ERF Working Papers Series

Structural Transformation in MENA and SSA: The Role of Digitalization

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ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية

Working Paper No. 1547
May 2022

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[1] Thanks to Sanjay Kathuria for insightful discussant comments and to Joel Cariolle, Ibrahim El-Badawi, Shahrokh Fardoust and Olga Solleder for helpful suggestions on a preliminary draft. The authors thank the ERF for funding. They remain responsible for any errors and opinions.

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First published in 2022 by
The Economic Research Forum (ERF)
21 Al-Sad Al-Aaly Street
Dokki, Giza
Egypt
www.erf.org.eg

Abstract

The paper focuses on two challenges of digitalization for structural transformation in MENA and SSA, one particularly relevant for SSA countries, the other for MENA countries. For SSA on the way to account for half of the growth in the global labor force over the first half of the 21st century, the most pressing challenge is that automation presents a threat for employment. Digital technologies (digitech) could rob SSA from its demographic dividend enabled by rising wages in China. For MENA countries where manufacturing has largely failed to take off, the digital transformation where 'value creation shifts from capital to knowledge' presents an opportunity for structural transformation. Successful digitalization would then allow MENA countries to achieve a service-sector led high-productivity growth structural transformation. For countries in both regions, improving digital skills to close the growing digital gap will be necessary. Digitalization is only starting across developing countries and is barely visible in the data and estimates reported in this paper. The paper covers evidence on three aspects of digitalization.

First, disparities in digitalization across countries in both regions may be increasing in a digital world increasingly data-driven. New technologies entering the exports of firms participating in GVCs present a threat for low-income countries through two channels. First, the new technologies are biased towards skills and other capabilities, reducing the comparative advantage of unskilled labor-abundant countries, like those in SSA. Second, this bias makes it harder for low-income countries to offset their technological disadvantage with their labor-cost advantage.

Next, the paper documents the weak performance of services in SSA and MENA, a sector that has become the engine of structural transformation. SSA and MENA stand out for having registered the slowest average labor productivity growth in services across regions over 1995-2018. Great differences in the state of national data infrastructures are observed across both regions, a signal that many countries are not ready for cross-border e-commerce, an essential ingredient of the digital transformation. It reports on firm-level evidence establishing causality between exports of software-intensive services exports and the quality of data infrastructure.

Third the paper shows that trade costs have remained higher and participation in supply chain trade lower than in most other regions. New econometric estimates suggest that an increase in telecom 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.

In sum, 'this time may be different' because the labor displacement effects of automation may not be accompanied by reinstatement effects observed during past episodes of widespread technological change when jobs were created to implement the new technologies. The complementarity between humans and machines observed in previous spells of technical progress may be threatened by the continued growth in automation and robots. MENA and SSA countries should also prepare for regulation of cross-border e-commerce by, among others, weighing the costs and benefits of data localization measures that can provide consumer protection and give an advantage to local firms. For African countries engaged in the AfCFTA, negotiations on protocol for e-commerce in phase III provides a unique opportunity for African countries to collectively establish common positions in e-commerce that would help guide their structural transformation.

Keywords: trade policy; global value chains; digitalization; Servicification; trade costs; national date infrastructure; Sub-Saharan Africa, Middle-East and North Africa

JEL Classifications: F1, F6

ملخص

تركز الورقة على تحديين للرقمنة من أجل التحول الهيكلي في منطقة الشرق الأوسط وشمال إفريقيا وأفريقيا جنوب الصحراء، أحدهما وثيق الصلة ببلدان إفريقيا جنوب الصحراء، والآخر لبلدان الشرق الأوسط وشمال إفريقيا. بالنسبة لأفريقيا جنوب الصحراء في طريقها إلى تحقيق نصف النمو في القوى العاملة العالمية خلال النصف الأول من القرن الحادي والعشرين ، فإن التحدي الأكثر إلحاحًا هو أن الأتمتة تمثل تهديدًا للتوظيف. يمكن للتقنيات الرقمية (digitech) أن تسرق SSA من عائدها الديموغرافي الذي تم تمكينه من خلال ارتفاع الأجور في الصين. بالنسبة لبلدان الشرق الأوسط وشمال إفريقيا حيث فشل التصنيع إلى حد كبير ، فإن التحول الرقمي حيث "تحول خلق القيمة من رأس المال إلى المعرفة" يمثل فرصة للتحول الهيكلي. ستسمح الرقمنة الناجحة بعد ذلك لبلدان الشرق الأوسط وشمال إفريقيا بتحقيق نمو هيكلي عالي الإنتاجية يقوده قطاع الخدمات. بالنسبة للبلدان في كلا المنطقتين ، سيكون من الضروري تحسين المهارات الرقمية لسد الفجوة الرقمية المتزايدة. بدأت الرقمنة فقط عبر البلدان النامية وهي بالكاد مرئية في البيانات والتقديرات الواردة في هذه الورقة. تغطي الورقة أدلة على ثلاثة جوانب للرقمنة.

أولاً ، قد تتزايد التفاوتات في الرقمنة عبر البلدان في كلا المنطقتين في عالم رقمي يعتمد بشكل متزايد على البيانات. تمثل التكنولوجيات الجديدة التي تدخل صادرات الشركات المشاركة في سلاسل القيمة العالمية تهديدًا للبلدان منخفضة الدخل من خلال قناتين. أولاً ، تنحاز التقنيات الجديدة نحو المهارات والقدرات الأخرى ، مما يقلل الميزة النسبية للبلدان غير الماهرة ذات العمالة الوفيرة ، مثل تلك الموجودة في أفريقيا جنوب الصحراء. ثانيًا ، يجعل هذا التحيز من الصعب على البلدان منخفضة الدخل تعويض عيبها التكنولوجي بميزة تكلفة العمالة

بعد ذلك ، توثق الورقة الأداء الضعيف للخدمات في أفريقيا جنوب الصحراء والشرق الأوسط وشمال إفريقيا ، وهو قطاع أصبح محرك التحول الهيكلي. تتميز منطقة جنوب الصحراء الكبرى والشرق الأوسط وشمال إفريقيا بتسجيلهما أبطأ متوسط نمو في إنتاجية العمل في الخدمات عبر المناطق خلال الفترة 1995-2018. لوحظت اختلافات كبيرة في حالة البنى التحتية للبيانات الوطنية عبر كلا المنطقتين ، وهي إشارة إلى أن العديد من البلدان ليست مستعدة للتجارة الإلكترونية عبر الحدود ، وهي عنصر أساسي للتحول الرقمي. ويبلغ عن أدلة على مستوى الشركة تثبت العلاقة السببية بين صادرات الخدمات كثيفة البرمجيات وجودة البنية التحتية للبيانات.

ثالثًا ، تظهر الورقة أن تكاليف التجارة ظلت أعلى وأن المشاركة في تجارة سلسلة التوريد أقل مما هي عليه في معظم المناطق الأخرى. تشير التقديرات الاقتصادية القياسية الجديدة إلى أن الزيادة في اشتراكات الاتصالات مرتبطة بمرونة مباشرة للمشاركة في سلاسل القيمة العالمية تبلغ 0.4 وتأثير غير مباشر قدره 0.25 من خلال خفض تكاليف التجارة.

باختصار ، "قد تكون هذه المرة مختلفة" لأن آثار إزاحة العمالة للأتمتة قد لا تكون مصحوبة بآثار إعادة العمل التي لوحظت خلال الحلقات السابقة من التغيير التكنولوجي الواسع النطاق عندما تم إنشاء الوظائف لتنفيذ التقنيات الجديدة. قد يكون التكامل بين البشر والآلات الذي لوحظ في فترات سابقة من التقدم التقني مهددًا بسبب النمو المستمر في الأتمتة والروبوتات. يجب أن تستعد دول منطقة الشرق الأوسط وشمال إفريقيا ودول إفريقيا جنوب الصحراء أيضًا لتنظيم التجارة الإلكترونية عبر الحدود من خلال ، من بين أمور أخرى ، الموازنة بين تكاليف وفوائد إجراءات توطين البيانات التي يمكن أن توفر حماية المستهلك وتعطي ميزة للشركات المحلية. بالنسبة للبلدان الأفريقية المشاركة في اتفاقية التجارة الحرة القارية الأفريقية ، توفر المفاوضات بشأن بروتوكول التجارة الإلكترونية في المرحلة الثالثة فرصة فريدة للبلدان الأفريقية لتأسيس جماعيًا مواقف مشتركة في التجارة الإلكترونية من شأنها أن تساعد في توجيه تحولها الهيكلي.

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1. Two challenges for Structural transformation: Employment (SSA) and Services-led industrialization (MENA)

Digitalization, broadly defined as the use of digital technologies and digitized data, impacts how work gets done and transforms how customers and companies engage and interact. Digitalization is considered essential in the structural transformation of developing countries. The many facets of digitalization are challenging to describe/measure as they take different forms across countries. In this paper, we focus on two challenges, one particularly relevant for SSA countries, the other for MENA countries.

For SSA where the size of the digital economy is small, digital-readiness is low, the cost of capital is high, the challenge is that automation presents a threat for employment. With SSA on the way to account for half of the growth in the global labor force over the first half of the 21st. Century. The arrival of digitalization could rob SSA from its demographic dividend opportunity offered by rising wages in China.

In many MENA countries manufacturing has failed to take off. Here, the digital transformation where 'value creation shifts from capital to knowledge' (Baldwin and Forslid, 2020) presents an opportunity for structural transformation. Successful digitalization would then allow MENA countries to achieve a service-sector led high-productivity growth structural transformation. For MENA, the challenge is improving across-the-board low indicators of competitiveness for their per capita-income level (see MENA competitivity vignettes in annex A3, especially the low scores for math and science).

For countries in both regions, taking advantage of digitalization will require institutional and regulatory frameworks that support access to and use of digital technologies and market platforms accessible for micro, small, and medium-sized enterprises (MSMEs). Mastering digitalization will be required to capture a greater share of value-added along the supply chain. As documented and argued in the paper, overcoming the digital gap within each region will also require cross-border provision and competition of data infrastructures.

At the outset, take note that digitalization is just reaching developing countries, this because the infrastructure of Information and Communication Technologies (ICT) is only starting to reach countries in both regions even though Covid-19 is accelerating digitalization everywhere. To cite an example, industrial robots have grown rapidly especially since 2010, though not yet in many developing countries. Banga and Te Welde (2018) estimate that in the furniture industry, robots will become cheaper than labor in the US in 2023 but only in 2034 for Kenya. Growth of additive manufacturing through frontier 3D systems and CAD/CAM technologies in developing countries depends on the expiry of core patents and remains expensive because of the high cost of capital. According to WEF (2015), these, along with big-data and cloud computing, and access to Artificial Intelligence (AI) are expected to become widely accessible in developing countries by 2022-25 (cited in Mayer 2018). The upshot is that the effects of digitalization are, at best, only starting to be visible in the data so much of the discussion about digitalization belongs to the realm of conjectures.

Section 2 presents the factors affecting the pace of digitalization (figure 1) emphasizing two aspects: the disappearance of jobs associated with 'globotics' (figure 2), and the effects of digitalization on the shape of the `smile' curve (figure 3).

Section 3 analyses the state of national data infrastructures in both regions which is essential in a digitalized world of exploding e-commerce. Differences across countries are great, a signal that many countries are not ready for cross-border e-commerce, an essential ingredient of successful digitalization. Measures of participation in supply chain trade (measures of participation in Global Value Chains (GVCs) in table 3) show comparatively low participation rates for both regions while measures of bilateral trade costs have remained high over the past 20 years.

Section 4 documents the weak performance of SSA and MENA on services, a sector that has become the engine of structural transformation for some developing countries, mostly in Asia. SSA and MENA stand out for having registered the slowest average labor productivity growth in services over 1995-2018.

Section 5 reports on two outcomes, employment and participation in Global Value Chains (GVCs). New econometric estimates suggest that an increase in telecom 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. Other evidence from firm-level data shows causality between the quality of data infrastructure and exports of services. Firm-level estimates show that by reducing the fixed costs associated with exporting, access to internet platforms reduces the share of exports of big firms to the benefit of smaller-sized firms.

Section 6 concludes with recommendations for country-level reforms to accelerate the pace of digitalization and for the design of regulations at a regional level. At the international level, data localization measures can offer protection for consumers and local firms but at the cost of lower overall efficiency.

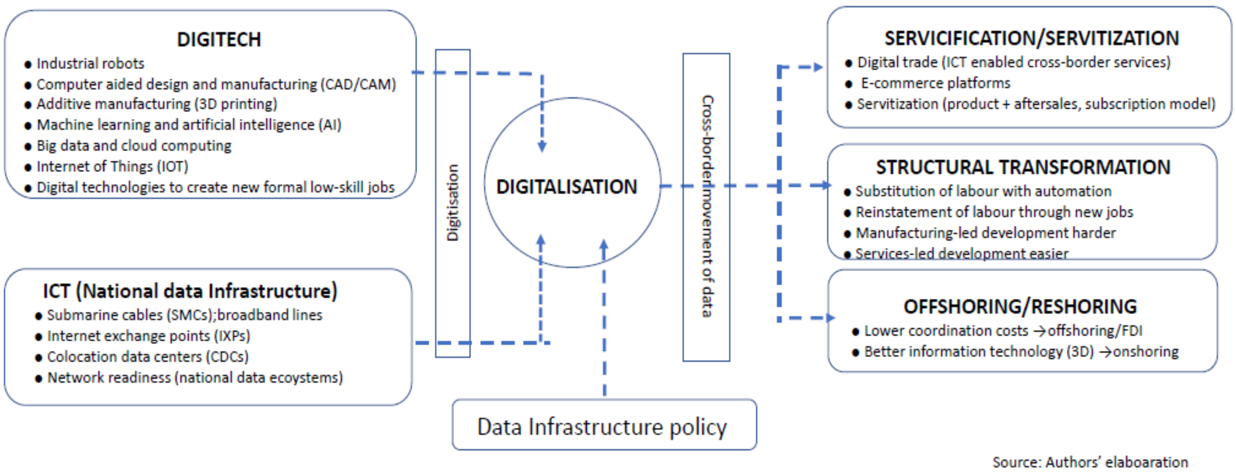
2. A sketch of the digital economy

Figure 1 sketches elements and outcomes of digitalization as it affects the structural transformation in MENA and SSA. Digitalization The digital transformation involves changing/modifying existing businesses and developing new business processes and products using digitalization technologies. Digitalization rests on the hard and soft inputs on the left-hand side. Because MENA and SSA are largely beneficiaries of Digitech[3] developments do far mostly developed elsewhere,

[3] Digitech includes the 4 cross-cutting base technologies (data collection, cloud computing, big data analytics, artificial intelligence) and the two market domains: industrial applications like "industry 4.0", and consumer applications like platforms, products and services. For Sturgeon (2019, table 1), a product or service is part of the digital economy if it includes one or more of the 4 cross-cutting technologies.

these are not covered here although successful digitalization in developing countries will require developing new technologies that create formal low-skill jobs. Instead, emphasis is on ICT infrastructure needed for digitization and digitalization. [4] As shown in section 3, data ecosystems are at very different stages of development across countries in both regions. Poor/unaffordable connectivity and lack of digital skills are the drivers of the 'digital divide' in the digital world.

