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**Working Paper**

## Patterns and Correlates of Supply Chain Trade in MENA and SSA

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# Patterns and Correlates of Supply Chain Trade in MENA and SSA\*

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## Abstract

Strong participation in Global Supply Chains (GSCs) (aka Global Value Chains (GVCs)) is an indication of the structural transformation at the heart of the 'Africa we want' described in African Union's Agenda 2063 project. We discuss challenges at measuring GSCs and report new input- output based measures (upstreamness and downstreamness of exports) at several levels: across countries, regions, and sectors over the period 1995-2015. We also report participation measures based on firm-level data and new estimates of factors affecting participation of sectors in GVCs over the period 1995-2015.

On average, for both Africa and MENA, exports have a low content of imported intermediates and exports undergo further transformation in destination countries before reaching consumers. Compared with other regions, both Africa and MENA mostly engage in supply chain trade with countries outside their respective region. Firm-level estimates for several countries show that African firms are scarcely engaged in supply chain trade. In sum, in spite of regional trade agreements focussing on reducing trade barriers to intra-regional trade, regional value chains have failed to develop in both regions.

**JEL Classification Numbers:** F1, F2, F6.

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

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Countries with high growth rates in services also display high growth rates in goods. Africa has not participated in the explosive growth in services (a factor of 10 between 1980 and 2014). In spite of some catching up over 2000-14, the gap of trade in services with other regions has widened. GVC participation rates in services (high and low-tech) in Africa and MENA have not increased between 1995 and 2015. The slow growth of participation in GVCs could then reflect slow growth in trade in services and low levels of GVC participation in services sectors.

High trade costs hamper bilateral trade. Gravity-based estimates show that average bilateral trade costs for SSA countries were over twice (close to twice for MENA countries) those of the 15 largest importers in 1995 with a catch up rate of 21 percentage points by 2015 for MENA (about twice the SSA catch up rate). Assume that bilateral GVC participation depends on bilateral costs which in turn depend on indicators of hard (national data infrastructure like telecoms) and soft infrastructure (like regulatory policies). Then, the intensity of GVC is positively associated with telecom subscriptions with a direct elasticity of 0.4 and an indirect effect through a reduction in trade costs of 0.25.

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## 1. Introduction

All countries participate in Global Supply Chains (GSCs) (aka GVCs) in some form. The importance of supply chain trade in the process of structural transformation cannot be over-emphasized since countries that participate in a supply chain can enter in niches along the chain without having to build the whole product through vertical specialization as was the case previously. An increasing content of imported intermediates in exports and exports undergoing further elaboration in destination countries before reaching the consumer are indicators of participation in GSCs. Participation in GSCs is also an indicator of structural transformation. Structural transformation is at the heart of the 'Africa we want' described in African Union's Agenda 2063 project, transformation to take place through the flagship initiative projects (see list [here](#)). Drawing on a taxonomy of GSCs classifying manufacturing on a ladder from concentration on commodities to concentration on innovation activities, the World Bank's World Development Report (WDR 2020) shows that GDP per capita grows more rapidly when countries move away from commodities into limited manufacturing GSCs or beyond to innovative activities. Thus participation in GSCs is also apparently associated with higher growth.

In a companion paper, we discuss two aspects of digitalization: globotics and the disappearance of jobs; and the participation trade-offs along the smiley curve. Drawing on several indicators of structural transformation, we show that, in general, both regions have lagged in the process of digitalization and in participation in supply chains (Melo and Solleder (2022)). Among others, we note that labor productivity growth in industry and services has been slow in both regions - half the rates in the next slowest growing region.

In this paper, we discuss challenges at measuring global value chains and report measures at several levels: across countries, regions, and sectors for input- output based measures. We also report measures based on firm-level data. Section 2 discusses challenges at measuring participation in supply chains with the trade-off between sector-level input-output based estimates and firm-level estimates that capture more directly, though imperfectly, flows across firms involved in the supply chains.

The remainder is about evidence, often focussing on comparisons at the regional level to detect any particularities in MENA and SSA. Section 3 documents the weak performance in SSA and MENA on services, a sector that has become an engine of structural transformation across most regions since the start of the ICT revolution. Section 4 gives evidence of participation by MENA and SSA countries in GSCs over the period 1995-2015. Indicators show that both regions are less engaged in supply chain trade than other regions. Their participation is more downstream (exports that undergo further processing in the importing countries) than upstream (a high import content in gross exports). Section 4 reports on firm-level estimates that show that African firms are scarcely engaged in supply chain trade.

Section 5 explores linkages between indicators of bilateral GVC trade, bilateral trade costs and measures of regulatory quality in origin and destination countries. The estimates suggest that an increase in telecom subscriptions is associated with GVC trade with a direct elasticity of 0.4 and an indirect effect through a reduction in trade costs of 0.25. Section 6 concludes.

## 2. Dimensions of Supply chains: countries, sectors, and firms

### 2.1 Early developments

In the early 1960s, trade in intermediates started growing faster than trade in final goods. Then the importance of GSCs took a first turn from the 1980s onwards when Information and Communication Technology (ICT) transformed the competitive landscape by creating a high-tech, low-wage combination (skills in the headquarter firms, production in low-wage countries). As documented by Baldwin (2016), this allowed a handful of countries in East Asia and Central Europe to establish/join ‘factory Asia’ and ‘factory Europe’. This made it possible for firms to unbundle manufacturing processes, intensifying further trade in intermediates. This first phase corresponded to the period when national policies and multilateralism were moving together.

A second turn started with the financial crisis of 2008-09 prolonged with the global pandemic starting in 2020. Already, between 2009 and 2015, growth in overall trade was weak and GVC trade actually contracted (WDR 2020, figure 2). At the time of that crisis, world trade fell more sharply than GDP and investments needed to fuel GVCs dried up (WDR 2020). A tally of trade measures applied by countries shows that discriminatory measures have been growing more rapidly than liberalizing measures since the crisis and that these measures have impacted trade.<sup>1</sup> Trade uncertainty, as measured by perceptions in the press, also increased during 2009-15.<sup>2</sup>

Two other factors covered in our companion paper also contributed to the levelling off of GVC activity. One is the increased risk of a globalized economy in a world of increasing political tensions.<sup>3</sup> Another is the growth of artificial intelligence, automation and robotics, machine learning and big data analytics, the Internet of Things (IoT), autonomous vehicles,

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<sup>1</sup> See <https://www.globaltradealert.org/> for the count of trade measures reported to the WTO and Evenett and Fritz (2015) on how these measures discriminated most against LDCs.

