. Despite the lack of accuracy of such an indicator, since it measures de jure status not de facto (e.g., the issue of the independence of the regulator, which might be stated by law, but de facto the ministry has a large influence on the regulator), the indicator still shows that SSA, despite improvement over the years, still lags behind MENA (Atiyas and Dutz, 2022).

Table 3. Overall ICT Regulatory Tracker scores for 2022 in Select MENA and SSA countries in ascending order[6]

Countries	Score
Saudi Arabia	94
Kenya	90
Nigeria	88
Rwanda	88
Morocco	86.5
Burkina Faso	86
Iran, Islamic Rep.	86
Malawi	86
Bahrain	85.5
Jordan	85.5
South Africa	85.3
Oman	84
Egypt, Arab Rep.	83.5
United Arab Emirates	82
Cabo Verde	78.7
Botswana	77
Angola	75.7
Tunisia	73.8
Israel	73.5
Kuwait	73
Qatar	72.7
Cameroon	72
Benin	69
Algeria	68.5
Gabon	67
Burundi	60.7
Syria	51.5
Lebanon	25
Libya	7

Source: https://app.gen5.digital/tracker/metrics

Market structure

According to Alemayehu (2022), the potential reasons behind the weak adoption of digitalization in the Ethiopian banking sector include the close nature of both the banking and

[6] The ICT Regulatory Tracker is an evidence-based tool published by the International Telecommunication Union (ITU) to help decision-makers and regulators make sense of the rapid evolution of ICT regulation. The Tracker pinpoints the changes taking place in the ICT regulatory environment. It facilitates benchmarking and the identification of trends in ICT legal and regulatory frameworks. The Tracker does not measure the quality, level of implementation, or performance of regulatory frameworks in place but records their existence and features. It helps track progress and identify gaps in regulatory frameworks, making the case for further regulatory reform toward achieving a vibrant and inclusive ICT sector. The ICT Regulatory Tracker is a composed metric based on a total of 50 indicators (11 composite, see full list below) grouped into four clusters: Regulatory authority (focusing on the functioning of the separate regulator), Regulatory mandates (who regulates what), Regulatory regime (what regulation exists in major areas), and Competition framework for the ICT sector (level of competition in the main market segments (https://app.gen5.digital/tracker/about).

telecommunications sectors. The lack of competition in both sectors and the hegemonic control of the State in both sectors implies the reluctance to accept new innovations, including digitalization. The NDS of Ethiopia highlighted that the monopolistic position of the sole governmental fixed phone and mobile operator had a negative impact on the country's digitalization as a whole, a situation that is likely to end in 2022 due to the opening up of the telecommunications sector.

Zaki (2022b) shows some evidence that restrictive measures in the Egyptian and Jordanian services sector (as proxied by the ad valorem equivalent of the trade restrictiveness index) negatively affect the ability of firms to adopt technology.

Furthermore, Atiyas and Dutz (2022) explain that there is a significant negative correlation between the Internet and technology uptake and the degree of concentration in the mobile market, as well as the key regulatory variable of Mobile Termination Rates (MTRs). They associate this with the regulatory framework governing the market, which has an important role in determining the shape and degree of competition in the market. This has been confirmed by other studies (for instance, see Houngbonon et al., 2021) that find that the low penetration in SSA and MENA is highly associated with restrictive measures and regulatory barriers in such markets, including abuse of the dominant position of the incumbent in the telecommunications sector and the relatively high barriers of entry to the market, including an expensive and complex licensing regime.

Such evidence identifies that market structure plays an important role in the adoption of technology. The more open the market and the less degree of concentration, the more firms are likely to adopt new technologies.