Figure 1: Inputs and outcomes of the digital economy



The right-hand side lists three outcomes of digitalization covered in the paper. In the center is structural transformation that will affect the shape of supply chains through some substitution of labor with automation but also with some creation of jobs in new activities (section 5.1).

Digitalization combined with regulatory policies will shape the balance between offshoring (aspects of digitech making it profitable for MNEs to disperse activities) and reshoring (digitech activities like 3D printing and digital protectionism). These likely outcomes are yet to be observed at scale in MENA and SSA.

Digitalization is just starting. In developing countries, this transformation will shift workers from agriculture to export-oriented services sectors (as opposed to the 'old' low-productivity-growth non-traded services sectors). It could also shift jobs out of manufacturing although, as noted by Choi et al. (2020), this effect is likely to be small in SSA because of the low share of employment

[4] Digitization is converting analog representations of tangible objects or attributes into a digital format. Digitalization is applying digital technologies to existing business processes.

in manufacturing. The speed at which this transformation takes place will depend on the performance of the services sector through:

- `servicification' (more intensive use of services in manufacturing, jobs in manufacturing becoming more service-oriented with outsourcing of services not specifically related to manufacturing process) and,
- `servitization' (services like aftersales bundled with goods in the sales of firms).[5]

So far, as shown in section 4, servicification in MENA and SSA has been slow.

2.1 The rise of Globotics and the disappearance of jobs

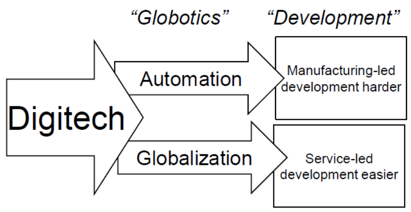
'Telemigration', the new form of work that allows workers to sit in one nation and work in offices in another country is the result of the combination of globalization and robotics—what Baldwin calls `globotics'. This means that workers can now deliver services remotely, for example workers in GCC countries delivering services to firms operating in Europe. For Baldwin (2019), teams will no longer be operating within countries. High-skill workers sitting in the HQs of multinationals firms in the North will be working with teams in lower-wage South. Automation will make a manufacturing-led development more difficult, a preoccupation for SSA countries facing the problem of how to absorb their bulging workforce. By contrast, the use of ICT enabled by the spread of 5G (expansion of bandwidth and reduction in latency) will make a service-led development easier (figure 2(a)). Manufacturing industrialization and service-oriented development strategies would then be substitutes as envisioned by GCC countries.

Digital innovations are a form of capital-biased technical progress that will result in a substitution of capital for labor, a fear expressed by Rodrik when analyzing the employment prospects of digitalization for developing countries. These innovations include machine learning, Artificial Intelligence (AI), and other forms of digitech like CAD/CAM that present a challenge for employment. Many jobs involving routine (and thus codifiable) tasks such as banking transactions that are already digitized, may disappear. Jobs susceptible to rule-based logic will be the most vulnerable. Those where pattern recognition is important will be less vulnerable while those tasks involving human work should continue to be in demand (figure 2b).

[5] In their overview of the stages of development, Baldwin and Forslid (2020) refer to the 'services transformation' when value creation shifted from capital to knowledge. This shift took place in the early 1970s when many manufacturing tasks were automated, but is only starting in developing countries. As pointed out by Sturgeon (2019), updating technology systems in the midst of ongoing operations is akin to "changing a tire while the car is moving".

The flexible allocation of tasks to factors raises productivity, creating a demand for labor in non-automated tasks. This 'reinstatement effect' may not take place as strongly as in the past (see evidence on the US in Acemoglu and Restrepo (2019)). In their overview of the changing nature of work in SSA, Choi et al. (2020) give concrete examples of net job creation in Nigeria and Kenya through new business models. [6]

Figure 2: Two Challenges of Digitalization: (a) Globotics and (b) Disappearance of jobs



Increasingly Difficult to Program →

	Rule-based logic	Pattern recognition	Human work
Variety	Computer processing using deductive rules	Computer processing using inductive rules	Rules cannot be articulated and/or necessary information cannot be obtained
Examples	Calculate basic income taxes	Speech recognition	Writing a convincing legal brief
	Issuing a boarding pass	Predicting a mortgage default	Moving furniture into a third-floor apartment

Source: Frank Levy and Richard Murnane, Dancing with Robots, NEXT report 2013, Third Way.

Source: (a) Baldwin and Forslid (2020); (b) Tirole (2017, table 15.1)

This fear of employment loss, already a preoccupation, has been amplified by Covid-19 which has reinforced what we were already observing: white-collar robots-software perform functions, like those in call centers, traditionally accomplished by humans. With a permanent shift towards Work from Home (WFH) fewer Services activities will be relying on face-to-face contacts.[7] New forms of employment are already taking place. Self-employment is increasing along with the fragmentation of labor into micro jobs.[8] This is a new challenge for many jobs in Manufacturing

[6] In Nigeria, a start up company, a mobile payment system, PAGA was a net job creator via mobile payment system even though human-based transactions were automated as low-skill jobs were created to give access to financial services in small stores. It has been estimated that the well-know M-PESA mobile money system resulted in a loss of 600 bank jobs in Kenya between 2014 and 2017 but that the number of mobile payment agents increased by almost 70,000 (Choi et al. 2020, p.1

[7] Dingel and Neiman (2020) estimate that 35% of US jobs can be performed at home for the US. For a sample of developing countries, Saltiel (2020) estimates it in the range 9% (Ghana) to 23% (Yunnan, China).

[8] Tirole, chapter 15 gives examples of the many platforms that make possible microjobs (Amazonflex, Mechanical Turk, Task rabbit) to name a few.

and Services industries, notwithstanding the observations by Ghani and O'Oconnell (2016) of a services-sector led convergence.[9]

2.2 Navigating the smile curve

Different speeds at digitalization across countries will modify their participation and position along supply chains, i.e. in the pre-production, production or post- production phases along the chain as represented by the `smile curve' which links value-added along supply chains according to the position of the stage in the chain. (See Milberg and Winkler (2013) and Meng et al. (2020) for empirical support to the smile curve.).

The smile curve highlights the distribution of value creation across the segments in a supply chain. Its U-shape indicates that value addition is concentrated at the beginning (design, R&D) and end (Marketing, Services) of the chain. In terms of the international distribution of value-added, developing countries fear that they will lack the capacity to digitalize sufficiently rapidly, and so will be stuck in the production stage where value creation is lowest.[10]

The smile curves in figure 3 depict two possible outcome scenarios of digitalization for a country or region. In one, the region (or some countries in the region) stay stuck in low value-added manufacturing production (scenario 1). Taking the example of the automotive sector over the period 2000-14 in which value-added is broken down into processes (management, R&D, fabrication), Mayer (2018) documents a decrease in the share of value-added going to labor, leading him to conclude that this may be evidence that digitalization may be reflected in a deepening of the smile curve. Under the second possibility, digitalization leads to a fragmentation of production in which production moves closer to the customer (scenario 2).

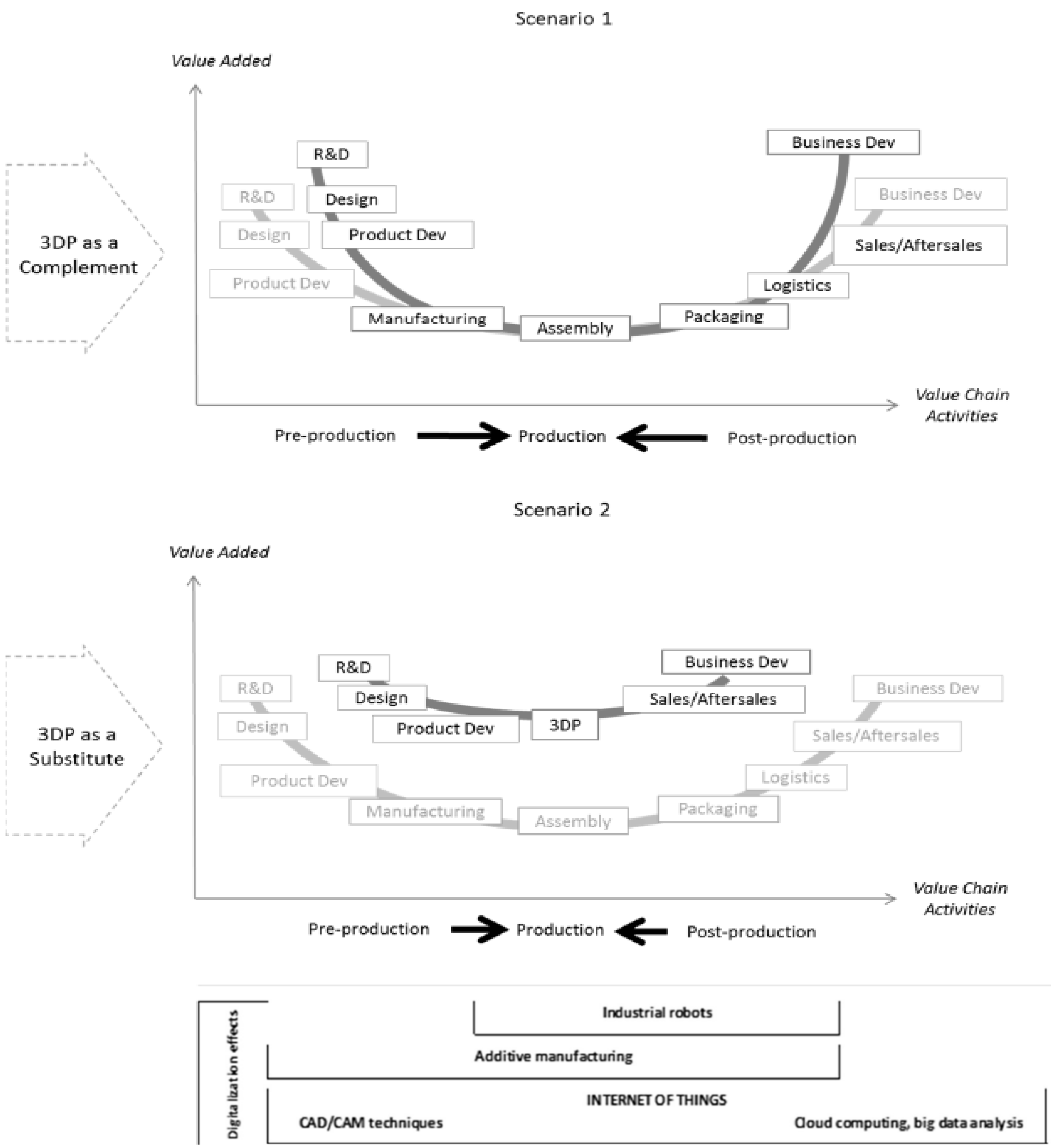
Rehnberg and Ponte (2017) discuss both scenarios by illustrating how the advent of 3D printing could restructure the organization of GVCs. As examples, they discuss the aerospace and automotive industries. They argue that in aerospace, 3D printing may reinforce the current 'unipolarity' of GVCs in which lead firms reap the gains of 3D printing at both ends of the chain. In this complementarity outcome (scenario 1 in figure 3), 3D printing would move the 'sources of comparative advantage' away from the cusp where production is in high volumes. Rehnberg and Ponte note that this scenario reinforces the current unipolar power relations in which lead aerospace

[9] Ghani and O'Connell (2016) show that global growth convergence has been faster in services than in manufacturing They argue that services have contributed more to growth than agriculture and manufacturing in low-income countries. However, for SSA, labor productivity growth has been weak in both MENA and SSA (see figure 4).

[10] De-industrialization is feared in developed countries where employment in manufacturing is being hollowed out as low and medium-skilled jobs have been offshored to developing countries and are also under threat from digitalization (Acemoglu and Restrepo (2019).

firms remain the lead actors with firms in periphery countries caught in the cusp (assembly) of the chain.

Figure 3: 3DP adoption along the smile curve Two scenarios



Source: Adapted from Renhberg and Ponte (2017, figure 5) and Mayer (2018, figure 1). Darker line denotes possible future scenarios; lighter lines denotes status quo

Another possibility is that digitalization leads to a flattening of the curve, perhaps with an upward shift (scenario 2 in figure 3). With 3D printing it is files, not products that move around the world, a way to bypass import barriers. 3D printing has been used both for prototyping and product development and in manufacturing production where economies of scope are important.

In a *complementarity scenario*, 3D and traditional manufacturing technology overlap with 3D allowing higher value added at the two ends of the chain. In aerospace, existing GVC structures remain entrenched with 3D printing with competitive advantage moving away from the ability to produce high volumes at low cost towards design and other segments of the value chain. In a substitution scenario, production moves significantly towards 3DP, production becomes decentralized moving closer to the customer, reducing the need for assembly, packing and transport. Production becomes closer to on-demand with the smile curve flattening to a 'smirk' (Rehnberg and Ponte, 2017). This alternative would represent a more domestically-oriented industrialization in which value-added generating activities would be close to the customer.