<sup>2</sup> See Ahir, Bloom, and Furceri (2019) “The Global Economy hit by Higher Uncertainty”, VOXEU <https://voxeu.org/article/global-economy-hit-higher-uncertainty>.

<sup>3</sup> Baldwin and Freeman (2021) cite Autor et al. (2013) documenting large adjustment costs in US manufacturing from trade with low-wage nations, many involved in GVCs as the wake-up call in policy circles. Rising populism is also attributed to the hollowing out of the ‘elephant curve’ of the cumulative distribution of household incomes (Lakner and Milanovic 2013) occupied by the middle-income segment of high-income countries.

3D printing, all driving structural transformation of economies. The continued growth of economies like China and India where the stages of supply chain are increasingly carried in the domestic economy also contributed to a slowing down of cross-border supply chain trade.<sup>4</sup>

## 2.2 Measuring supply chains

Quantifying the effects of these changes on structural transformation is a challenge because customs provides data on where the transacted good or service was produced but not how, that is which countries contributed value to it. Likewise, customs data record where the transacted good is flowing to but not whether it will be fully consumed at destination or if it will undergo further processing before consumption. When aggregated to a sector level and combined with input-output (IO) tables, customs data can be used to quantify the intensity of trade in intermediates. However, participation in supply chain trade is by firms, not by sectors as captured by IO tables. Firm-level data then allows to capture the characteristics of firms that participate in GVCs. Firm level data collected by customs give information on firm transactions and their foreign partner countries. This gives a finer understanding of firms input decisions than those obtained from sector-level input-output tables. Yet, these data do not trace firm-to-firm transactions. And since customs data across countries are not linked, it is difficult to come up with firm-level measures of forward and backward participation that can be calculated from IO tables because it is impossible to establish whether firms' imports are final goods or intermediates. So firm-level measures identify the extensive margin of GVC participation, i.e. which firms participate, but not by how much as estimated from IO tables (World Bank 2020 box 1.4 discusses differences).

Estimates of participation in supply-chain trade, an indicator of structural transformation, are very different when based on multipliers from IO tables and when based on firm surveys. Section 4.1 reports on measures of the intensity of supply chain trade based on IO tables. These have the advantage of availability over a long period and covering all sectors. Section 4.2 reports on firm-based measures of supply chain trade. Remarks about implications of the discrepancies between the two indicators are then raised in section 4.3.

Borin and Mancini (2019) and others define GVC trade as “trade flowing across at least two borders”.

The three measures of participation derived from IO tables are<sup>5</sup>:

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<sup>4</sup> Using the TiVA database, Miroudot and Nordstrom (2020) show that supply chains have become more domestic rather than more regional in that sample. They estimate that since 2012, the average length of supply chains has shrunk by 50 km per year.

<sup>5</sup> The length of the production chain, (i.e. the average number of production stages in a production process in a region or world) is fourth measure. We report only measures of complex GVCs, i.e. situations where value-added crosses borders at least twice. Measures of the average length of the production chain are not presented here because multiple crossings are rare in the environment of high trade costs in both regions. Melo and Twum (2020, table 1) show that among African RTAs and comparators, between 1990 and 2015, the



- **GVC participation rate (GVC<sub>s</sub>):** Measures the share of a country's exports that either makes use of value-add imported from another country or is exported to another country for further processing. A subset of this is Regional Value Chain (RVC) participation where exports are defined as exports that cross at least two borders within the same region. See annex 2 for the list of countries in SSA and MENA.
- **Backward GVC participation (GVC<sub>bs</sub>):** measures the share of a country's exports that include value added previously imported from abroad (sometimes called Foreign Value Added (FVA)). For example, if Egypt imports textiles from Ethiopia to produce apparel, then Egypt is said to be participating in backward GVC participation when it exports apparel.
- **Forward GVC participation (GVC<sub>fs</sub>):** measures the share of a country's exports that are used by the importing country to produce for export. In the example of apparel, Ethiopia is engaging in forward GVC participation because its exports are used as intermediates by Egypt for the production of its apparel exports.

**Regional Value Chains (RVCs).** For RVCs, exports are defined as exports that cross at least two borders within the same defined region. For SSA, Africa is defined as the same region since all African countries are members of AFCFTA. For MENA, the same region are the 17 members of MENA listed in annex 2.

- **Backward RVC participation:** Intermediate goods and services sourced directly from a country member of the region by A, and used to produce A's exports to any country (regional import content of exports).
- **Forward RVC participation:** Value added originated in A, exported directly to a member of the region, then re-exported to any country.

Cross-border activities along a production chain are limited. Four factors influence the length and geography of production networks. First, for transaction costs, a task perspective operates like compound interest with transaction costs increasing more than proportionally with the number of stages.<sup>6</sup> Second, the effect of a marginal variation in trade costs along the chain is much larger when there is more than one international transaction.<sup>7</sup> Third, a

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share of GVC trade under simple [complex] GVCs fell [rose] except for MERCOSUR, an indication of the regionalisation of supply chains among members.

<sup>6</sup> An example, taken from Diakantoni and Escaith, illustrates the importance of lowering trade costs along a supply chain. Let trade costs apply in proportion to the value of the good. Ferrantino (2012) shows that the total costs of delivering the final good to the consumer increases exponentially with the number of production stages. With 5 [10] stages and an ad-valorem transaction cost of 10%, the ad-valorem tariff equivalent is 34% [75%]. This is why the number of stages across borders is small.