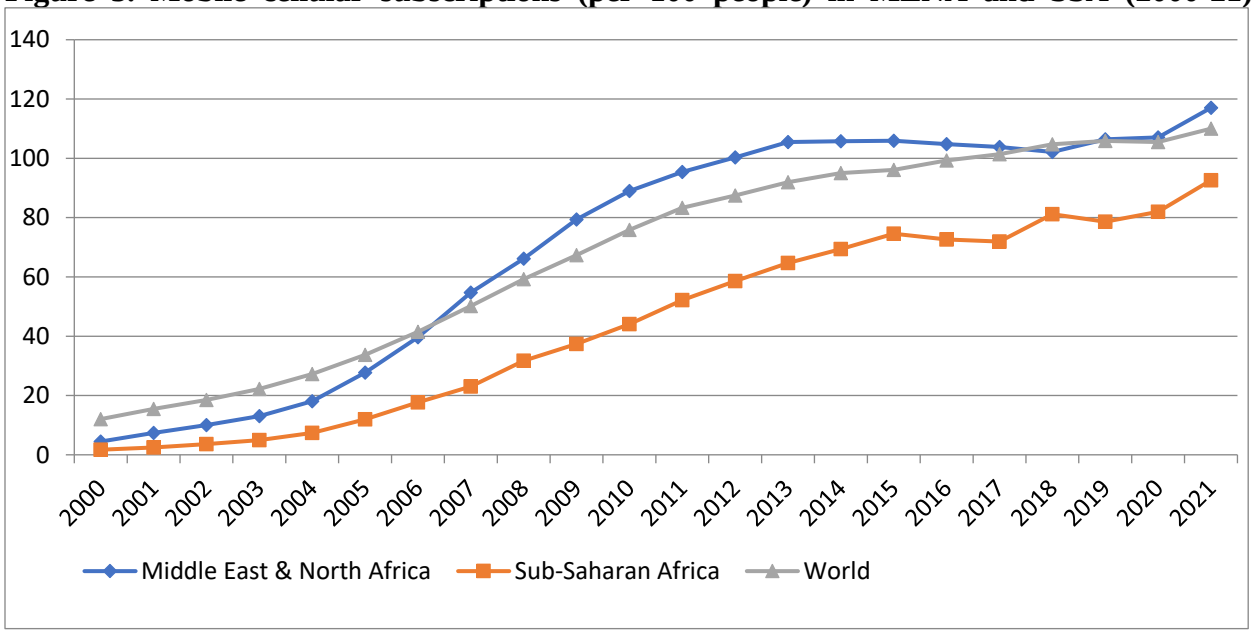
Physical infrastructure and an enabling environment (associated with geography and location)

In the case of SSA, Onsomu et al. (2022) show that the inability of the agricultural sector in Kenya to utilize technology efficiently is due to several reasons, including the poor ICT-related infrastructure, the unreliable supply of electricity, and poor network coverage. This is at odds with the heavy investment of the Kenyan government in submarine cables, where there are currently four undersea fiber optic cables that land off the coast of Kenya, namely SEACOM, TEAMS, EASSY, and LION2. This is also confirmed by Atiyas and Dutz (2022), who identify the role of complementarity assets, such as access to electricity.

Meanwhile, Grzybowski (2022) finds that affordability and Internet coverage play a role in adopting technology in the case of South Africa. His results indicate that richer people tend to buy smartphones and more advanced mobile phones than poorer people, which, in turn, enables them to have better access to technology. The same is associated with network coverage, where better network coverage (often found in the case where richer people live) enables them to have better access to technology than areas with poor network coverage (where poor people reside). Figures