These two scenarios represent extremes. In the complementarity scenario the current Northern-owned GVCs lead firms retain control and the associated benefits strengthening unipolarity. In the substitution scenario, the geographic distribution of functions changes, moving closer to the customer towards multipolarity, a more favorable outcome for the South. Mayer (2021) notes that as data on customers becomes a reality thanks to digitalization, middle-income countries could adopt data infrastructure policies that would prevent (or make it costly) for Northern GVCs to acquire that information. Controlling data flows through data localization requirements could then guide structural transformation.

3. National data infrastructures in MENA and SSA

Digital connectivity is the supply side of digital transformation. As of 2019, the Broadband Commission noted that people living in SSA paid an average of 6-8% of monthly income to get broadband data access. Compared with the global average of 2.7% of monthly income (Comini et al. 2021, p.4), this results in major gaps in broadband connectivity across countries, often between rich and poor countries. Many firms and households do not have access to adequate internet speed at affordable cost creating internal connectivity gaps. High costs for transit of data packets to end-users result in low uptake that in turn stymies the overall growth of the data economy through a negative feedback loop (World Bank (2021, chapter 5). Offering adequate internet speed at affordable prices is essential to deliver growth in the services sector.

Both, hard infrastructure to transport goods and digital connectivity to transport data, are necessary to participate fully in supply-chain trade. Poor performance in both infrastructures is a handicap for countries engaging in supply chain trade and digitalizing, especially for SSA countries. Section 3.1 describes the performance of the national digital infrastructure using a ladder established by Comini et al. (2021). section 3.2 explores some outcomes of the quasi-exogenous staggered arrival of submarine cables (SMCs) on indicators of performance, focusing on SSA.

3.1 A data infrastructure maturity ladder

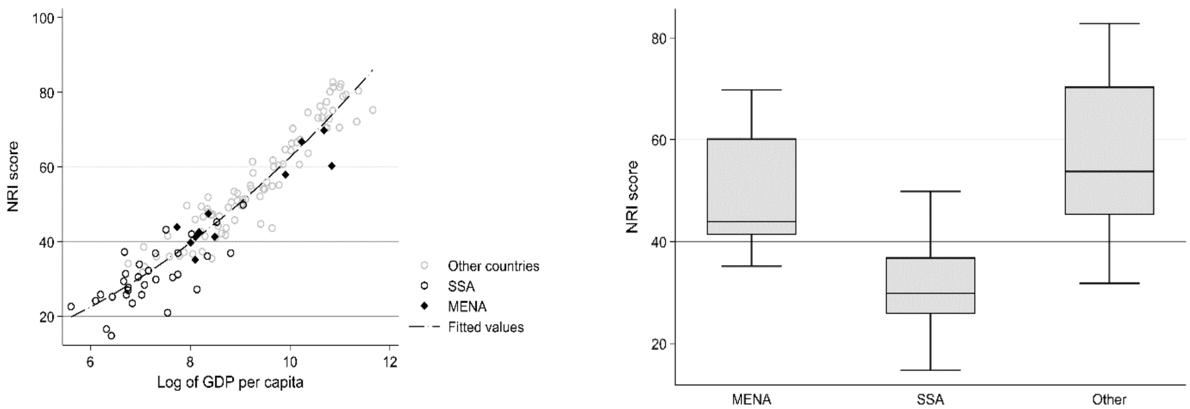
Increased use of data is key for structural transformation. Value of collecting/having access to data arises in the transformation of raw data from raw data collection through analysis and processing. This depends on digital flows both within and across borders which in turn depend on digital connectivity, the costs of connectivity, and regulatory policies.[11] The Network Readiness Index (NRI) in figure 4 shows, that, on average, both MENA and SSA have lower scores than other regions (4b) with many countries below the average predicted by per capita income (4a).[12]

The low average scores of the two regions on the NRI index indicate a data infrastructure of low quality. These low scores are reflected in a shortfall of connectivity that can be summarized in terms of three types of gaps: *coverage* (access to internet), *usage* (access but no use), *consumption* (usage too low to support basic and economic functions) (WB, 2021, chp.5). These gaps are the result of supply and demand factors that are captured in the data infrastructure supply chain ladder in figure 7. MENA and SSA countries are spread along the ladder across 4 stages, each corresponding to different average prices for fixed and wireless broadband. The higher the stage, the lower the costs of connectivity and the lower the price for fixed and mobile broadband.

[11] The Enabling Digitalization Index (EDI) gives evidence that during the pandemic, countries with a better performing digital infrastructure have grown faster. Using the EDI, controlling for several performance-related factors in a sample of 78 countries, Garatti et al. (2021) estimate that an additional point in a country's 2020 EDI score translated to +0.25pp GDP growth in Q3 2020 y/y (i.e., compared to Q3 2019), suggesting that digitization played the role of shock absorber during the COVID crisis. Unfortunately, few MENA and SSA countries are included in the EDI

[12] The NRI is built up from four pillars, each with sub-components. This index of connectivity is selected because it has broader country coverage than the EDI with 31 SSA countries and 14 MENA countries.

Figure 4: Network Readiness Index (NRI) scores in MENA and SSA



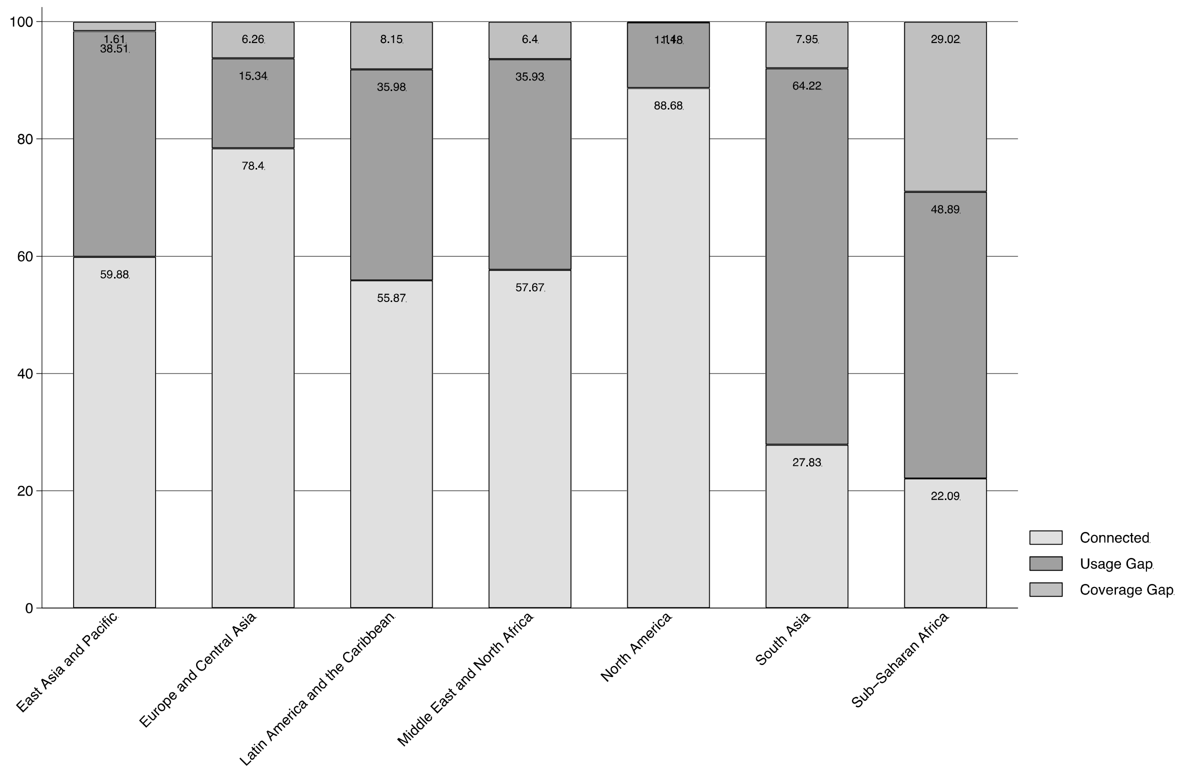
Notes: Scores based on a simple average of scores (number of indices per pillar in parenthesis) over four pillars: Technology (16), people (16), Governance (14), Impact (14). Except for technology, SSA and MENA, figure in the bottom of the regional rankings

Source: Authors' from NRI (2021) data for 132 countries (31 SSA and 14 MENA).

Return to the three categories of digital connectivity gaps. Averages per region for each gap are displayed in figure 5 (the sum of the gaps adds up to population). The *coverage gap* --as measured by 3G availability (i.e. at least 42MBS which is the minimum necessary for broadband access)-- captures the last-mile digital infrastructure availability. In 2018, all but 8 percent of world population (not shown here) had coverage. At 6 percent in MENA, the coverage gap is slightly below the world average. By contrast, in SSA 29 percent of the population does not have access to the internet. This is the highest gap across regions (South Asia, the next highest region with no access to internet stands at 8 percent).

In terms of use, only 49 percent of the population in SSA uses the internet. This is the second highest *usage gap* after South Asia (64 percent). At 36 percent, the usage gap in MENA is about the same as in the other regions, though higher than North America and Europe and Central Asia. Only 22 percent of the population in SSA *consumes* the internet for basic economic and social functions, only slightly above a third of the 58 percent consumption in MENA.

Figure 5: Gaps in 3G wireless broadband internet connectivity across regions (2018)



Notes: Percentage of population on left axis. Coverage gap: percent of population not connected (29% for SSA, 6.4% for MENA). No coverage gap in North America. Usage gap: percent of population that does not use internet (48.9% in SSA). Consumption gap: percentage of population that uses internet (22% in SSA, 58% in MENA)

Source World Bank (2021, figure 5.3 b). Data for 2018

The coverage gap has been closing (See the broadband subscriptions trajectories in figure 8) but the usage and consumption gaps remain high. To close the usage and consumption gaps, countries have to be close to the optical fiber backbone infrastructure--which gives speed-- combined with retail competition. [13] In many SSA countries, the market is so small that several providers would not be profitable.

[13] In Africa, 45% of the population lives at more than 10 km from fiber-optic infrastructure. The Broadband Commission (2019) estimates it will cost $100 billion to deliver universal broadband access to internet across Africa alone.

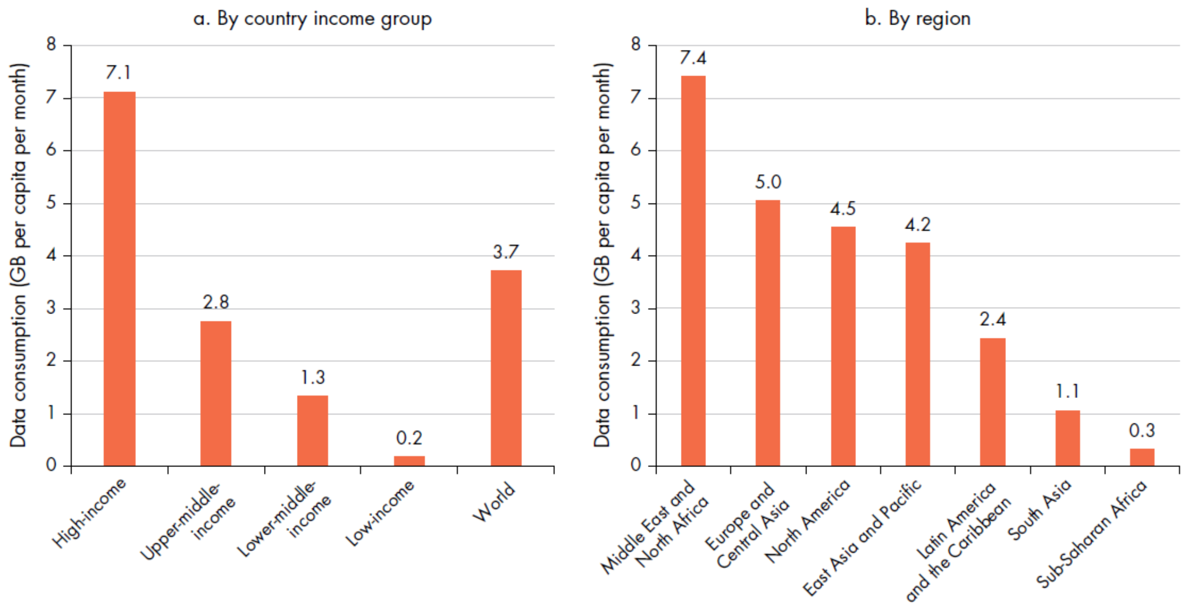
Moreover, restrictive regulatory policies can result in pricing above cost (see e.g. Djibouti in the monopoly cluster in table 1). Furthermore, in countries strapped for cash, governments tax where they can, in this case internet usage since governments control the hard infrastructure. It is instructive that government policies often include high taxation of mobile operators. Rota-Graziosi and Sawadogo (2020) compute the Average Effective Tax Rate (AETR) for a representative mobile operator in 19 gold exporting countries across SSA countries. They estimate an AETR of 46% in the gold mining sector and 68% in the mobile sector. They estimate that higher AETRs are associated with lower market penetration and lower GNI per capita.[14]

SSA and MENA also differ in terms of affordability constraints relating to prices practiced by mobile operators across markets. Figure 6 shows average mobile data consumption across regions. These are large across income groups, a reflection of a combination of low-incomes and high costs. In low-income countries, households are caught in a trap, spending much more on voice a d text-messaging rather than on data services, between 2 and 4% of monthly income (World Bank, 2021). Moreover, up to 70 percent of the population not using the internet is being held back by deficiencies in digital literacy. The mobile consumption gap between MENA and SSA is huge. These diverging patterns could be indicative of their inability to climb up the infrastructure maturity ladder in Figure 7.[15]

[14] Taxation on imports of digital trade is beyond the scope of this paper. AU (2021) estimate that applying the G7 Base Erosion and Profit Shifting (BEPS) tax on the top 10 automated digital services companies would bring around $700 million per annum.