<sup>7</sup> Miroudot et al. (2013) estimate that the EU pay an average tariff of 3.7% on imported products from India with only 51.5% being paid at the EU border. Because the cumulative effect of tariffs (and other border costs) is bound, so long as intermediate goods of domestic origin along the supply chain are substitutable, to some extent at least, complex GVCs cannot develop when tariffs are above a certain threshold. The same applies to RVCs where tariffs are zero, but other border trade costs are important.

small decrease in tariffs (or more generally border-related transaction costs) can induce a tipping point at which vertical specialization (i.e. cross-border trade in tasks) kicks in (Yi (2003)). Fourth, rules of origin (also part of trade costs), often time-consuming and costly to satisfy for developing countries. Felbelmayr et al. (2019) show that transport costs across most countries are sufficiently high to prevent trade deflection among countries in an FTA, an indication of high trade costs at crossing borders and hence a brake on multiple border crossings in GVCs.

The measures reported here follow Borin and Mancini (2019) where GVC-related trade from country  $s$  to destination country  $r$  is defined as<sup>8</sup>:

$$GVC_s(\text{GVC related trade}) = \frac{\sum_{r \neq s}^G GVCX_{sr}}{U_N E_{s*}} \quad 1(a)$$

$$GVCX_{sr} = U_N E_{sr} - DAVAX_{sr} \quad 1(b)$$

$$u_N E_{sr} = DVAsource_{sr} + DDCsource_{sr} + FVAsource_{sr} + FDCsource_{sr} \quad (2)$$

$GVC_s$  is the GVC trade-related indicator. It is the sum of domestic and foreign value-added ( $U_N E_{sr}$ ) ( $U_N$  is a matrix of 1 along the diagonal and 0 off-diagonal) excluding the domestic value added absorbed directly by its importer (DAVAX) as a share of total gross exports  $E_s$ . DAVAX is the sum of

- 1) the portion of production that is produced entirely in a country and exported with no intermediates from outside its borders;
- 2) the intermediates inputs that are completely produced in a country and exported to a country for production of final goods that are entirely consumed by the domestic market of the importing country<sup>9</sup>.

The share of value-added in gross exports,  $GVC_s$ , decomposes into backward ( $GVC_{bs}$ ) and forward GVC ( $GVC_{fs}$ ) participation shares:

$$GVC_s = GVC_{bs} + GVC_{fs} \quad (3)$$

*Backward GVC participation* measures the share of a country's exports that include value added previously imported from abroad (also called "downstreamness" somewhat confusingly to some). For example, if Egypt imports textiles from Ethiopia for the production of apparel for export then Egypt is said to be participating in backward GVC participation when its exports. On the other hand, *forward GVC participation* measures the share of a country's exports that are used by the importing country to produce for export (also called

<sup>8</sup> The Borin and Mancini (2020) approach improves on the accuracy of earlier GVC measures by eliminating the issues of double counting. The methodology also estimates a GVC-related trade indicator taking into consideration the country of origin, sectoral classification of exports and the destination of exports.

<sup>9</sup> See Borin and Mancini (section 4.2 p. 31) for the corresponding GVC measures at the sector level

“upstreamness”). In the example of apparel, Ethiopia is engaging in forward GVC participation because its textile exports are used as intermediates by Egypt for the production of apparel.

The backward and forward estimates provided by the formulas described above inform on two aspects of supply chain trade. On the one hand, high forward and backward shares suggest that a country/region is benefiting from the efficiency gains associated with outsourcing and the fragmentation of production. On the other hand, high values are an indication of vulnerability to supply shocks via high backward shares, and to demand shocks via high forward shares.<sup>10</sup> Summed at the industry or country level, these two measures give an estimate of the share of trade in value-added in gross exports for an industry or country.

### 3. EORA-based estimates of backward and forward participation trends: 1990-2015

Two standard measures are used in the following tables and figures. The backward participation share ( $GVC_{bs}$ ) is the share of gross exports that embodies imported value-added. The forward-participation share ( $GVC_{fs}$ ) is the share of gross exports that is not fully absorbed in the importing country. This is the share of imports that undergoes further processing before final consumption. The sum of these two shares,  $GVC_s$  is an estimate of outsourcing/dispersion across countries in supply chains.<sup>11</sup> Only available at a very aggregated sectoral level (26 sectors in the EORA data base used here), these measures do not capture the growing fractionalisation of tasks along supply chains, nor the fact that a growing share of trade in services do not cross borders and hence are not recorded in customs data. These limitations and the fact that the EORA data base does not draw on a single country IO table for any country in SSA and MENA are discussed in Annex A1.

#### 3.1 Regional GVC participation trends

Table 1 displays the evolution of average participation in GVC trade over the period 1995-2015 for all regions and for a selection of countries in MENA and SSA. At the world level, the share of trade in intermediates in GVCs increased until 2010, then fell. For SSA and MENA, the shares rose until 2008 then stabilized (last column in table 1). Among regions, North

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<sup>10</sup> Baldwin and Freeman (2021) mention a widely read paper by O’Leary in The Atlantic “The Modern supply chain is snapping: The coronavirus exposes the fragility of an economy built on outsourcing and just-in-time inventory”. They discuss the alternatives of making GVCs shorter and more domestic or more diversified. In either case, Rules of origin will be a key lever to achieve the objective.

<sup>11</sup> Forward GVC, also known as IVA (indirect value added) is domestic value-added contained in inputs sent to third countries for further processing. It is a measure of forward integration, indicating that the firm is far from the final consumer. Backward GVC or FVA (foreign value-added) is an indicator of backward integration, that is that the firm is closer to the final consumer.

America (including Mexico) showed the sharpest fall, a consequence of the 2008-09 financial crisis.

Both MENA and SSA started low and stayed low on backward shares indicating relatively less increases in imported inputs over the 20-year period than for other regions. This pattern is consistent with high policy-imposed trade barriers, or at least with trade barriers falling less rapidly than in other regions. On average, according to these measures, exports from MENA and SSA embody fewer intermediate imports than other regions.

On the forward side, both regions have the highest shares throughout the period, an indication of exports concentrated in raw materials and agricultural products with little transformation. For other regions, the share of further processing of exports in destination countries has either remained constant or decreased.