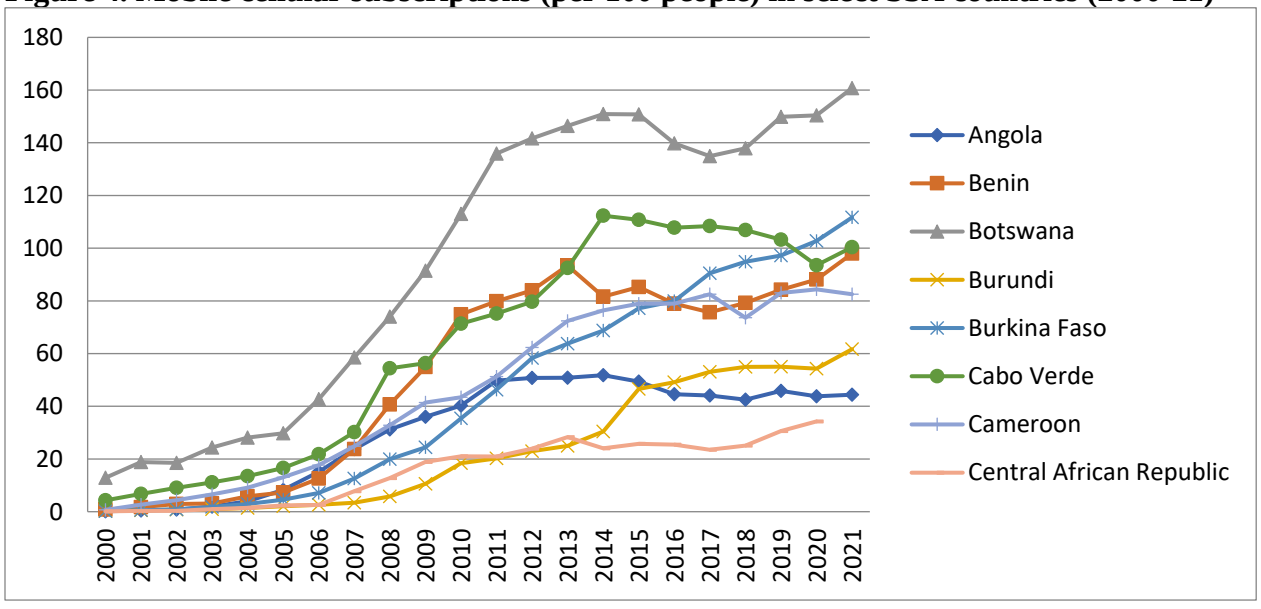
3, 4, and 5 show that the variation in mobile cellular subscriptions among MENA and SSA countries and within each region is relatively huge and is an issue that should be considered both when dealing with each region independently and when comparing the two regions. It should also be noted that for both regions, specifically SSA, data on mobile cellular subscriptions should be dealt with cautiously due to the widespread phenomenon of the use of multiple SIM cards.

Figure 3. Mobile cellular subscriptions (per 100 people) in MENA and SSA (2000-21)



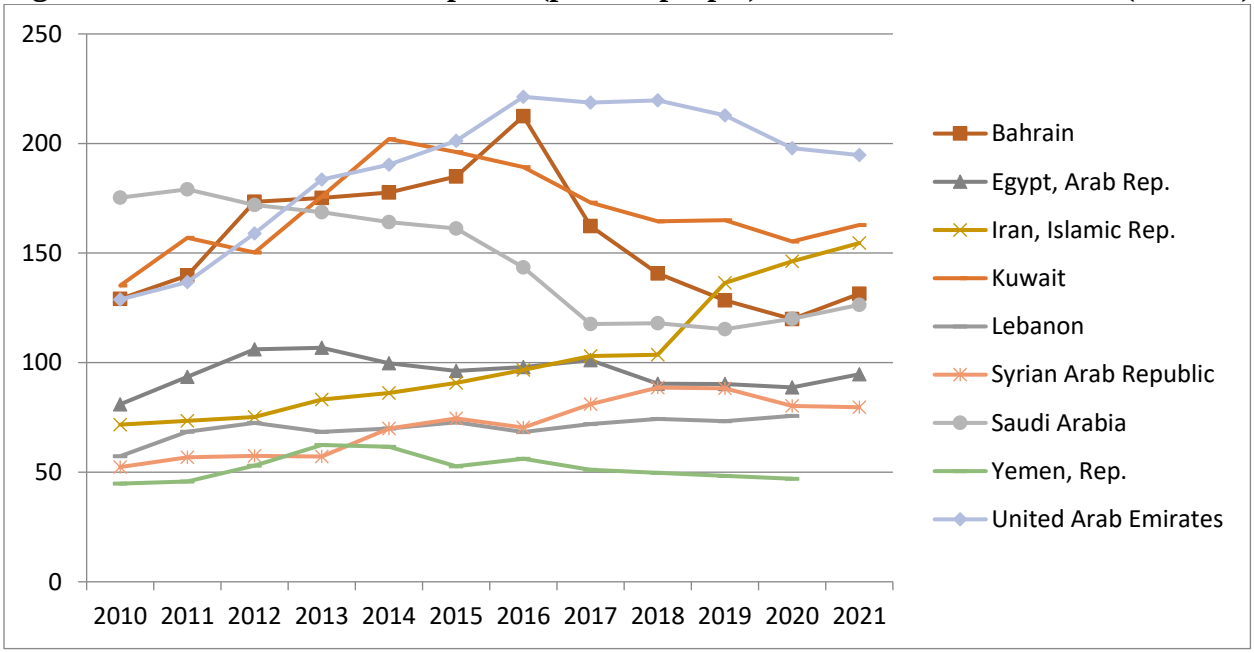
Source: World Bank (2022).