[15] The two-way dependence between adoption and affordability could give rise to a “trap”. The situation is akin to the debate around the case for a ‘big push’ via foreign aid which was founded on the possibility of poverty traps. See Easterly (2009). Here a big push would be needed to raise digital literacy. Also, the discussion of data national data infrastructure here is reminiscent of the discussion on the balance of aid disbursement in the Aid-For-Trade (AFT) literature. Should the mix of AFT disbursements be tilted towards hard-infrastructure (roads, dams) or towards soft infrastructure (customs and regulation, logistics)? Here the mix could be tilted either towards less taxation of mobile operators or towards improving the data infrastructure by increasing the number of IXPs and CDCs.

Figure 6: Mobile data consumption across country income groups and regions

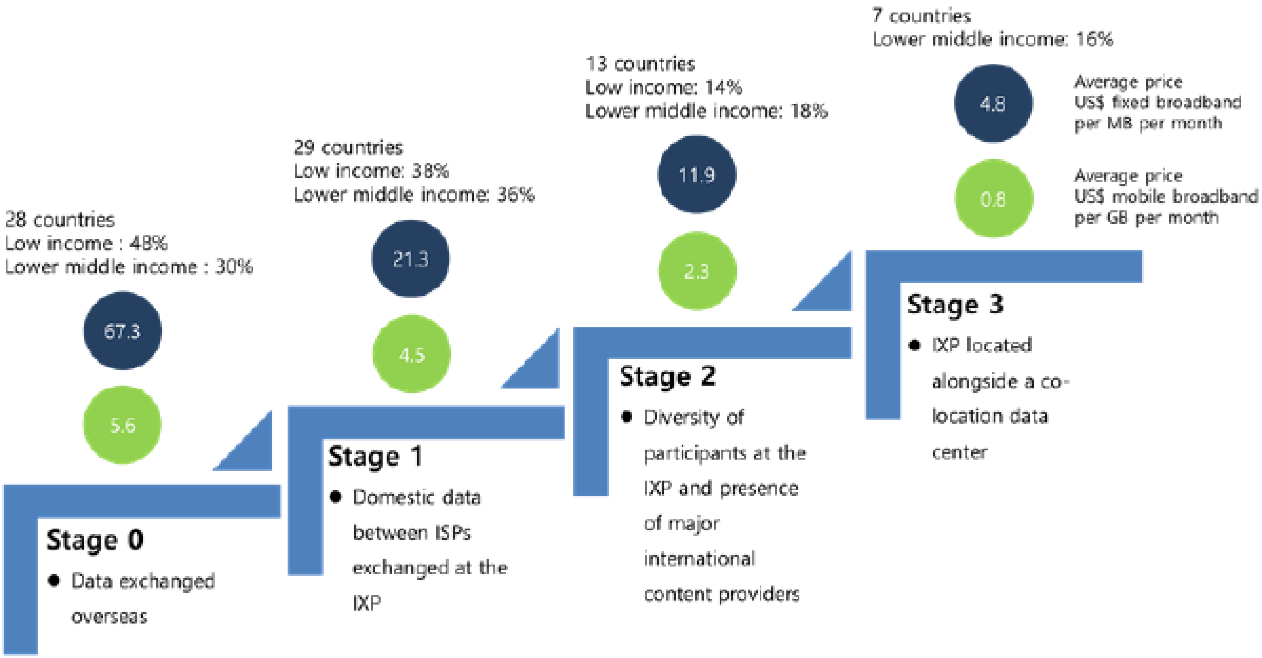


Source: World Bank (2021, figure 10).

The combination of these factors results in national data ecosystems displaying a wide range of prices for fixed and mobile broadband across countries. Figure 7 summarizes these disparities on a data infrastructure maturity ladder. A country's location on the ladder depends on geographical conditions (e.g., market size, landlocked), policies that affect hard infrastructure (e.g., Internet eXchange Points (IXPs) necessary to avoid tromboning[16], and Colocation Data Centers (CDCs) to reduce latency) and soft infrastructure (extent of competition among Internet Service Providers (ISPs)).

[16] Tromboning occurs when within-country information travels back and forth through the network via other countries to reach its destination, causing latency.

Figure 7: Digital data infrastructure maturity ladder



Notes: See table 2 for the list of MENA and SSA countries at each stage in the ladder. Number of internet exchange points (IXPs) per region and number of Colocation Data Centers (CDCs) in Comini et al. figures 7 and 10.

Source: Comini et al. (2021, figure 2). Sample of 65 LIC and LMIC countries. IXP: Internet Exchange Point

Table 2 lists the MENA and SSA countries in each stage on the ladder and in clusters that regroup countries with similar characteristics in terms of income status, access to SMCs, and mobile market concentration. MENA and SSA countries dominate the sample of 65 countries, especially in stages 0, 1, and 2 where there is no participant diversity in terms of internet providers. Profitability in small markets may be too low to support the presence of several providers.

Table 1: National Data Infrastructure in SSA and MENA: by stage and cluster

	Stage 0 (no IXP)	Stage 1(IXP)	Stage 2 (IXP with participant diversity)	Stage 3IXP + CDC
Cluster 1 Competitive market; relatively high levels of mobile and fixed broadband penetration; heterogeneous access to SMCs	CAR Mauritania Niger Somalia Yemen, R.	Burkina Faso Cameroon Cote d'Ivoire Egypt Madagascar Senegal Sudan Tanzania Sudan Tunisia Uganda Zambia	Congo, Dem.Rep. Morocco Mozambique Gambia	Ghana Nigeria
Other *	**5**	**6**	**4**	**2**
Cluster 2 Higher market penetration, fewer IXPs and heterogeneity in terms of access to SMCs	Cabo Verde Chad Guinea Bissau Lesotho Sao Tome & Principe. Sierra Leon South Sudan Syrian Arab Rep.	Benin Congo,Rep. Liberia Malawi Mali Rwanda Togo	WBank & Gaza	Kenya
Other *	**3**	**3**	**2**	**1**
Cluster 3 SIDS with no IXP or small markets with monopolies of duopolies	Comoros Eritrea Ethiopia	Eswatani		Djibouti
Other *	**3**	**3**	**2**	**1**

Notes: Data for 2018. Sample of 65 Low and middle-income countries. *: number of other LIC and LMIC countries in each stage and cluster.
Source: Comini et al. (2021, table 2). See description of characteristics in each stage on the ladder in figure 8. The three clusters are obtained from non-hierarchical clustering over the following characteristics: income status, mobile penetration (3G), access to SMC, and mobile market concentration (Herfindhal index).

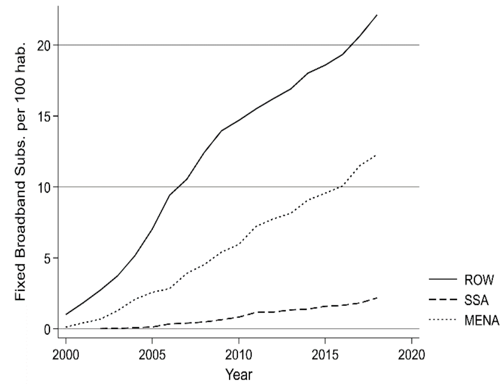
3.2 Access to submarine cables

The growth of the digital economy depends first on the availability of the hard infrastructure through the network of SubMarine Cables (SMCs). Figure 8 shows the time profile of broadband subscriptions in MENA and SSA compared with those for the Rest-Of-the-World (ROW). In absolute terms, the gap between SSA and the ROW (and MENA) has increased. Considering broadband and fixed lines together, MENA had reached a coverage of about 102% of the population, implying that at least some users subscribed to both fixed and broadband connection. Figure 9 suggests that the digital divide—understood in terms of internet connectivity, access and use---has reduced for MENA but not for SSA.[17]

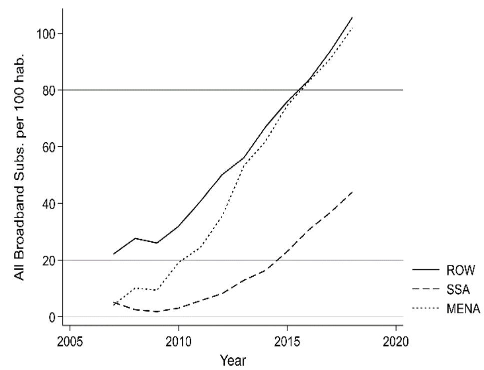
[17] Choi (2020, p.34) reports that Africa's continent-wide level of international internet bandwidth used in 2017 (7,314 billion bits per second) represented only 1 percen of the World's total, one-third the level of MENA, about equal to

Figure 8:Broadband subscriptions MENA, SSA, and the ROW

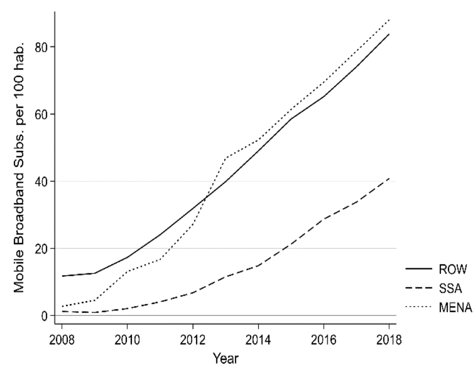
a) FIXED



b) MOBILE



c) ALL



Notes: Percentage of the population with subscriptions (simple averages across countries in each region). ROW figures exclude MENA and SSA regions. ALL(c) subscriptions = FIXED(a) + MOBILE(b).
Source Authors from ITU (2020)

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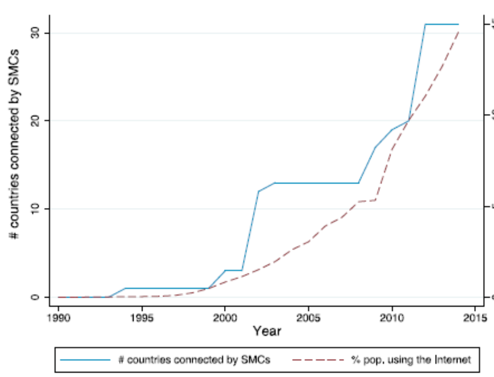
the level of Chile or Romania. Of the 20 least wirelessly connected countries in 2017, 18 are in SSA (Telegraphy 2018)..

The relatively slow penetration of the Internet in SSA could be due to the slow deployment of SMC cables, or of usage, once coverage secured. [18] Figure 9a shows that the share of population using the internet has grown exponentially with the cumulative number of African countries connected to the world communications network. Yet, in 2015 less than 20% of the population was connected to the internet. Fixed-effects estimations of the successive arrival of SMCs laid on African coasts over 1990-2014 suggest that one SMC laid on the African coast is associated with an average 2.4 percentage point increase in internet penetration rates (Cariolle (2020, table 1)). However, it could still be that the laying of SMCs cables was not exogenous and/or that political and geographical factors influenced adoption rates.

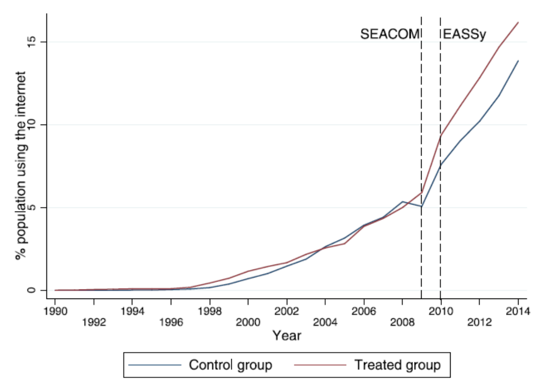
The arrival of the EASSy/SEACOM cables in 2008-09 was an exogenous technological shift in the capacity to carry international communications. The deployment of these cables was a quasi-experiment since all countries along the southern and eastern African coast got access regardless of the maturity of their national ecosystems. Figure 9b shows that up until the arrival of this new generation of cables, subscription rates of countries along the eastern and southern African coast were parallel with those in the rest of Africa (control group). Adoption rates diverged sharply thereafter.

Figure 9: Submarine cables (SMCs) arrivals and subscription rates in SSA

(a) SMCs internet subscription



(b) : Internet penetration: high-speed SMCs



Source: Cariolle (2020, figures 4 and 5) from ITU (2019) and Teleography). (a) is data for 49 countries; (b) Vertical bars indicate year of arrival of SEACOM and EASSy cables.

[18] Over 1990-2010, 400 SMCs transmit 99% of international communications (broadband internet, phone calls, videos, text messages and all other digitized data)..

To check that SMC deployment led to an increase in internet usage, Cariolle regressed adoption rates over 2002-2012 on an SMC arrival dummy, country dummies, a time dummy, and a set of controls that included GDP per capita, percent of urban population, public expenditures/GDP, population size, access to electricity and the number of IXPs. Controlling for these factors, arrival of the EASSy/SEACOM cables led to a statistically significant (at 1% level) 5-6 percentage point increase in the share of the population using the internet, a result robust to exclusion of landlocked countries, large countries with emerging telecom markets. His estimates also show that internet uptake is significantly correlated with the number of IXPs.

Also exploiting the exogenous arrival of SMCs, Simione and Li (2021) estimates a large and significant effect of internet penetration on real per capita GDP growth and productivity at the aggregate and sector levels across SSA. They show that higher internet penetration is positively associated with the share of services in the economy and negatively associated with the share of industry. Internet penetration has a positive association with services employment. These findings are in line with predictions of models of the ICT revolution where manufacturing becomes jobless and services, highly tradable (Baldwin and Forslid (2020) and Mayer (2021)). The relatively low internet connectivity documented here could have contributed to the low labor productivity growth in services in MENA and SSA countries.

It is still early to hope to detect the range of likely effects of the ongoing digitalization described in table 1. However, firm-level estimates point to the possibility that the arrival of fiber-optic SMCs may be leading, at least temporarily, to a divide between firms in high-income and low-income countries when it comes to exporting. Cariolle et al. (2020) merge data from the World Bank's Exporter Dynamics Data Base (EDD, Fernandes et al. (2016)) for 48 coastal countries with bilateral data on maritime infrastructure deployment across 171 countries over the period 1997-2014 during which the share of cable-connected countries rose from 40% to 90%. Using data on bilateral exports, they find that the arrival of an SMC connection increases the number of exporting firms by 9.6% in high-income countries and reduces it by 3% in low-income countries. They also find that exposure to seismic events in the vicinity of SMC landing stations provokes additional exits of firms in export markets. Their results are robust to the inclusion of lead and lagged variables (lead variables are not correlated with participation but lagged are, suggesting no reverse causality).