Table 1: Trends in GVC participation by region\*

	Backward (GVC <sub>bs</sub> )			Forward (GVC <sub>fs</sub> )			Total (GVC <sub>s</sub> )			
	1995	2005	2015	1995	2005	2015	1995	2005	2015	Trend
By region										
<b>World</b>	<b>0.25</b>	<b>0.29</b>	<b>0.28</b>	<b>0.19</b>	<b>0.20</b>	<b>0.20</b>	<b>0.44</b>	<b>0.49</b>	<b>0.48</b>	↗
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	↗
L. Am. & Caribbean	0.19	0.20	0.19	0.13	0.13	0.15	0.33	0.33	0.33	—
<i>M. E. &amp; N. Africa</i>	<b>0.18</b>	<b>0.15</b>	<b>0.14</b>	<b>0.22</b>	<b>0.26</b>	<b>0.27</b>	<b>0.39</b>	<b>0.41</b>	<b>0.41</b>	↗
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	—
<i>Sub-Saharan Africa</i>	<b>0.15</b>	<b>0.14</b>	<b>0.13</b>	<b>0.22</b>	<b>0.25</b>	<b>0.25</b>	<b>0.37</b>	<b>0.39</b>	<b>0.39</b>	↗
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.

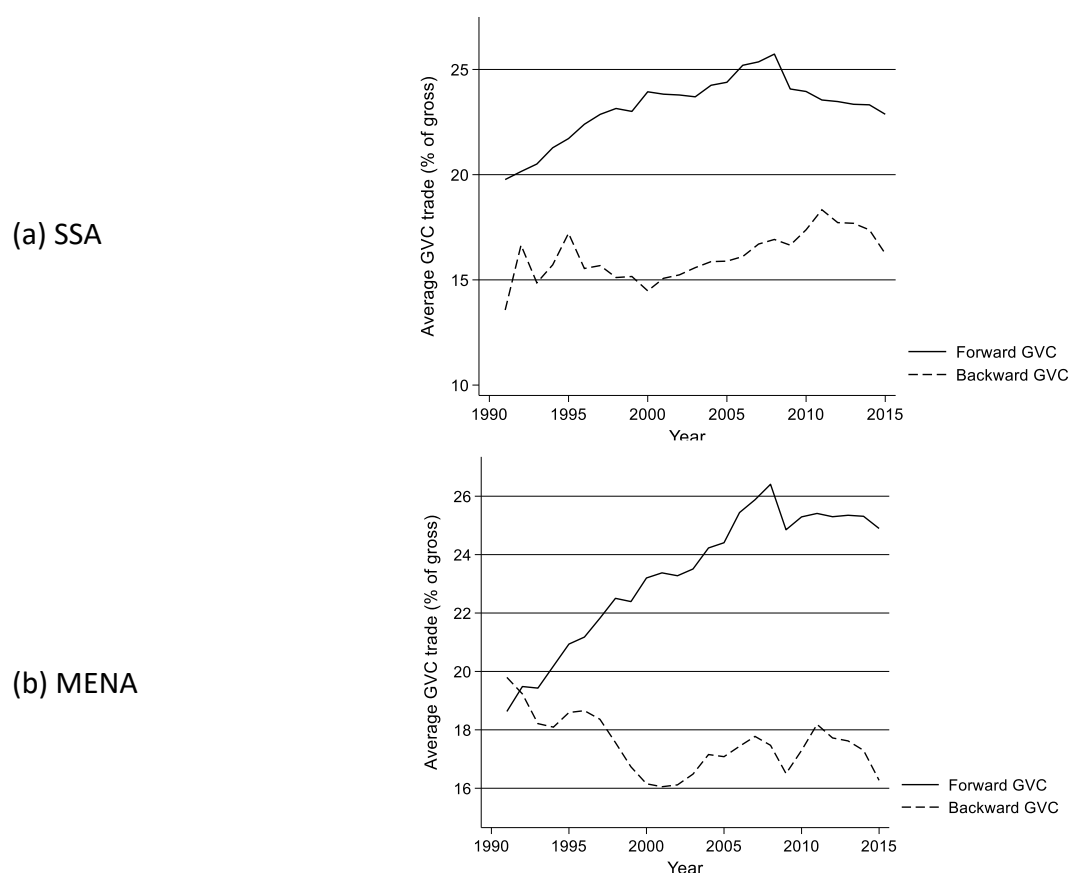
(GVC<sub>bs</sub>) is the share of imports in gross exports and (GVC<sub>fs</sub>) is the share of gross exports that enters into exports of destination country. (GVC<sub>s</sub>) = (GVC<sub>bs</sub>)+(GVC<sub>fs</sub>)

**Source:** Authors' estimates

The bottom of the table shows participation rates for a selection of MENA and SSA countries. Since regional figures are averages across countries, differences are greater at the country level. 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.

Figure 1 shows the time-path of the average indices of backward and forward since 1990, the first year of constructed data in the EORA data base (See annex A1). The trends show a sharp increase in forward participation up until 2010 for both regions then a decline. Since GVC measures are calculated at current prices, as Europe is the major trading region for Africa and MENA, the Euro's decline relative to the dollar could have contributed to the stagnating trend in forward shares in figure 1. In any case, both regions have remained downstream with relatively little rise in participation in the ongoing fragmentation of production.