Figure 4. Mobile cellular subscriptions (per 100 people) in select SSA countries (2000-21)



Source: World Bank (2022).

Figure 5. Mobile cellular subscriptions (per 100 people) in select MENA countries (2010-21)



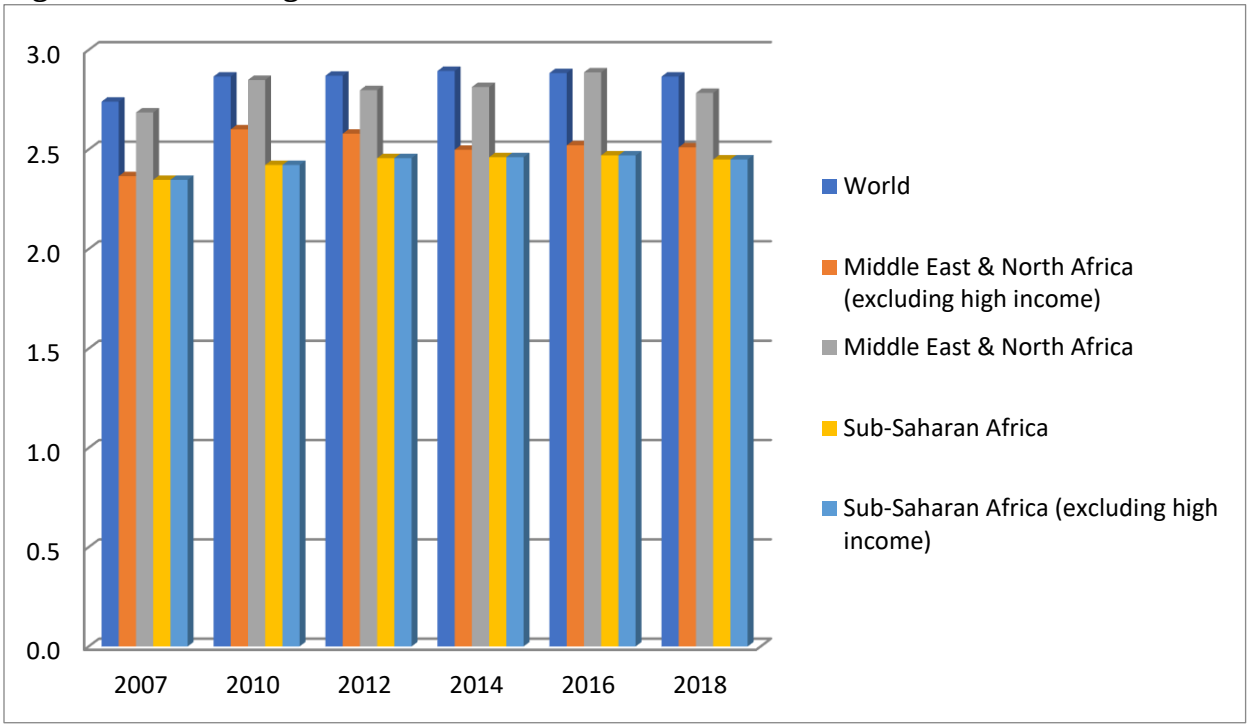
Source: World Bank (2022).