In sum, studies suggest that the arrival of fast internet through SMC rollouts have had positive effects on employment so far. Information and communication costs have been reduced but what has been observed so far is only part of digital transformation described in figure 1. As shown in section 4, these developments have not translated in a rapid growth of export of services across MENA and SSAis may not be sufficient for the less productive firms lacking financial and organizational capacity.

4. Servicification and GVC participation patterns in MENA and SSA

A growing share of services in GDP (often called `servicification') is part of an economy's transformation along its development path. This process is well documented, at least since Chenery and Syrquin (1975) on the basis of Engel's law (food is an inferior good and services are a normal good in consumption baskets). However, until the advent of the ICT revolution, the "simultaneity of production" and "non-storability and perishability" that characterized services emphasized the physical proximity between producers and consumers. The importance of face-to-face interactions was viewed as a 'cost disease'. Providers of Services could not break the curse of the domestic market through international trade[19]. This is no longer so, as advances in technology allow some services to be stored (e.g. music, financial transactions, e-commerce) resulting in increasing portability and tradability. World trade in services has grown by 5.4% annually over 2005-2017, a faster rate than trade in goods WTO (2019).

Taking clue from urban economics where services, like cities, seem subject to external economies, Baldwin and Forslid (2020) argue that service exports spurred by digitalization can be the engine of structural transformation in developing countries provided that the use of telerobots is not constrained by high costs. For Baldwin and Forslid, with machine-learning, "it is only a matter of time before the face-to-face and face-to-machine constraints are relaxed (p. 8). However, while a relatively slow pace of adoption of robots will slow structural transformation, it gives breathing space for countries to exploit their comparative advantage in low-skill activities. [20]

Evidence is also growing that firms jointly selling products and services perform better than those focusing on only one. Drawing on a large panel of Belgian firms, Ariu et al (2016) show that firms selling goods and associated services ('bi-exporters') fared better during the 2008-09 financial crisis. On the same data set, Ariu et al. (2020) establish a superior performance for bi-exporters over those selling the same products to the same markets but without associated services. They attribute this result to the perception that a good alone and the same good with the service are viewed as two different products, so that at a given price, the demand for the good is higher when a complementary – and costly – service is exported along with the good. This is equivalent to increasing the perceived quality of the good. So far however, there is no evidence of similar outcomes in developing countries.

[19] (Nayyar et al. 2021) cite Baumol's example of the cost disease as musicians could not increase wages as in manufacturing when labor productivity went up allowing firms to raise wages an cut costs.

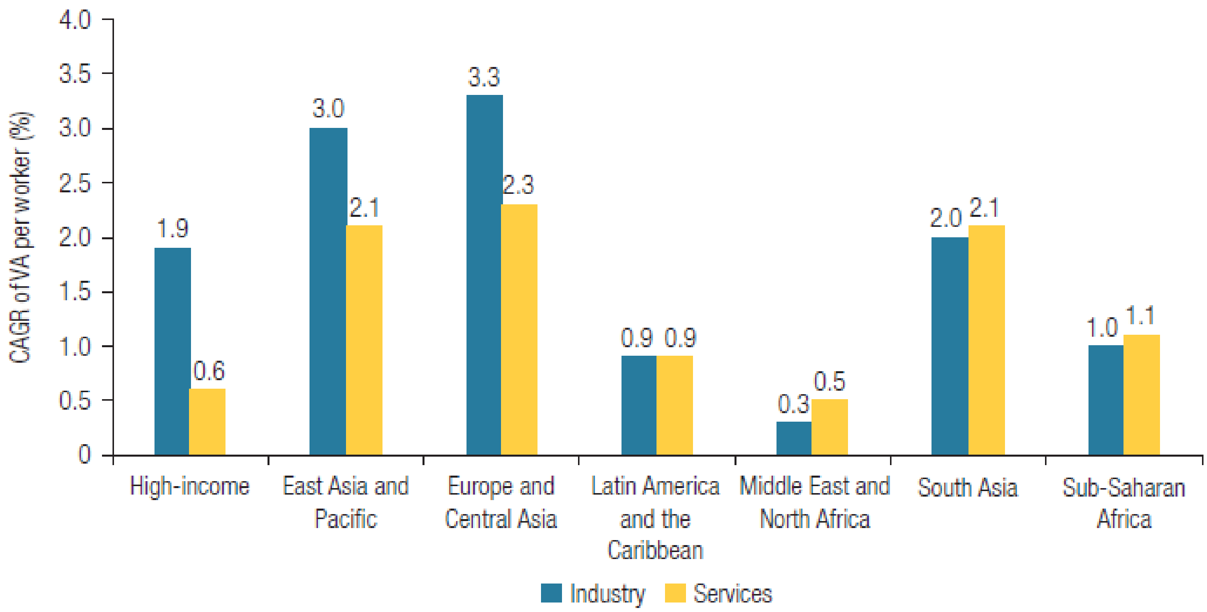
[20] Data over 2000-2014 on the stock of industrial robots from the international Federation of Robotics shows a stock of 1127 robots in advanced, emerging and transition economies and 52 in the rest of the world. The share of Africa (all countries included) was about 2% of world sales in 2015, 15 times lower than its share in world GDP (Banga and Te Velde (2018, figure 9)).

4.1 Slow servicification across MENA and SSA

Servicification has been slow in Arab countries over the past two decades in spite of high internet penetration. Since 1990, the share of services in GDP rose by 7.5 percentage points in Arab economies, half the increase for middle-income countries (MICs). Services share stood at 49.7% in Arab countries vs. 54.7% in MICs. Over 1980-1999, services export grew on average by less than 10% a year compared to the world average of 16% and Africa was the region that contributed the least to trade in services, accounting for only 1% of world trade in services (WTO 2019).

Both regions also stand apart for their low rates of labor productivity growth. In both regions, labor productivity growth is low in both industry and services. In MENA, labor productivity growth rates are half those in the next lowest region (figure 4). Further decomposition shows that two-thirds of the productivity growth is attributable to within-sector productivity growth (rather than between as in e.g. a shift of labor out of agriculture). And, except for East Asia, productivity growth within the services sector contributes more than productivity growth within industry to aggregate productivity growth.

Figure 10: Labor Productivity Growth in industry and services by region, 1995-2018



Notes: CAGR: Compound Annual Growth Rate. High income countries: GNI above $8995 in 1994. Industry includes manufacturing, mining, utilities and construction.
Source: Nayyar et al. (2021, figure 01) Data from WDI data base

This diverging pattern for the two regions is significant for at least three reasons. First, stylized facts from Services firms in 20 countries reported by Nayygar et al (2020) suggest Services have characteristics that should be favorable for that sector to fulfil the 'ladder' role for industrialization

(Ghani and O'Connell (2016)). Recognizing heterogeneity across sectors, overall, services are not very capital intensive, and size matters less than for manufacturing, two favorable characteristics for start-ups in capital-poor countries where achieving minimum scale is difficult. Second, better communication and organization technologies lower coordination costs encouraging offshoring reflected in increased FDI, vertical specialization and intra-industry trade. This makes it more difficult to pursue a manufacturing-sector led growth as discussed in section 2. These outcomes are coherent with the observed earlier peaks of manufacturing (i.e. at lower per capita incomes) in African countries.[21] Third, Fujiwara and Matsuyama (2020) show in a technology-gap model that if adoption of new technologies in the services sector in low-income countries is slower than in the manufacturing or agriculture sectors, then premature industrialization obtains. Peaks in manufacturing productivity are reached at lower shares, later, and at lower per capita income compared to richer countries with smaller technology gaps which industrialized earlier.

4.2 A Services readiness indicators

These low labor-productivity growth rates in MENA and SSA suggest barriers to trade in services.[22] Table 1 displays indicators of services readiness for MENA and SSA countries. Col. 1 shows that among SSA countries, Ethiopia has a closed policy regime, Ghana and Kenya, open regimes. With the exception of Morocco, in most cases, the Services Trade Restrictiveness Index (STRI) scores for MENA countries are above 50, an indication of a fairly restrictive policy regime. The Network Readiness Index (NRI) in column 7 (also reported in figure 5) shows high values for GCC countries and somewhat higher values for other MENA countries than for SSA countries, with the lowest scores for SSA LDCs. Internet use by firms (col. 2) and individuals (col.3) are higher in MENA countries than in SSA countries. The digital skills index (col. 4) scores are higher for MENA than SSA countries, yet are relatively low.

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[21] See McMillan et al. (2014) and Cadot et al. (2016)

[22] Hoekman (2021, figures 14 and 15) reports STRIs for most Arab countries in 2008 and AVEs for a handful of countries for 2016. A tally of the number of harmful measures over 2009-2020 show that Egypt and Saudi Arabia account for ¾ of the 709 measures across 14 countries.

Table 2: Services Dashboard

Economy	Services trade restrictiveness index (STRI) (0-100)	Percentage of firms using email	Percentage of individuals using the internet	Digital skills index (0-100)	Magnitude of forward linkages for global innovator services (%)	Magnitude of forward linkages for low-skill tradable services (%)	NRI index (0-100)
Column	1	2	3	4	5	6	7
MENA - GCC							
Bahrain	50.8	—	99.7	65.7	0.8	1.3	57.6
Qatar	60.1	—	99.7	72	0.9	1.1	60.3
Saudi Arabia	42.5	—	95.7	71	1.5	1.0	58.0
MENA – non GCC							
Egypt	51	68.5	57.3	61.0	1.2	1.8	42.6
Iran	66	—	70.0	51.8	1.8	5.9	43.9
Jordan	48.2	59.1	66.8	65.3	—	—	47.5
Lebanon	43	84	78.2	67.5	—	—	41.3
Morocco	21.0	98.4	74.4	48.0	—	—	39.7
Tunisia	44.5	95	66.7	53.9	0.5	10.7	41.3
SSA - LDC							
Ethiopia	88.2	78.6	18.6	45.8	0.9	4.6	23.5
Lesotho	27.3	46	29.8	41.5	—	—	27.7
Madagascar	18.7	59.6	4.7	39	0.3	1	25.8
Malawi	34.2	78.3	13.8	30.7	—	—	25.2
Mozambique	18.6	50.8	20.8	29.0	0.3	6	24.2
Togo	—	80.4	12.4	—	0.5	7.9	—
Uganda	34.5	39.2	23.7	40.4	0.5	4.4	31.4
Zambia	21.0	55.8	17	41.7	—	—	30.5
SSA – non LDC							
Botswana	41.7	82.4	41.4	44.9	—	—	36.9
Cameroon	26.4	52.0	25	48.3	0.7	7.0	29.9
Ghana	18.4	64.7	37.9	53.5	1.7	13.7	37.0
Kenya	29.5	69.5	22.6	59.1	—	—	45
Mauritius	16.9	68.4	64.0	55.7	2.6	1.8	49.8
Namibia	37.0	76.5	36.8	43.9	7	5.9	36.1
Nigeria	27.1	24.1	7.5	40.4	—	—	30.4
Senegal	19.0	67.0	29.6	53.4	0.9	10	36.9
South Africa	34.5	54.2	56.2	37.9	—	—	45.3
Tanzania	30.7	29.1	16.0	47.8	0.6	1.4	33.9

Source : Nayyar et al. (2021, table A1 for cols. 1-6. Col. 7 Network readiness Index.
Notes col.1 Open policy regime (STR score 0-25). Closed policy regime (STR score 75-100). Col. 5. share of intermediate sales in the output of information and communication technology, finance, and professional, scientific and technical services multiplied by the share of these services in total employment. Col. 6 is the share of intermediate sales in the output of transportation and wholesale and retail trade multiplied by the share of manufacturing in GDP. — = no data available.