Figure 1: Region-wide average backward and forward participation: 1990-2015

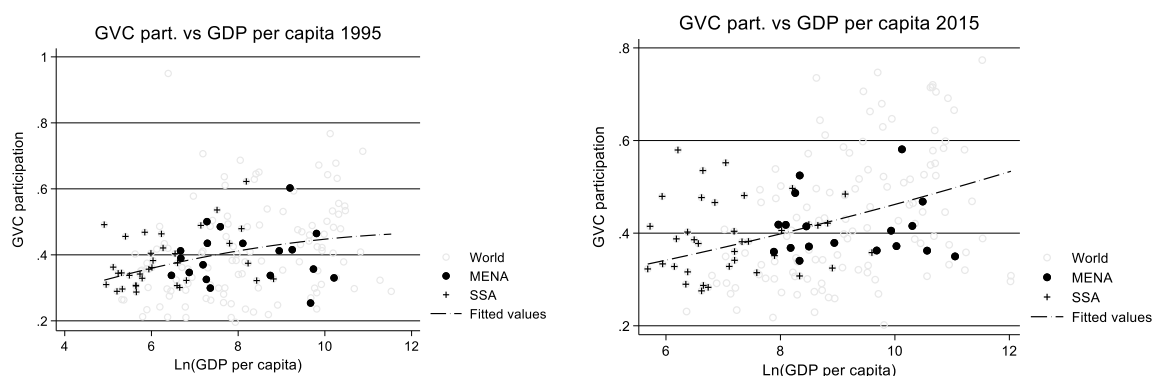


**Notes** Simple averages across countries in each region. List of countries in annex A2.

**Source:** Authors' calculations from EORA data base.

Figure 2 compares GVC participation for MENA and SSA countries along the fitted line for the whole sample. Countries are dispersed around the fitted line with a larger share of MENA countries under-performing, especially in 2015. For SSA countries, comparing the two graphs suggests growing disparity between 1995 and 2015 at the low-end of the scale.

Figure 2 GVC Participation versus per capita income: MENA and SSA\*



**Notes:** The sample includes only 40 SSA and 20 MENA countries (see selection in Annex 2 and country list in table A1). Participation measures the share of a country's exports that either makes use of value-added imported from another country or is exported to another country for further processing. It is the share of trade over its total gross exports.

**Source:** Author's from EORA data base

Figure 3 contrasts the patterns of supply-chain trade across regions over the longest time-period possible, 1990-2015. Figure 3a displays three distinct patterns. First is the very low growth of regional supply chain trade for SSA and MENA (small length). Second, is the divergent experience between MENA and SSA on the one hand, and other regions on the other, where most supply chain trade is non-regional, i.e. it takes place outside of the defined regional blocs.<sup>12</sup> These patterns may reflect a weak governance and regulatory environment that hamper the development of RVCs. Third is the pattern for East Asia and Pacific and Europe and Central Asia, both already emerging hubs in 1990s with growth over 1990-2015 mostly around RVCs.

This pattern -- dubbed 'factory Asia' by Baldwin (2006) -- reflects several forces at work, largely absent across MENA and SSA. First are strong agglomeration economies (external economies and the development of specific skills in the work force). Second is the widespread adoption of trade facilitation policies, characterized by Vezina (2014) as-a 'race-to-the bottom', unilateral tariff cutting across the region to attract Japanese FDI. Other trade facilitation measures include simple and transparent rules of origin to facilitate cross-border trade in the region (Cadot et al. (2010)). Third, is the importance of institutions that

<sup>12</sup> North America displays a pattern in which supply chain trade developed around NAFTA during the 1990s, followed by a switch starting around 2000 towards non-regional partners.

have high indicator values for the Asia and Pacific region.<sup>13</sup> These enabling forces have been largely absent across MENA and SSA.

MENA and SSA have mostly developed supply chain trade outside the region rather than regionally, i.e. the GVC<sub>s</sub> indicator in figure 3a has moved vertically rather than horizontally. This presents a challenge for the AfCFTA project where the growth of RVCs is an important objective. From figure 3a in 2015, only 3.5% of total SSA exports were connected to supply chain trade within the SSA region. This stands in contrast to the 25.5% RVC integration for East Asia and the Pacific, almost 8 times the integration level of SSA. On the other hand, SSA is more integrated into non-regional GVC<sub>s</sub> (35.6% of exports in 2015) than all regions except the Middle East and North Africa. Even though these estimates should be interpreted with caution (see the firm-level estimates in section 4), the magnitude of differences across regions is large enough to strongly suggest that MENA and SSA stand apart.

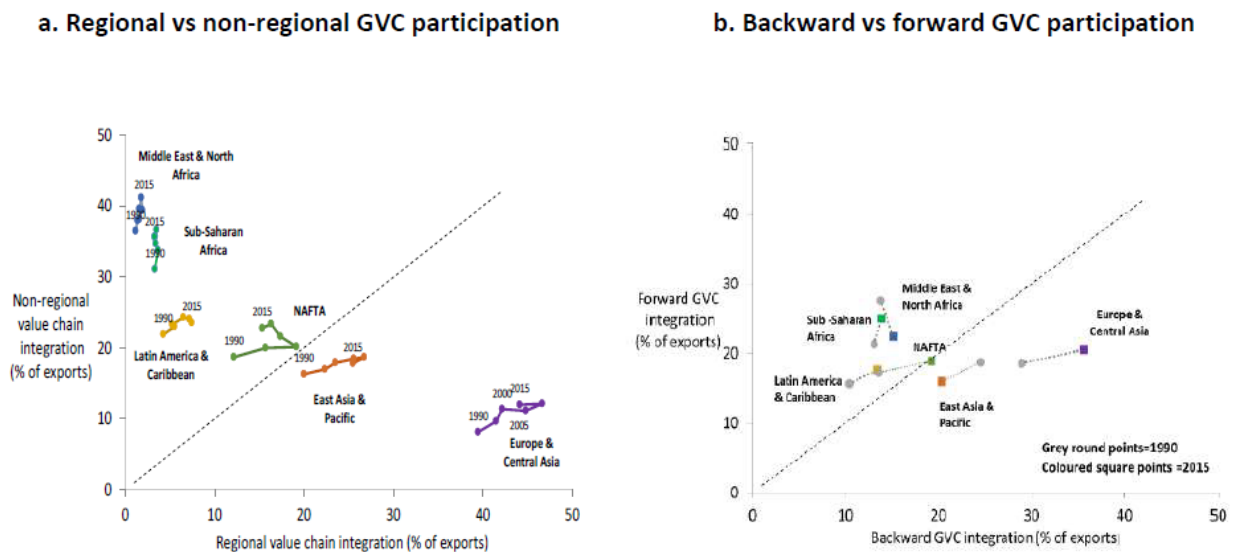
Figure 3b shows a move towards greater intra-regional trade in intermediate inputs in the ‘factory economies’ of East Asia and Pacific and Europe and Central Asia where countries are both makers and buyers of components and parts stands out. This could reflect that goods were moving seamlessly across borders. By contrast, for both SSA and MENA most trade in value-added has been forward (i.e. selling its exports that undergo further processing a reflection that SSA exports mostly raw materials) rather than backward (a country’s exports have a low share of imported inputs). The downstream pattern of intermediates SSA and MENA exports are destined outside the region. Will applying digital technologies to existing business processes change these patterns?