In the case of MENA, Zaki (2022a) notes that geography or location can play a role in the ability of firms to harness technology. In his explanation, he identifies that firms in Upper Egypt have more difficulties than firms in Cairo (the capital) in adopting technology. A similar result was reached by Ben Youssef (2022) for Moroccan firms in adopting e-commerce. His study points out that firms located in the Oriental, Casablanca-Settat, and Souss-Massa regions are less likely to adopt e-commerce than those located in the Tangier-Tetouan-Al Hoceima region. Ben Youssef (2022) does not explain whether the results associated with location are due to access to physical infrastructure or other reasons, but it can be safely argued that, in both Egypt and Jordan, this is mainly due to the lack of physical and national data infrastructure, where disparities among different parts of the countries are not captured by the macro data.

Moreover, Zaki (2022b) finds that a major aspect that affects the ability of firms to adopt digitalization is the issue of access to related physical infrastructure (Figure 6 shows the overall discrepancy between the two regions and the relative catch-up of SSA, as well as the fact that when high-income MENA countries are excluded, the divergence between MENA and SSA is narrowed down). He notes that the reasons for the relative superiority of firms in Jordan adopting digitalization when compared to their Egyptian counterparts include access to reliable and stable electricity. He also identifies that, in general, Jordan and Egypt suffer from the modest performance of physical infrastructure.

The specific geographical location of the firm within a country as a determinant of adopting technology is also overlooked by the literature, where the focus is always on the overall aspects such as access to electricity in a specific country. Yet, the country case studies in both SSA and MENA identify that, on the country level, there might be differences based on the location of the firm or the people, which, in turn, affects the harnessing of technology. Figure 6 shows the Logistics Performance Index (LPI) for both regions where the two regions, surprisingly, are highly similar if the high-income MENA countries are excluded.

Figure 6. Overall Logistics Performance Index in MENA and SSA



Source: World Bank (2022).

Firm characteristics

Zaki (2022a) identifies that firm size plays an important role in the adoption of technology, where larger firms have more willingness to adopt technology than small and medium-sized firms. In both Egypt and Jordan, Zaki (2022b) shows that large firms have a better ability to adopt technology than small and medium-sized ones, contrary to Ben Youssef (2022), who reveals that size has no impact on Moroccan firms in adopting e-commerce.

Relatively large and young firms in Egypt, Jordan, and Morocco are more likely to engage in e-commerce (Zhu and Luo, 2022). Sector might matter as well, as Zhu and Luo (2022) find that some firms in specific sectors are more evident in ICT, namely the finance and real estate sectors. There are other sectors where firms adopt e-commerce but to a lesser extent compared to the aforementioned sectors, including non-metal products, transportation and storage, and

accommodation and food services. The nature of the sector and the product produced within that sector could be a reason why e-commerce is adopted more in some sectors compared to others. In general, Zhu and Luo (2022) show that e-commerce participation is relatively low in firms in Egypt, Jordan, and Morocco compared to regional peers or countries with similar development levels.

Hence, there seems to be a tilt in evidence toward larger and younger firms adopting technology more than smaller and older firms. However, it cannot be generalized as it differs in some countries as revealed by the different case studies.

III. Effects (implications)

This section discusses the effect of digitalization on the performance of SSA and MENA regions on the macro level (e.g., growth, employment…etc.) and on the firms' performances in different sectors while linking, as much as possible, the effects on the two regions with the determinants explained in the section before. Differences in both regions are highly expected in this regard given the economic structure and level of development.