4.3 Performing national data infrastructures are reflected in more intense trade in services

Several recent studies using Instrumental Variables (IV) techniques to establish causality, show that the quality of data infrastructures (SMCs, IXPs, CDCs) influence firm performance. The samples cover developing countries including MENA and SSA countries, though the evidence are not focused solely on these two regions like the results in table 4. Most evidence suggests that connectivity is helpful to increased participation in trade, at least at the firm or product levels, but some suggests that a digital divide across countries may be growing.[23]

[23] In a companion study for this project, Atiyas and Dutz (2021) focus on uptake and use of mobile internet focussing on household data. Among others they uncover a negative correlation between uptake and the degree of concentration

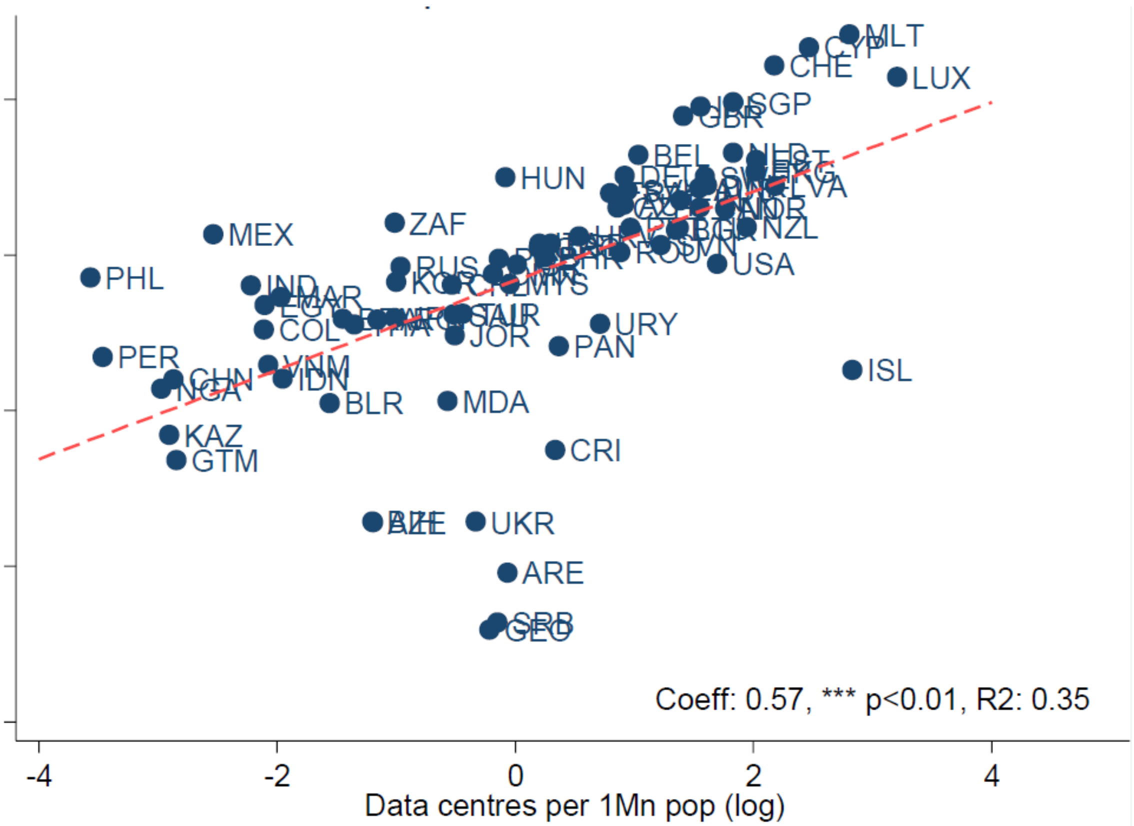
Using the OECD-WTO Balance Trade in Services Database (BATIS), in a cross-section covering 11 categories of Services for 191 countries, El-Sahili (2020) finds that cross-country variation in the number of SMCs and their timing of arrival stimulate services trade, though not always significantly at the sector level. To control for the likelihood that SMC cables are not exogenous, he constructs two instruments for SMCs and the number of regional internet users excluding the country in question. Both instruments are significant at the 1% percent level. In the sample including only non-OECD countries, the elasticity to SMCs of aggregate exports of services is 0.24 and 0.1 for imports. For exports, doubling the number of SMC cables would lead to an increase in aggregate exports of services of $2.5 billion.

Van der Marel (2021) explores the sources of comparative advantage for trade in Services by interacting services sector shares with two indicators of hard infrastructure (Internet Exchange Points (IXP) and Colocation Data Centers (CDCs) in a cross-section of 222 countries drawn from the WTO-UNCTAD-ITC annual trade in services data set. Figure 11 shows a strong positive correlation between the export of information services as a share of total services exports and data centres per million population.

To establish causality between exports of Services and data infrastructure, Van der Marel interacts the infrastructure variables multiplicatively with variations in software-intensity across Services sectors (taken from the US). To control for the endogeneity of country-level availability of infrastructure, IXPs and CDCs are regressed on indicators of exposure to natural hazards. The IV results indicate that a 10 percent increase in data centers results in a statistically significant expansion of data-related services of 1.6 percent. The statistical significance of the results generally holds when using a revealed comparative indicator instead of export shares and introducing GDP per capita as a regressor.

in the mobile market as well as the key regulatory proxy of Mobile Termination Rates (MTRs) which is the price operators pay to rivals for terminating a call when a subscriber of an operator calls a subscriber of another operator.

Figure 11 :Correlation between exports of information Services in GDP and Data Centers



Source: Van der Marel (2021, figure 4)

Access to internet platforms give the opportunity for Small and Medium Enterprises (SMEs) to enter exporting as they pay lower fixed export costs. Fixed costs of indirect exporting fall at a higher rate than fixed costs of direct exporting. Using eBay data, Lendle and Olarreaga (2017) show that the internet gives access to exporting. Lainz et al. (2018) find that SMEs tend to participate more in GVCs in countries with a higher share of population that has fixed broadband subscriptions. Using the World Bank's Enterprise Survey (WBES) data, controlling for various country characteristics Meng Sun (2021) shows that the development of the internet reduces the share of the top 5% or 25% of exporters in bilateral trade at the HS6 level. He also finds that improved SMCs connection leads to a lower share of exports for large firms. By contrast, telephone development is not negatively associated with the export share of large firms suggesting that the formation of e-commerce platforms is a game changer, but not development of the telephone. Visser (2019) finds that broadband subscriptions are positively associated with the extensive and intensive margins of differentiated exports. Splitting the sample into development levels, internet penetration may facilitate the extensive margin of exports between low and high-income countries, but not within these groups.

5. Jobs, trade costs, data infrastructure and GVC-related trade

This section covers evidence on three inter-related of digitalization. First is the fear of job losses from the advent of the digital technologies in SSA. Section 5.1 summarizes some of the evidence. Second is the effect of digitalization on the 'death of distance'. Trade costs are still high in SSA and MENA. These high trade costs are reflected in the low participation by both regions in the supply chain indicators reported in section 5.2. Third is the nexus data infrastructure-trade costs-GVC participation. Section 5.3 reports on econometric estimates showing that an increase in telecom subscriptions increases GVC participation, directly, and also indirectly via a reduction in trade costs.[24]

5.1 Arrival of fast internet and jobs

The future of work will be determined by the tension between automation in what Choi (2020) calls "old" sectors and innovation in "new" sectors. New technologies entering the exports of firms participating in GVCs present a threat for low-income countries through two channels. First, the new technologies are biased towards skills and other capabilities, reducing the comparative advantage of unskilled labor-abundant countries, like those in SSA. In addition, this bias makes it harder for low-income countries to offset their technological disadvantage with their labor-cost advantage as the elasticity of substitution between new technologies and unskilled labor is low (Rodrik (2018)). Alonso et al. (2020) reach a similar conclusion in a model where the AI revolution, an increase in the productivity of capital that substitutes closely for labor. An increase in the productivity of robots then drives a wedge between North and South as they benefit differentially from the reduction in costs. Robots are adopted first in the North where gains are greatest.[25] When robots substitute for unskilled labor, technical progress leads to a permanent decline in the terms of trade of the South. Their simulation-based projections suggest that Africa's demographic dividend (by 2030 more than half of the global labor force is expected to come from Africa), may be stolen by robots. [26]

[24] Participation in supply chain trade takes place at the firm level. We review firm-level evidence in our companion paper. Studies using firm data show that Foreign Direct Investment (FDI) is the primary driver of GVC expansion. See Qiang et al. (2021) for further evidence and country case studies.

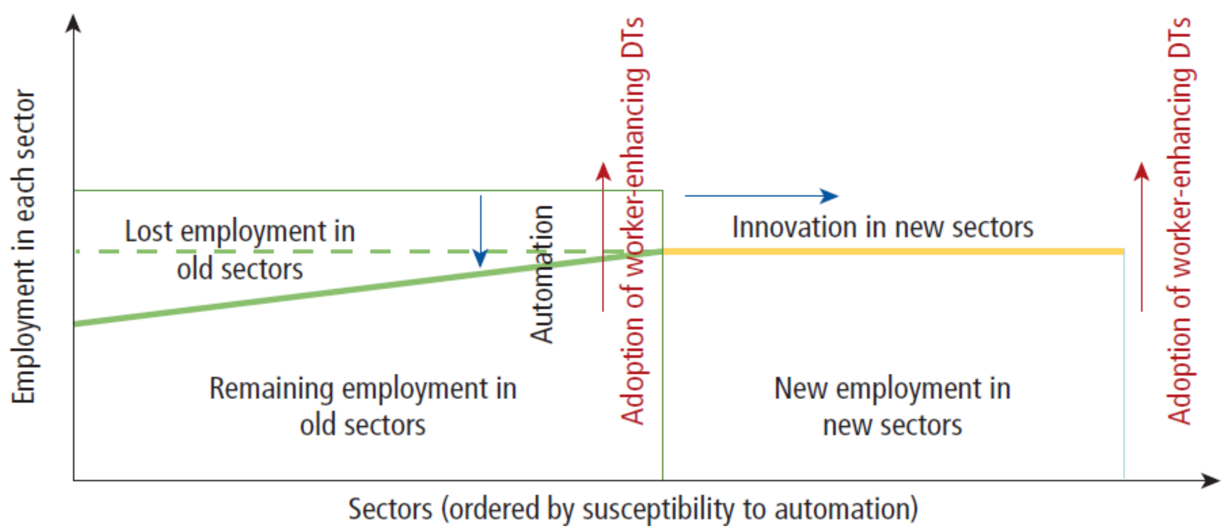
25 This conjecture is supported by a scatter plot of robot adoption and changes in wages which shows a positive association, a proxy for the elasticity of substitution between robots and labour (See their figure 4). They report on suggestive simulations in a model with two types of labour where robots and unskilled labour are substitutes. For an elasticity of substitution between robots and unskilled labour above unity, an increase in the productivity of robots results in a fall in per capita GDP in the South.

[26] Based on data on the stock of industrial robots from the international Federation of Robotics, Ghosdi et al. (2020) find support for a complementarity of robots with skilled labour and substitutes with unskilled labour.

Choi et al. (2019) advance three reasons why digitalization in SSA has the potential to benefit less-skilled work. First, the displacement effect of skill-biased digital technologies will be less in SSA because the manufacturing sector is small (8 percent of employment). Second, productivity improvements may create demand for many products, if only because, in contrast with the saturated markets in high-income countries, demand is not satiated so that demand would be less responsive to price reductions from further productivity improvements. If digitech generates increases sufficient increases in production, new jobs will be created by the reinstatement effect discussed in section 2. Third, the low levels of human capital provide scope for the creation of new low-skill jobs as in the case of M-PESA mobile payment jobs in M-PESA in Kenya.

Figure 12 illustrates the employment effects of technological progress on employment opportunities in 'old' sectors (i.e. manufacturing) and 'new' (i.e. new activities). Loss of opportunities in old sectors is less in SSA (shown by the dotted line) than in high-income countries because manufacturing harbors relatively few jobs and wages are lower making adoption of new technologies in old activities less profitable. Job opportunities through innovation in new sectors is large because demand is not satiated. Figure 12 then suggests that it is possible that digitalization will be a net job creator.

Figure 12 Impact of Technological Progress on Work Opportunities



Source: Choi (2020, figure 1.1) adapted from World Bank 2019
Note: The upward red arrows illustrate the potential adoption of worker-enhancing digital technologies to boost the productivity of low-skilled workers across sectors, lowering costs, expanding output and increasing employment. The blue lines show the effects of technical progress on employment in old and new sectors. The dotted line show that employment loss in 'old' sectors (the area of the trapezoid in the left) is expected to be smaller than the gain in the 'new' sectors (rectangle on the right). DT= Digital technology

In a first study exploiting the gradual arrival of SMC cables across Africa, Hjort and Poulsen (2019) explore the arrival of 'fast internet' on the performance of firms in 12 countries covering half a billion people during 2006-2014 by combining household and firm data. They use data on night lights as a proxy of changes in incomes. They show that the probability of an individual being employed increases with the arrival of the internet for individuals is similar for individuals along the education ladder and that the probability of holding an unskilled job did not decrease (i.e. was not statistically different from zero) with the arrival of SMCs. They also estimate that internet arrival has shifted employment shares towards higher-productivity occupations. For their large sample of countries, arrival of fast internet has had positive effects on employment over the period. [27]

5.2 Trends in GVC trade by region

Insufficient hard infrastructure in Africa's generally inhospitable environment, has been singled out as the major culprit for poor integration outcomes. Africa's road [paved] density of (3.4) km [0.7] per 1000 inhabitants is less than (one half) [one fifth] of the respective global averages (Gwilliam, 2011). [28] Poor quality hard infrastructure combined with deficient logistic markets have resulted in high trade costs reflected in low participation in Global Value Chains (GVCs) across SSA and MENA.

Trade costs estimated from a gravity model for a sample of 167 countries show that. on average, the 35 SSA countries had bilateral trade costs of 256 percent above those of the top importers in 1995 and of 226 percent in 2015, showing catch up during the period. The corresponding estimates for the 15 MENA countries are 182 percent in 1995 and 144 percent in 2015.[29] According to the gravity view of the world, average bilateral Trade Costs (TC) for both regions are about two to three times those of the top importers. For MENA, the average catch-up rate to the benchmark is 21 percent, almost twice that for SSA at 12 percent. When disaggregated into two sub-groupings

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[27] For the West Africa Monetariy Union (WAEMU), Avom et al. (2021) estimate that the arrival of internet destroys low-skill jobs and creates high-skilled jobs with a net positive effect on total employment.

[28] Using data on roads for 39 African countries combined with geo-referenced data and an extraneous trade-cost elasticity to distance, Jebwab and Storeygard (2019) estimate that increased market access from improved roads, contributed an extra 5-10% to the observed urbanization over the 1960-2010. Applying these estimates to the proposed Trans African Highway (TAH) project which calls for increasing the current (2010) 1490 km network to 42000km, they estimate that, by 2040, the induced increased market access from the TAH would increase urbanization by 0.7%-6%. In an ideal setting with controls for many confounding influences, Ghani et al (2016) study the effects of the staggered rehabilitation of roads in India's 'golden triangle'. They estimate that output levels increased by 49% over the decade for incumbent firms in the 0-10 km range while there was no growth for firms in the 10-50 km range.

29 Figures from Melo and Solleder (2021, figure 1) Ever since the start of the literature on the 'border effect', estimates of the border effect have been high. Anderson and Van Wincoop (2004) estimate trade costs around 70 percent between Canada and the US, two countries in an FTA sharing a common language.

in each region, for MENA, bilateral TC fall faster for non-GCC countries that catch up with GCC countries. Within SSA, trade costs are higher for the landlocked group than for coastal countries, falling, yet less rapidly, than for the benchmark group, suggesting that this group is losing ground.