This move towards RVCs would be expected if transaction costs associated with border crossings were falling more rapidly within regions than across regions. This is the pattern followed by all regions in figure 3a except for SSA and MENA. Other geo-political and economic factors, like conflicts, also contribute to GVCs usually developing along geographically proximate production chains.

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<sup>13</sup> Nunn and Trefler (2015) show that the patterns of revealed comparative advantage in contract-intensive industries (those that dominate in supply chains) are closely related to the quality of domestic institutions.

Figure 3: Global Supply Chain participation by region (a) and by type (b)



Source: Melo and Twum (2020, figure 4).

The stark difference between SSA and MENA and the other regions begs for a search of underlying factors and whether the emerging information technologies might help close this gap. This search is beyond the scope of this paper, though contributing factors must include a geography inhospitable to trade (i.e., geography such as artificial borders, a high share of landlocked countries) or policy-imposed barriers (high tariffs and NTBs)<sup>14</sup>, two factors that account for the high bilateral trade costs reported in figure 6, and/or weak governance and regulatory environments.<sup>15</sup>

### 3.2 Sector-level participations: Manufacturing vs. Services

Evidence is growing that services and goods activities are complementary (Ariu (2016), Ariu et al. (2020)). Countries with high growth rates in services also display high growth rates in goods trade. The slow growth of participation in GVCs could reflect slow growth in trade in services and low levels of GVC participation in services sectors. Africa has not participated in the explosion of world trade in services which grew by a factor of 10 between 1980 and 2014. Using a new data set assembled by Lougani et al. (2017), Ariu and Ogliari (2022) document that most growth in services took place around the 2000s with little participation by Africa and Latin America, as shown by the regional growth rates of trade in services. They

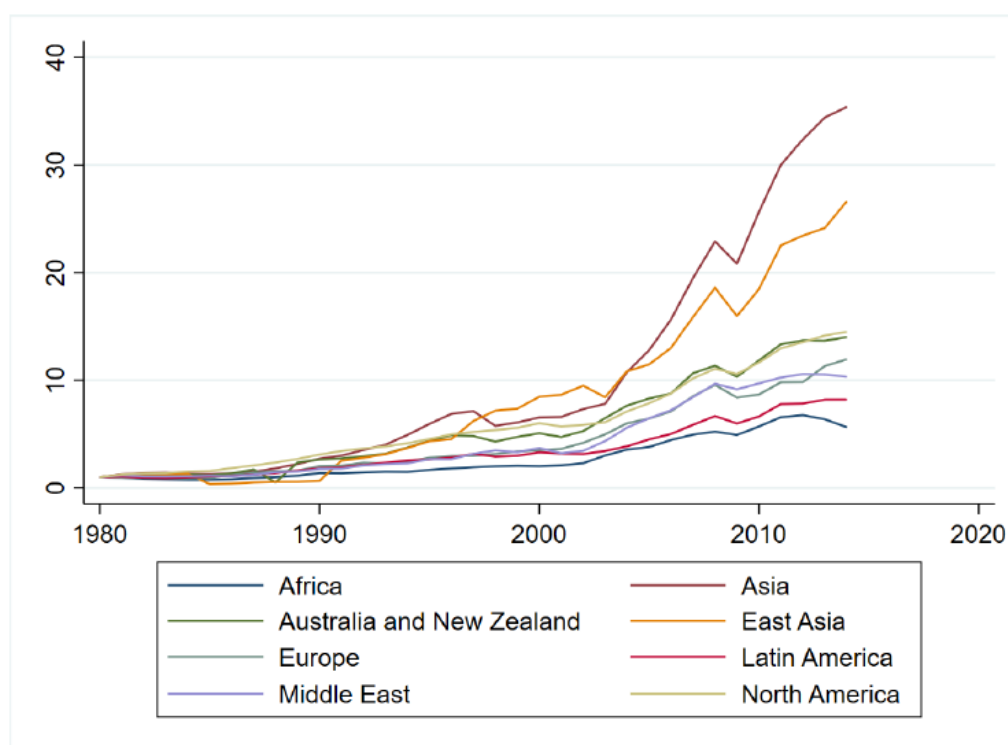
<sup>14</sup> The three regions with the highest average applied tariffs and percentage tariff peaks—both in parenthesis are MENA (7.3%;16.1%), SA (12.6%; 28.8), SSA (11.3%;334.3%) DAVIS and Zaki (2020, figure 8).

<sup>15</sup> Nunn (2007) showed that higher technology industries that produce a more specialized product are more sensitive to institutional quality. Dollar and Kidder (2017) uncover a positive correlation between GVC participation and several measures of institutional quality.



report that over 1980-99, services grew on average by less than 10% per year (compared to the world average of 15%) and, in spite of some catching up during the 2000-2014(13% annual growth compared with the world average of 16%), the gap with the rest-of-the-world has been increasing (see figure 4).

Figure 4: Trade in Services Growth by Region, 1980=1



**Note:** This figure shows the evolution of services exports for different continents during the period 1980-2016. Data source: Loungani et al. (2017).