Effect on the SSA region

Alemayehu (2022) finds that a 10 percent increase in digitalization results in 0.5 percent growth in the gross domestic product (GDP), which is further decomposed into one percent growth in the service sector, 0.3 percent growth in the Ethiopian agricultural sector, and no effect on the industrial sector. This is in line with what de Melo and Solleder (2022) identify in terms of the positive impact of digitalization on servicification in the SSA and MENA regions, though de Melo and Solleder (2022) are more optimistic for the MENA region in this regard.

Meanwhile, Diallo et al. (2022) show that, in the case of Senegal, technology adoption affects the likelihood of benefiting from social contracts but does not affect the likelihood of benefiting from incubation internships, apprenticeships, and spinoff contracts. They also find that technology adoption helps the unemployed continue their job search efforts but does not reduce the duration of their unemployment. Contrary to expectations, they find that the adoption of digital technology by Senegalese firms increases the demand for both skilled and unskilled jobs, but with a higher rate for unskilled labor compared to skilled labor. This contrasts with what de Melo and Solleder (2022) anticipate.

The case of Kenya identifies the dichotomy of the impact that can appear. Kenya has been in a relatively advanced position compared to the rest of the SSA region in terms of innovation, technology adoption, and the application of DTs in several sectors, including the financial and tourism sectors. It has been coined as the 'Silicon Savannah' (Onsomu et al., 2022). Yet, the

diffusion of such technology has not reached the agricultural sector in relative terms. The agricultural sector in Kenya has been the focus of the government's interest and several strategies and efforts have been put in place to enhance productivity in this sector (examples of such projects and programs include the Kenya Agricultural Productivity Project (KAPP), the National Agriculture and Livestock Extension Program (NALEP), the Agriculture Sector Program Support (ASPS) and the National Accelerated Agricultural Inputs Access Program (NAAIAP)). In fact, the efforts have paid off and productivity in the agricultural sector has been enhanced, yet the role of technology in enhancing such productivity remains modest, to a large extent.

In their study, Avenyo and Bell (2022) show a correlation between South African manufacturing firms engaged in exporting and the adoption of advanced technologies. Although the direction of causality was not investigated, the correlation was clear enough. They also find the same correlation between the adoption of advanced technology and firms' willingness to innovate. Finally, they conclude that firms with access to broadband have a higher likelihood to export, implying that access to digitalization has a positive impact on firm performance.

Grzybowski (2022) finds that technology adoption, provided that an enabling environment is provided, can have a positive impact on decreasing the digital divide and income inequality in South Africa. He supports his results with the case of the transfer of money from richer people in advantageous areas (with good network coverage) to poorer people (in less advantageous areas) using mobile phones. He also states that, in the case of South Africa, mobile phone ownership has a positive impact on employment status and having a mobile phone and owning a computer in a household both reduce the likelihood of becoming unemployed.

By surveying recent literature, Atiyas and Dutz (2022) find that digitalization has a significant positive on increasing jobs, including mobile money (as Safaricom was introduced in Kenya in 2007 and the new banking product M-Shwari was introduced later). The increase in jobs was mainly due to more firms entering the market, fewer firms exiting the market, and more productivity gains in existing firms. The increase in jobs is associated with skill level, where high and secondary education is the most likely to be employed, yet even at the primary education level, on-the-job training helped increase the jobs allocated to them. As surveyed by Atiyas and Dutz (2022), the welfare effects of Internet availability are positive and significant in a number of SSA countries, including Nigeria, Senegal, and Tanzania. Internet availability (3G or 4G coverage) had a positive significant effect on reducing poverty, increasing consumption, and, in some cases, increasing women's labor participation. Moreover, the introduction of mobile money and banking products (e.g., Safaricom and M-Shwari) helped further reduce poverty and enhance welfare effects.