Table 3 displays the evolution of measures of participation in GVCs for three years over the period 1995-2015 for all regions and for a selection of countries in MENA and SSA. Both regions started low and maintained low backward shares (GVC_{bs}) indicating relatively less increases in the imported input content of gross exports over the 20 year period than for other regions. This pattern is consistent with high policy-imposed trade barriers and of other barriers to trade, or at least with trade costs falling less rapidly than in other regions. On average, according to these measures, exports from MENA and SSA embody less intermediate imports than other regions. On the forward side (GVC_{fs}), both regions have the highest shares throughout the period, an indication of exports concentrated in raw materials and agricultural products with little transformation undergoing further transformation before final consumption. For other regions, GVC_{fs} measures have either remained constant or decreased. In sum, participation in GVC trade is low on the backward side for both regions, and unlike other regions, GVC trade on the forward side has not fallen implying that value-added generated in the region has not gone up.

Table 3: Trends in GVC participation by region

	Backward (GVC_{bs})			**Forward (GVC_{bs})**			**Total (GVC_s)**			
	1995	**2005**	**2015**	**1995**	**2005**	**2015**	**1995**	**2005**	**2015**	**Trend**
By region										
World	**0.25**	**0.29**	**0.28**	**0.19**	**0.20**	**0.20**	**0.44**	**0.49**	**0.48**	
East Asia & Pacific	0.22	0.25	0.25	0.17	0.19	0.19	0.39	0.44	0.43	
Europe & Central Asia	0.31	0.35	0.35	0.20	0.21	0.21	0.51	0.56	0.56	
Latin America & Caribbean	0.19	0.20	0.19	0.13	0.13	0.15	0.33	0.33	0.33	
Middle East & North Africa	*0.18*	*0.15*	*0.14*	*0.22*	*0.26*	*0.27*	*0.39*	*0.41*	*0.41*	
North America	0.16	0.18	0.16	0.20	0.21	0.21	0.35	0.39	0.37	
South Asia	0.11	0.14	0.15	0.18	0.20	0.19	0.29	0.34	0.35	
Sub-Saharan Africa	*0.15*	*0.14*	*0.13*	*0.22*	*0.25*	*0.25*	*0.37*	*0.39*	*0.39*	
By Country										
Egypt	0.11	0.14	0.11	0.23	0.25	0.26	0.35	0.38	0.37	
Kenya	0.15	0.17	0.17	0.18	0.20	0.19	0.33	0.37	0.36	
Morocco	0.11	0.12	0.16	0.21	0.27	0.26	0.33	0.40	0.42	
Nigeria	0.11	0.08	0.06	0.25	0.26	0.29	0.36	0.34	0.35	
Rwanda	0.16	0.12	0.18	0.25	0.32	0.25	0.41	0.44	0.43	
Saudi Arabia	0.21	0.16	0.13	0.20	0.24	0.28	0.41	0.40	0.41	
South Africa	0.16	0.17	0.17	0.22	0.25	0.25	0.37	0.41	0.42	

Notes: Estimates from the sample of 148 countries listed in table A2. Simple average at the region level. (GVCbs) is the share of imports in gross exports and (GVCfs) is the share of gross exports that enters into exports of destination country. (GVCs) = (GVCbs)+(GVCfs)
Source: Melo and Solleder (2021, table 1).

The bottom of table 3 shows participation rates for a selection of MENA and SSA countries. The import content of exports is low in the resource-rich countries, Egypt, Morocco, and Nigeria (low GVC_{bs} values) while exports undergo further processing in the importing countries (high GVC_{fs}

values). Morocco Kenya and Rwanda stand out for increased upstream and downstream participation.

5.3 Trade costs, national data infrastructure and GVC participation

High trade costs contribute to low GVC participation rates. So, does poor quality in data infrastructures which also contributes to high trade costs. These channels are examined here using the two proxies for the quality data infrastructure presented in section 4 with data on bilateral trade for MENA and SSA with all their partners. In Melo and Solleder (2021), we estimate the following system of equations:

$$GVCs_{o,d,t} = f\left(TC_{o,d,t}\ , Z_{o,t}\ , Z_{d,t}\right) \cdots (1a)$$

$$TC_{o,d,t} = g\ \left(RQ_{o,t}, RQ_{d,t}, X_{o,d}, V_{o,t}, V_{d,t}\right) \cdots (1b)$$

Where subscripts (o, d, t) refer to origin, destination and time (2000,2005,2010,2015), and GVC refers to the GVC measures reported in table 3. TC data are the bilateral costs estimated in Melo and Solleder (2021). In the GVC participation equation (1a), the vectors $\left(Z_{o,t}, Z_{d,t}\right)$ capture control variables (FDI and GDP pc) and data infrastructure variables (telecom subscriptions or the number of SMC lines as robustness check). In the trade cost equation (1b), governance is captured by an index of Regulatory Quality (RQ), time invariant bilateral controls (distance, common language, common border) in $\left(X_{o,d}\right)$, and the time-varying country-specific factors (GDP pc, data infrastructure proxies) in $\left(V_{o,t}, V_{d,t}\right)$. Year fixed effects are included. The model is estimated in logarithmic form for each one of the three GVC indicators using a multiple GMM estimator for all three GVC measures and for both data infrastructure proxies. Full results are reported in Melo and Solleder (2021, tables 3 and 4).

Table 4 reports estimates for the aggregate GVC measure (top of table) and trade costs (bottom of table) for the two sets of proxies for the quality of data infrastructure: percentage of the population with telecom subscriptions, and the number of submarine cables (SMCs). Telecom subscriptions serves as a first proxy for the "extensive margin" of the telecommunication infrastructure. Adding the number of SMCs in each country serves as a proxy for the intensive margin.

For the trade cost estimates in the bottom of the table, a 1% increase in distance raises trade costs by about 0.2%.[30] Both proxies of telecom infrastructure, entered separately (cols 1 and 2) or jointly (col. 3) show that higher infrastructure quality is associated with lower trade costs. Coefficient estimates are relatively stable, suggesting that these proxies capture different aspects of the quality of national data infrastructures. In the top part of the table, higher trade costs are associated with lower GVC trade. Each percentage increase in trade costs is estimated to reduce GVC trade by

[30] All other geographic variables are significant with expected signs. Regulatory quality is significant with the expected sign, but only in the origin country.

between 2.7% and 3.4%. Taking the estimates with the subscription proxy in column 1, we estimate that a 1% increase in telecom subscriptions at origin leads to a direct increase in total GVC trade of 0.44% and an indirect effect of (-0.0829*-2.718) = 0.23% through a decrease in trade costs yielding a total effect of (0.44% +0.235)= 0.67% increase in GVC trade. Similar orders of magnitude showing important indirect effects of the quality of data infrastructure on GVC participation obtain for the estimates reported in columns 2 and 3.

Table 4: Correlates of trade costs and GVC participation

	(1) log(GVC$_s$)	(2) log(GVC$_s$)	(3) log(GVC$_s$)
log(TC)	-2.718***	-3.424***	-2.828***
	(0.0859)	(0.102)	(0.100)
log(Tel. Subs.) Orig.	0.442***		
	(0.0266)		
log(Tel. Subs.) Dest.	0.443***		
	(0.0238)		
Ln(Nb. lines) Orig.		0.349***	-0.181*
		(0.0880)	(0.0944)
Ln(Nb. lines) Dest.		0.663***	0.289***
		(0.0611)	(0.0692)
log(Tel. Subs.) Orig.			0.604***
			(0.0429)
log(Tel. Subs.) Dest,			0.445***
			(0.0316)
log(TC)			
log(Dist)	0.258***	0.218***	0.289***
	(0.0118)	(0.0123)	(0.0115)
log(Tel. Subs.) Orig.	-0.0832***		
	(0.00550)		
log(Tel. Subs.) Dest.	-0.126***		
	(0.00475)		
Ln(Nb. lines) Orig.		-0.116***	-0.0969***
		(0.0180)	(0.0185)
Ln(Nb. lines) Dest.		-0.178***	-0.0387***
		(0.0124)	(0.0131)
log(Tel. Subs.) Orig.			-0.0730***
			(0.00801)
log(Tel. Subs.) Dest.			-0.129***
			(0.00568)
FE	YEAR	YEAR	YEAR
Observations	1847	1644	1427

Standard errors in parentheses
* p < 0.05, ** p < 0.01, *** p < 0.001

Notes: Other coefficient estimates reported in Melo and Solleder (2021, table 4). Cols. 2 and 3 have removed non-coastal countries
Source: Melo and Solleder 2021

6. Summary: Looking Ahead

Summary. Digital technologies (digitech) will be the engines of structural transformation in the manufacturing and services sectors in MENA and SSA. These technologies described in figure 1 include industrial robots, additive manufacturing (3D printing), Big data and cloud computing, computer-aided design and computer-aided manufacturing techniques, artificial intelligence (AI). Even though the pandemic is accelerating this digitalization, this structural transformation is only starting across developing countries: it is barely visible in the evidence reported in this paper. For example, industrial robots have grown rapidly especially since 2010, though not yet in developing countries. How the unravelling of the digital transformation in MENA and SSA is highly uncertain. As put by Sturgeon, "the eventual shape of the digital economy is unknowable and likely unimaginable" (Sturgeon, 2019, p.19).

Cross-border flow of data (e-commerce) will be an important aspect of digitalization. Drawing on a classification of national data infrastructure preparedness along a ladder for 45 MENA and SSA countries, the paper has documented some catching up in terms of connectivity to the internet for MENA though, relative to other regions, usage is low in both regions, especially in SSA. The usage/affordability landscape is very heterogenous across countries in both regions, as reflected in the national data infrastructure ladder in table 1.

The lack of catching for most of SSA is attributable to a lack of hard infrastructure (distance from transmission relays), high costs of connectivity (even for countries with access to hard infrastructure) and deficiencies in digital skills. The paper has documented that these high costs are related to market size in networks, non-competitive markets for provider services, and in some cases, high rates of taxation for mobile operators.

As to outcomes of digitalization, the prediction that globotics should favor a services-sector led industrialization at the expense of manufacturing is not apparent in the aggregate data. However, firm-level evidence suggests that firms operating in environments with performing data ecosystems export more data-related services. Also access to platforms is associated with a decline in the export shares of the largest firms in bilateral trade suggesting. Access to platforms levels the playing field across firm size.

New estimates in the paper on aggregate bilateral trade flows as captured by shares of backward and forward measures of GVC participation show that an increase in telecom subscriptions in MENA and SSA has a stable direct effect on GVC trade and an indirect effect through a decrease in trade costs. A 1 percent increase in telecom subscriptions is associated with a 0.4% direct increase in GVC participation and a 0.2% indirect increase via lower trade costs.

Looking ahead. Notwithstanding the examples mentioned in section 5, 'this time may be different' if the labor displacement effects of automation are not compensated by substantial reinstatement effects observed during past episodes of widespread technological change when jobs were created to implement the new technologies. If so, the complementarity between humans and machines observed in previous spells of technical progress may be threatened by the continued growth in automation and robots.

To counter or attenuate this possible outcome, at the national level, SSA (and to a lesser extent MENA) countries need to undergo a drastic increase in productivity gains in their large informal sectors that account for close to 60% of employment (ILO 2018). Three areas of investment are required in addition to social protection: (i) building human capital for a young, rapidly growing, and largely low-skilled labor force; (ii) increasing the productivity of informal workers and enterprises including through the creation of new formal low-skill jobs, and ; (iii) create fiscal space for investments in human capital by strengthening underused tax instruments including through digitalization (Choi et al. 2020).

At the international level, African countries need to cooperate to avert 'data colonialism' (Mayer 2021). Several reports, notably UNCTAD (2021), have warned that disparities across countries may be increasing in a digital world increasingly data-driven. the digital economy will the increasing imbalances in the currently 'unipolar' GVC networks where foreign-controlled MNEs are exerting a dominant position will persist? In a continuing unipolar world, the 'smile curve' would deepen with firms in MENA and SSA remaining in the cusp.

China and the US currently dominate the world's hyperscale data centers: together, they have the highest rates of 5G adoption in the world and have financed 94 percent of funding for all startups in the past 5 years, 70 percent of the world's top AI researchers and almost 90 percent of the world's largest digital platforms (UNCTAD 2021). The largest platforms (Apple, Microsoft, Amazon, Alphabet (Google), Tencent, and Alibaba) dominate all aspects of the global data value chain through: (a) data collection via user-facing platforms; (b) data transmission through SMCs; (c) data storage; (d) and data analysis, processing and use e.g. via AI, domination reflected in the stock prices of these major platforms largely outperforming other digital firms in the stock market.

Phase III of the Africa Continental Free Trade Area (AfCFTA) presents an opportunity for African countries to collectively establish common positions on e-commerce and harmonize digital-economy regulations. Results from a survey of small firms reported by Banga et al. (2021) shows high fees charged by third parties and low online trust among consumers Countries will have to prepare for regulation of cross-border e-commerce, weighing the costs and benefits of data localization measures that can provide consumer protection and local firms, a subject for further investigation beyond the scope of this paper. In conclusion, as noted by Mayer (2021), policymakers focusing on industrialization strategies in developing countries face a trade-off between inclusion in GVCs in an export-oriented industrialization with free cross-border data flows and a more domestically-oriented industrialization that tracks domestic customer preferences through data localization requirements to avert 'data colonialism'.

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Annexes

A1: Definition and Measurement of Supply Chains in estimates of GVCs

The GVC measures reported in table 3 come from the EORA MRIO annual (1990-2015) data base (189 countries) which has the largest country coverage: yearly over 1990-2015 for 189 countries and 26 sectors. This coverage is particularly relevant for the analysis of GVC activity in SSA and MENA. In fact, none of the countries in SSA and MENA are present in the the alternative WIOD and TiVA data sets.

Kowalski et al. (2015) carry out an extensive comparison of forward and backward linkages calculated across the 3 tables with common country and sector coverage. They compare those from the EORA data base that has the largest number of imputed values with those obtained from the WIOD and TIVA data bases (for common years, countries and sectors). These comparisons reveal large discrepancies in calculated GVC shares.[31]

A2: Countries, regions, sectors and sectoral categories

This annex justifies the selection of countries for the GVC analysis in section 3 and the classification of countries by region. It also gives the aggregation of EORA sectors into 5 categories for GVC analysis.