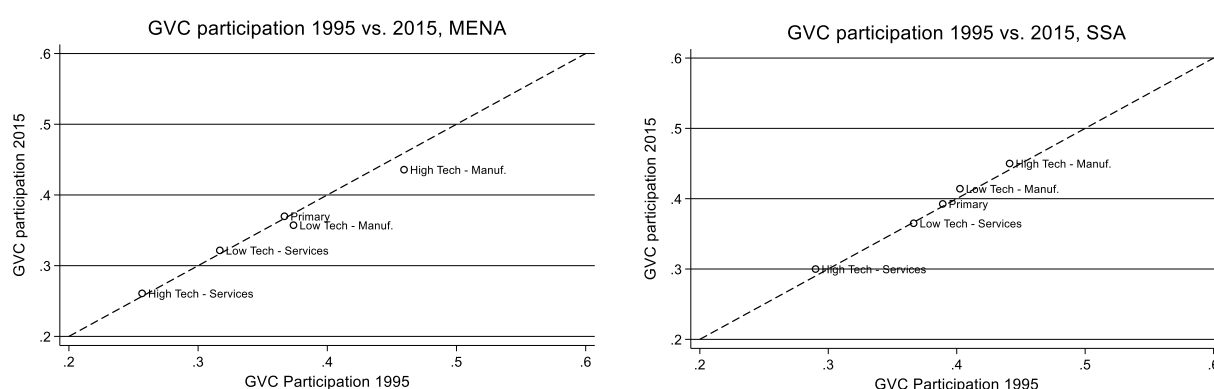
Source: Ariu and Ogliari (2022, figure 1)

As a final check on GVC patterns, figure 5 compares GVC participation rates for MENA and SSA between 1995 and 2015 for a sector classification that distinguishes between high and low-tech sectors in manufacturing and services. High-tech services include health and education, two activities with low shares of value-added that are traded which explains why they are the least traded group in figure 5. Low-tech services include retail, transport manufacturing all of which are traded more intensely. Both manufacturing categories have greater engagement in supply chain trade. However, a different categorization of services that would include what Nayyar et al. (2021) call 'global innovator services' group (Information and communication, financial and insurance, professional, scientific and technical) that are skill-intensive, should show greater participation in supply chains, though probably not in SSA. This group of activities with greatest scope for scale, innovation and spillovers are skill-intensive, attributes in short supply in SSA (and to a lesser extent in MENA). By contrast, low-skill tradable services (accommodations and food, transportation and

storage, wholesale), could be poised for greater participation in supply chain trade in coming years.

In interpreting these trends, recall that EORA has no IO information for any one of these countries. This lack of information and the recourse to algorithms to generate missing information is likely an important reason for the very similar patterns of GVC estimates for MENA and SSA. For both regions, the ranking of sectors is identical at the beginning and end periods and there is very little difference within sectors. These patterns stand in sharp contrast with those constructed with the WBES data over a shorter period (see section 4).

Figure 5: GVC Participation by digitalization prospects



**Notes:** See table A2 for the aggregation from 26 EORA sectors to the 5 sectors

Primary: (Agriculture, fishing, mining & quarrying); High-tech manufacturing (Petroleum products and chemicals). Low-tech manufacturing (all other manufacturing sectors). Low-tech services (electricity, gas, water; construction, maintenance & repair; wholesale trade; retail trade; hotels & restaurants; transport; private households; others). High-tech services (Port & telecommunications; financial intermediation; public administration; education, health and other services).

**Source:** Authors' estimates from EORA data base

## 4. Firm-level estimates of participation in GVCs

Almost all firm-level measures of GVC participation for MENA and SSA rely on the World Bank Enterprise Surveys (WBES) based on customs data of imports and export by firms. The WBES are usually collected at 3-5 years intervals. Data are available over the period 2005-2017 for a different sample of firms each time (hence cross-section rather than panel data). The question then is how to define 'GVC firms'. Two studies, one on MENA by Dosis and Zaki (2021), the other on SSA by Catalayud and Rochina (2021) using the classification of firms described below, give information on factors affecting GVC participation in manufacturing.

## 4.1 Estimates of correlates of GVC participation by manufacturing firms

Table 2: Distribution of firms by alternative GVC classifications.

	GVC1(%)	GVC2(%)	GVC3(%)	GVC4(%)	FVA(%)	IVA(%)
Column	1	2	3	4	5	6
East Asia & Pacific	9	6	3	2		
Europe & Central Asia	27	15	5	3		
Latin America & Caribbean	13	5	3	2		
South Asia	7	3	0	0		
Middle East & North Africa	13	6	2	1		
Sub-Saharan Africa	15	7	4	2	2.6	11.4
All	13	7	3	2		

**Notes:** WBES sample of developing countries over 2008-17. Weights obtained from the survey design to correct for over-sampling

GVC(1): Exporter + importer. GVC(2): exporter + importer + certification. GVC(3): exporter + importer+ foreign ownership. GVC(4): exporter + importer+ foreign investment + certification.

**Source:** Dovis and Zaki (2020, table 2 for cols. 1-4) and Catalayud and Rochina (2021, table 1, for cols. 5-6)

Table 2 gives the distribution of firms by the four classifications, going from the least restrictive, GVC1, that includes only firms that are importers and exporters, to the most comprehensive, GVC4, that also combines those firms that either also have an international certification, GVC2, combined with a share of their capital foreign-owned, GVC3. GVC2 and GVC3 definitions may be viewed as substitutes or complementary. A foreign-ownership status may be an indicator of integration into a GVC, as foreign-owned firms may serve as exporting platforms for foreign countries. When FDI goes hand in hand with supply chain trade to guarantee contract enforcement, this suggests “relational” GVCs (Antràs, 2020). An internationally recognized certification, which may be required in vertically fragmented production processes, provides another indicator of GVC integration.

In WBES, 60% of firms only sell domestically, 12.5% are exporter-only, 14.1% are importer-only and 13.2% are two-way traders (last row of table 2). Across the WBES, large firms measured by employment ( $L > 100$ ) are both internationally certified and have foreign ownership participation, the opposite holding for small firms. In both SSA and MENA, few firms participate in GVCs, never exceeding 15% of firms, an indication of room to expand.

Dovis and Zaki (2020) explore for MENA the dimensions of the business environment and of firm characteristics on the likelihood of firm-level participation for the GVC1 and GVC4 definitions in table 4.2. Each time, they first carry out likelihood estimates for all WBES firms, then they compare coefficient estimates for two samples: MENA and East Asia and

Pacific (EAP) where estimates refer to correlations between the selected GVC indicator (GVC1 or GVC4) and the selected business environment indicator, controlling for age.<sup>16</sup>

Two remarks on WBES data. First, the same firms are not surveyed multiple times. As there is no time variability for a given firm, firm-level fixed effects cannot be used in the estimation excluding exploring the impact of changes over time. Second, the correlations are carried out separately for each business environment variable rather than with the whole array of business variable to deal with multicollinearity so not much is done to control for confounding factors. Results should be interpreted as correlates between the measures of GVC linkage and the ensemble of business environment variables.