In a nutshell, the individual country case studies as well as the regional study find that digitalization is likely to have an overall impact on SSA economies, whether in terms of economic growth, creating jobs and employment (skilled and unskilled), international trade, or sectoral performance. Yet, there are major differences identified, where some of the sectors (based on the different countries) might not have benefited, such as the industrial and financial sectors in Ethiopia or the agriculture sector in Kenya. Moreover, the differentiation in the impact of digitalization based on the skilled/unskilled dichotomy differs by country, sector, and methodology applied.

Effect on the MENA region

On a further micro-level analysis, Internet usage has a positive impact on firm performance in the case of Jordan and Egypt, but to different extents. Zaki (2022a) explains that the use of the Internet in terms of listing a firm on an application is associated with increased sales in Egypt and Jordan, whereas self-built websites for payments have positive implications on exports in the case of Egypt. Zhu and Luo (2022) also find that e-commerce is positively associated with more production in firms in Egypt, Jordan, and Morocco. In addition, engaging in e-commerce enhances the trade of such firms on the export and import sides. Moreover, they find that the positive effect of e-commerce on productivity is significant only in Jordan, where e-commerce is most developed.

Comparison between MENA and SSA

Based on an extensive literature review, Zhu and Luo (2022) and Kamel (2021) observe that digitalization has a positive impact on economic growth through different channels. While focusing on MENA, and SSA, de Melo and Solleder (2022) argue that the digitalization happening across the globe is likely to deprive SSA of its comparative advantage based on the abundance of cheap, low-skilled labor. In fact, digitalization represents a great threat to employment in SSA whereas, in MENA countries, digitalization can support structural transformation if the countries shift toward achieving productivity growth led by the services sector. However, it is worth noting that the records of both MENA and SSA have been modest, where they registered the slowest average labor productivity growth in services across regions during 1995-2018. de Melo and Solleder (2022) further argue that as more advanced and new technologies enter the exports of firms participating in global value chains (GVCs), the comparative advantage of low-cost unskilled labor is becoming discriminated against, implying a negative impact on countries with such a characteristic in both MENA and SSA. The increase in telecommunications subscriptions in both regions results in a reduction in trade costs and therefore has a positive impact on the ability to join GVCs. de Melo and Solleder (2022) identify that an increase in telecommunications subscriptions is associated with a direct elasticity of GVC participation of 0.4 and an indirect effect of 0.25 through a reduction in trade costs at the global level.

According to the conclusions of the regional and individual country case studies, digitalization has a positive effect on both countries in MENA and SSA, with the exception of de Melo and Solleder

(2022) (that digitalization will deprive SSA countries of their comparative advantage), which did not receive consensus from individual country case studies. The extent of benefit for both regions and individual countries is difficult to compare due to the focus on different sectors or the usage of different datasets and methodologies.

Conclusion, policy implications, and lessons learned

So far, digitalization has had a limited positive impact on both the SSA and MENA regions. Based on the regional and individual country case studies, we believe that digitalization can have a paramount impact on the economies of the selected countries, provided that the determinants or preconditions for allowing it to play this role are present. This result has also been confirmed by other studies such as Kamel (2021) and Fardoust and Nabli (2022). Such preconditions include the required infrastructure (both physical and data), the appropriate institutional and legal framework, the needed human capital, and the other pillars of an enabling environment mentioned in section two of this paper. Aside from the aforementioned determinants, there is a need to adopt other complementary policies, which are emphasized by Kamel (2021), that include enhancing digital inclusion and improving the financial inclusion ecosystem.

Our findings include the importance of executing the developed national strategies and introducing an effective system for follow-up and monitoring. Nearly all the case studies cited in this report have developed national strategies, yet their impact has been limited. The relative failure in adopting national strategies is an issue that requires specific attention to stand on the reasons behind the divergence between what the national strategies imply and what has been adopted on the ground.