The Eora data base covers 189 countries. In a first step, following the guidance provided by UNCTAD Eora, we drop the following countries because of issues with GVC data: Belarus, Benin, Burkina Faso, Congo, Eritrea, Ethiopia, Guinea, Guyana, Libya, Moldova, Serbia, Sudan, Yemen, Zimbabwe, Former USSR. In addition, South Sudan is dropped from the sample because of many outliers.

Next, we limit our set of countries to only those with a population over 1 million in 2015. Based on this criterion, we end up dropping 28 countries: Andorra, Antigua, Aruba, Bahamas, Barbados, Belize, Bermuda, Bhutan, British Virgin Islands, Cayman Islands, Djibouti, Fiji, French Polynesia, Greenland, Iceland, Liechtenstein, Luxembourg, Maldives, Malta, Monaco, Montenegro, New Caledonia, Samoa, San Marino, Sao Tome and Principe, Seychelles, Suriname, Vanuatu.

[31] For China, the computed linkages across tables are (backward followed by forward in parenthesis): EORA (0.12,0.08), TiVA (0.22,0.12) and WIOD (0.33, 0.20). So the calculated backward linkage share is three times higher for WIOD than EORA. Similar comparisons cannot be carried out for SSA and MENA countries because they are not included in the WIOD and TiVA data bases. See Kowalski et al. figure D., p.159 for other comparisons.

Finally, an inspection of the data for our three GVC measures led us to drop Oman and Algeria because their share of manufacturing to GDP was over 100% in the WDI database. Iraq and North Korea were dropped because of incomplete information on tariff lines.

The result is the list of 146 countries in table A1.

Table A1: Memberships across regional categories

East Asia & Pacific[]27,21]	Europe & Central Asia [54,44	Sub Saharan Africa [46,36]	Middle East and North Africa[20,
Brunei	Albania	Angola	Algeria
Australia	Andorra	Benin	Bahrain(●)
Cambodia	Armenia	Botswana(◊)	Djibouti
China	Austria	Burkina Faso (◊)	Iran
North Korea	Azerbaijan	Burundi (◊)	Iraq
Fiji	Belarus	Cameroon	Israel
French Polynesia	Belgium	Cape Verde	Jordan
Hong Kong	Bosnia and Herzegovina	Central African Republic(◊)	Kuwait(●)
Indonesia	Bulgaria	Chad (◊)	Lebanon
Japan	Croatia	Congo	Libya
Laos	Cyprus	Cote d'Ivoire	Malta
Macao SAR	Czech Republic	DR Congo	Morocco
Malaysia	Denmark	Egypt	Gaza Strip
Mongolia	Estonia	Eritrea	Oman(●)
Myanmar	Finland	Ethiopia (◊)	Qatar
New Caledonia	France	Gabon	Saudi Arabia(●)
New Zealand	Georgia	Gambia	Syria
Papua	Germany	Ghana	Tunisia
New Guinea	Greece	Guinea	UAE(●)
Philippines	Greenland	Kenya	Yemen
South Korea	Hungary	Lesotho(◊)	**North America**
Samoa	Iceland	Liberia	Bermuda
Singapore	Ireland	Madagascar	Canada
Taiwan	Italy	Malawi (◊)	Mexico
Thailand	Kazakhstan	Mali (◊)	USA
Vanuatu	Kyrgyzstan	Mauritania(◊)	
Viet Nam	Latvia	Mauritius	**South Asia**
Latin America & Caribbean	Liechtenstein	Mozambique	Afghanistan
	Lithuania	Namibia	
	Luxembourg	Niger(◊)	
	Monaco	Nigeria	

Antigua Argentina Aruba Bahamas Barbados Belize Bolivia Brazil British Virgin Islands Cayman Islands Chile Colombia Costa Rica Cuba Dominican Republic Ecuador El Salvador Guatemala Guyana Haiti Honduras Jamaica Nicaragua Panama Paraguay Peru Suriname Trinidad and Tobago	Montenegro Netherlands Netherlands Antilles Norway Poland Portugal Moldova Romania Russia San Marino Serbia Slovakia Slovenia Spain Sweden Switzerland Tajikistan TFYR Macedonia Turkey Turkmenistan Former USSR Ukraine UK Uzbekistan	Rwanda(◊) Sao Tome and Principe Senegal Seychelles Sierra Leone Somalia South Africa South Sudan(◊) Sudan Swaziland Togo Uganda (◊) Tanzania Zambia (◊) Zimbabwe (◊)	Bangladesh Bhutan India Maldives Nepal Pakistan Sri Lanka

Notes: Landlocked (◊) GCC (●)

Table A2 gives the correspondence for the aggregation of the 26 EORA sectors into 5 categories: Primary; Low-Tech Manufacturing; High-Tech Manufacturing; Low-Tech Services; and High-Tech Services.

Table A2 Classification of EORA sectors by technological intensity

Table A1: Eora Sectors

Sector Number	Short Name	Type
1	Agriculture	Primary
2	Fishing	Primary
3	Mining and Quarrying	Primary
4	Food and Beverages	Low-Tech Manufacturing
5	Textiles and Apparel	Low-Tech Manufacturing
6	Wood and Paper	Low-Tech Manufacturing
7	Petroleum and Chemicals	High-Tech Manufacturing
8	Metal Products	Low-Tech Manufacturing
9	Electrical and Machinery	High-Tech Manufacturing
10	Transport Equipment	High-Tech Manufacturing
11	Other Manufacturing	Low-Tech Manufacturing
12	Recycling	Low-Tech Manufacturing
13	Electricity, Gas and Water	Low-Tech Services
14	Construction	Low-Tech Services
15	Maintenance and Repairs	Low-Tech Services
16	Wholesale Trade	Low-Tech Services
17	Retail Trade	Low-Tech Services
18	Hotels and Restaurants	Low-Tech Services
19	Transport	Low-Tech Services
20	Post and Telecommunications	High-Tech Services
21	Financial Intermediation	High-Tech Services
22	Public Administration	High-Tech Services
23	Education, Health and Other Services	High-Tech Services
24	Private Households	Low-Tech Services
25	Others	Low-Tech Services

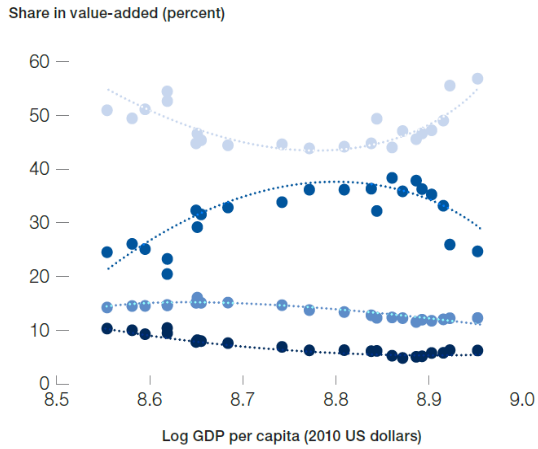
Source: Foster-McGregor, N., F. Kaulich and R. Steher (2015, table A1) .

A3: Vignettes on the competitiveness of Arab economies

This annex reproduces selected structural indicators across Arab countries and indices of competitiveness for each of the 12 indicators in the WEF competitiveness indicator. All figure numbers are those in the WEF report

Structural indicators in Arab Economies reflecting ...

Figure 2: Sectoral shares in value-added, Arab world, 1995–2015

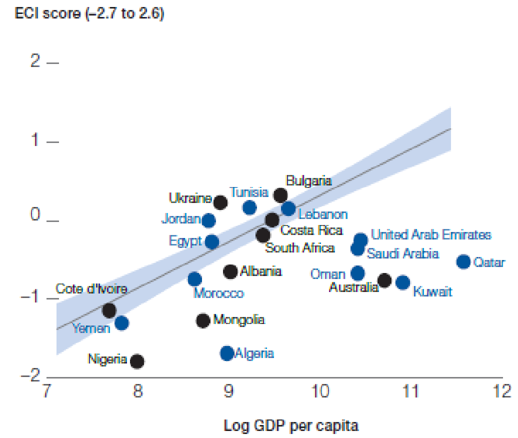


Key:
- Agriculture
- Manufacturing
- Extractive industries
- Services

Source: World Bank, *World Development Indicators*, April 2018, available at https://data.worldbank.org/data-catalog/world-development-indicators.

Note: Dotted lines are second-order polynomial trends.

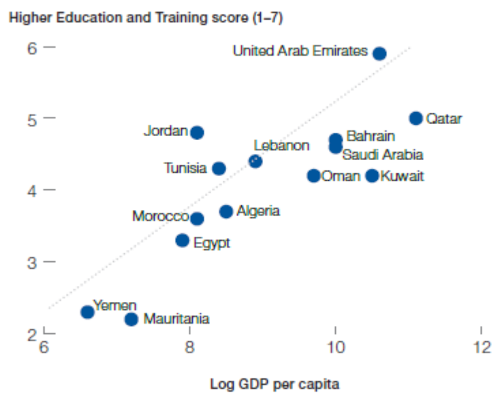
Figure 4: Economic complexity and per capita GDP, 2016



Sources: World Bank, *World Development Indicators*, January 2018, available at https://data.worldbank.org/data-catalog/world-development-indicators; MIT Observatory of Economic Complexity, Economic Complexity Index, available at https://atlas.media.mit.edu/en/.

Notes: The figure shows a 95 percent confidence interval. Arab world countries are highlighted. Recent ECI data for most states affected by fragility, conflict, and violence in the Arab world are lacking, hence these countries do not appear on this graph. ECI = Economic Complexity Index.

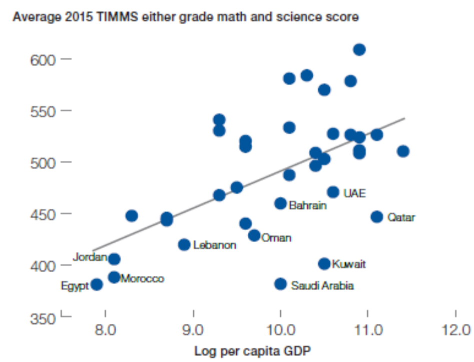
Figure 18: Higher education and training vs income level in the Arab world, 2015



Sources: World Bank, *World Development Indicators*, available at https://data.worldbank.org/data-catalog/world-development-indicators; World Economic Forum Global Competitiveness Index database, available at www.wef.ch/gcr.

Note: The line shows the global best fit between education and income rather than the best fit line for the Arab world.

Figure 20: TIMSS score vs income level in the Arab world, 2015

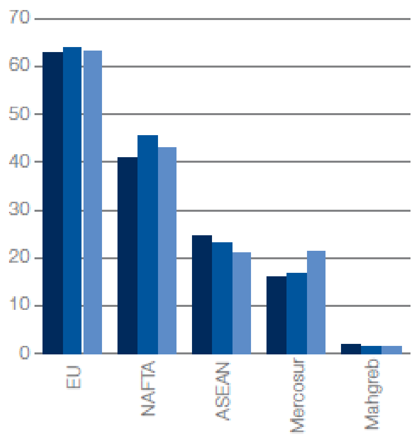


Sources: Calculations based on World Bank, *World Development Indicators*, available at https://data.worldbank.org/data-catalog/world-development-indicators; and TIMSS database, available at https://timssandpirls.bc.edu/timss2015/international-database.

Notes: The line shows the global best fit between TIMSS score and income rather than the best fit line for the Arab world. UAE = United Arab Emirates.

....underlying concerns about competitiveness

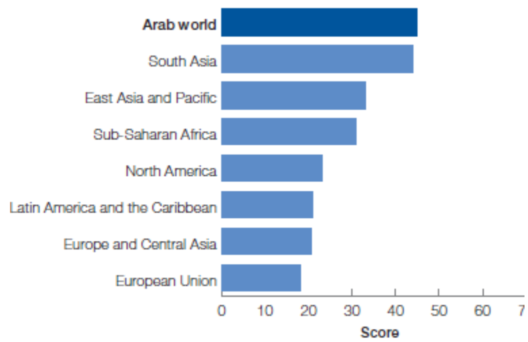
Figure A: Intra-regional merchandise trade: The Maghreb vs comparator groupings, 1995–2009



Source: World Bank 2011b.

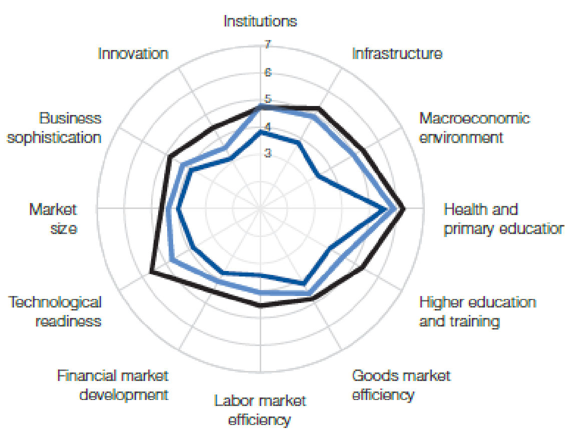
Notes: ASEAN = Association of Southeast Asian Nations; EU = European Union; NAFTA = North American Free Trade Agreement. Full members of Mercosur (Mercado Comun del Sur) are Argentina, Brazil, Paraguay, and Uruguay, and Venezuela (suspended in 2016); Associate members are Bolivia, Chile, Peru, Colombia, Ecuador, and Suriname; Observer members are New Zealand and Mexico. Maghreb in this figure includes only Algeria, Libya, Morocco, and Tunisia.

Figure 23: Service trade restrictions by region, 2012



Source: World Bank, Services Trade Restrictions Index, 2012, available at http://iresearch.worldbank.org/servicetrade/.
Note: Scale is 0 to 100; higher values are more restrictive.

Figure 2: Performance of the Arab world and OECD average along the 12 pillars of competitiveness



Key: — Resource rich — Resource poor — OECD average
Source: Calculations based on the results of the Global Competitiveness Index 2017–2018.

Source: All figures from WB-WEF report "The Arab World Competitiveness Report 2018", https://www.weforum.org/reports/arab-world-competitiveness-report-2018