The fear of the negative impact of digitalization on the displacement of labor, especially low-skilled labor (as argued by de Melo and Solleder, 2022), has not been revealed by any of the reviewed case studies. It is worth pointing out that this does not imply that de Melo and Solleder's (2022) fears are far from materializing, but rather that the authors of other studies did not focus on it and that their methodologies did not tackle such issues. In other words, this "macro" perspective seems to be overseen by the country studies, which argue that the potential of application of technology remains un-reaped and that their emphasis has always been on the inability to reap its gains due to "other aspects," such as ICT illiteracy or inadequate infrastructure. The argument is always that employment will be enhanced and sectoral growth improved if there is an ability to harness technology on the sectoral level. A more rigorous approach to tackling this issue should be adopted to research this debatable matter.

Another aspect that this report reveals is the issue of the dichotomy of macro indicators and micro foundations. Onsomu et al. (2022) pinpoint an important aspect that should be taken into account; the macro indicators might be hiding large intra-country divides or gaps (like the case of Kenya)

and how it is appraised for its adoption of technological tools, which has not been the case in the agricultural sector. In fact, it was confirmed by other country studies (e.g., Alemayehu, 2022). Yet, digging into the details reveals that there was no trickling-down effect of such macro indicators to the sectoral level, where an important economic sector in Kenya (like agriculture) does not seem to have enjoyed such technological advancements. The same has been repeated in Zaki (2022a) and Ben Youssef (2022), where the differences in the ability to adopt technology within Egypt, Jordan, and Morocco reveal that the location inside the country makes a difference. This implies that the general country studies using macro indicators should be treated with caution and should be complemented by sub-regional and sectoral studies to provide precise and practical policy implications.

We find that the results of firm characteristics in terms of adopting technology require further research. The results tilt toward the conclusion that large and new firms are more likely to harness technology compared to small and old firms, which has been the case in Egypt and Jordan as per Zaki (2022a and 2022b). However, this has not been confirmed by Ben Youssef (2022).

Our paper highlights the importance for both SSA and MENA countries to focus on servicification. Regardless of whether de Melo and Solleder's (2022) fears will materialize or not, SSA and MENA countries should devote more attention to servicification as a means to ensure the creation of jobs. This has also been emphasized by Fardoust and Nabli (2022) in the context of MENA countries. Yet, in both regions, there is a need to upgrade the level of labor skills to enable labor to cope with such changes and to cope with the servicification phenomenon.

The studies reviewed also reveal that the expected gains should be treated with caution. For example, it is true that digitalization is likely to have a positive impact on countries in both SSA and MENA in terms of enhancing their ability to be engaged in GVCs and reduce trade costs. Yet, such gains are not necessarily reaped by the economies of the countries concerned if there is a domination of multinationals. Hence, there is a need for a strong and solid institutional and regulatory infrastructure that strikes the balance between opening up the market for competition, preserving the rights of consumers, and avoiding monopolistic attitudes.

This paper simply identifies that digitalization is neither a panacea nor does it only require importing technology. Like several other phenomena, it carries benefits as well as costs. For SSA and MENA countries to enjoy the benefits, there are a lot of preconditions that need to be set in place. The readiness ability differs across both regions as well as within the regions. Issues such as human capital, physical infrastructure, and national data infrastructure, among others, seem to play a crucial role in the ability to harness technology. Moreover, the macro/micro dichotomy is important, where the macro indicators seem to hide a lot of information on the micro-sectoral or sub-regional level (the data gap has been magnified by the studies). The differentiation between

the coverage and the uptake of technology (e.g., mobile and internet) is important in understanding many of the unexplained issues of the inability to benefit from digitalization, especially in SSA. When the binding constraint is not coverage, but rather uptake, issues such as affordability and accessibility (e.g., electricity) need to be the issues to focus on. The ability to reap the benefits of digitalization and being able to be fully effective in engaging in value chains seem to be associated with many of the findings that the studies synthesized in this report have revealed.

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