Start with results for all firms. Their estimates show that the number of procedures to obtain electricity, the number of tax payments, the number of documents needed to export and import and to register property and infrastructure, are each negatively associated with the likelihood of a firm integration into a GVC.

Turning to a comparison of results between MENA and EAP regions, several differences appear. For both regions, owning a generator is negatively associated with being in GVC4, an indication that electricity is not reliable or strong enough to be part of an 'advanced stage' GVC. When comparing MENA and EAP, owning a generator is positively associated with GVC1 but only in MENA and the number of procedures to get access to electricity is associated negatively with firms in GVC1. Electricity procedures are a barrier for small and large firms in MENA, but are insignificant in EAP. This suggests that MENA countries are still handicapped by extensive red tape barriers.

For trade procedures, the number of documents to import is negatively associated with both GVC measures for MENA and EAP, but with higher coefficient values for MENA. For exports, the number of documents is only negatively associated with GVC participation for MENA, an indication that trade facilitation should be higher on the agenda in MENA. These more significant obstacles to participation in MENA could be a factor behind the low participation in GVC in that region relative to EAP.

Using the same GVC definitions and WBES data for 18 SSA countries and building two other continuous GVC indicators constructed from data on firms imports, Catalayud and Rochina (2021) explore the determinants of participation in GVC, then correlate these measures with proxies for firm performance. For the continuous GVC indicators they construct FVA from the share of firm imports originating in the UN SITC intermediates classification.<sup>17</sup> Under the additional assumption that the firm's FVA is then spread proportionally over all sales, FVA is

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<sup>16</sup> They also distinguish between large (above 75th. percentile in employment) and small firms and also of firms that operate in high and protection sectors and those that operate in low-protection sectors.

<sup>17</sup> Imports of textiles, chemicals, non-metallic products, electronics are classified as intermediates.

the share of imported imports on firm's exports. For IVA, domestic value-added as firm's sales less intermediate imports as classified above, are then expressed as a share of firm's exports, again assuming that the percentage of domestic value-added exported is the same as the percentage of domestic value-added on firm's total sales.

The results of these estimates are reported in table 2 columns 5 and 6. These estimates (are the FVA (2.6%) and IVA (11.4%) are far from the EORA estimates reported in table 4.1 (14% for FVA and 25% for IVA). At 39%, the estimated GVC participation under EORA is almost three times the estimated value (14%) under the WBES. Importantly, EORA estimates suggest that SSA has much higher backward integration (i.e. closer to the final consumption) than WBES estimates.<sup>18</sup> Since the EORA estimates for SSA do not rely on any IO table but are constructed from algorithm-based estimates that are not spelled out, it is tempting to conclude that those from WBES are likely to be more informative even though the selection of firms is not representative as large firms are over-represented. Then, SSA participation in GVCs is less than those reported from IO multipliers. Catalayud and Rochina report FVA and IVA estimates across sectors and across countries. Their estimates show much greater variability across countries and sectors than those reported in the bottom of table 4.1. For example, Cameroon and Kenya the two countries most engaged in GVC have mean participation rates more than twice those of other countries.<sup>19</sup>

Catalayud and Rochina then report probit estimations, in which fixed effects are included to absorb unobserved heterogeneity at country, sector and year levels, and results are checked that firm-level decisions like investing may be endogenous. They report that the following variables (with signs in parenthesis) are associated statistically significantly with belonging to each one of the GVC definitions: Having a generator (+); having a website (+); obstacles to finance (-); payment for security (+).

In a second step, they look for any impact of engaging in GVCs on firms' R&D decision, new products, labour productivity and wages again relying on IV estimates. Participating in GVCs significantly increases for firms the probability of investing in R&D and innovating, as well as their labour productivity, the average wages they pay and the employment they generate. Hence, these results suggest SSA firms can obtain important benefits from participating in GVCs, since firms that do so innovate more, are more productive, pay higher wages and turn to be bigger.

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<sup>18</sup> Calatayud and Rochina also produce estimates dropping the proportionality assumption. Results are barely affected. See their table A4.1. They also report that their estimate of 2.5% of imported intermediate content in exports are close to those using the African Investor Survey (Amendolagine et al. 2019)

<sup>19</sup> They report (FVA, IVA) estimates for Kenya (0.064,0.39) and Nigeria (0.006,0.064), estimates very far from those reported in table 4.1

## 4.2 Remarks on supply chain trade estimates for upgrading

The GVC measures presented are comparable across countries, sectors and over time. For those preoccupied that firms in the SSA and MENA regions may not have participated in the growth of GVCs, the (lengthy) discussion of the sole (EORA) data source allowing for a comprehensive assessment is relatively clear. On average, MENA and SSA have participated less in supply chain trade than other regions over the past twenty years. Uncertainty about the magnitudes presented here call for caution in interpretation especially when it comes to comparisons across sectors or between countries.

Reliable measures on the shares of trade in intermediates are expected to inform about economic “upgrading”, usually defined in terms of efficiency of the production process. Of the four types of economic upgrading identified by Humphrey and Schmitz (2002),<sup>20</sup> it is tempting to read these estimates as support for a viable strategy for developing countries. Economic transformation is then an upgrading along paths that would target specific “sophisticated” products or production stages along the “smiley curve” thesis. This view is inspired by the often-cited iPad case study of Kraemer et al. (2011).<sup>21</sup> Thus, firms would benefit by moving away from the assembly or manufacturing parts of the chain at the bottom of the ‘smile’ curve.

Kowalski et al. (2015) warn against an indiscriminate application of ‘upgrading’ citing as examples specialization in assembly of electronic devices by Asian firms who abstained from launching a new mobile phone to capture significant market share from incumbents, and by China in electrical equipment (Kowalski et al. figure 6) that increased the foreign content of their products while multiplying overall sales and profits. In sum, especially in view of the uncertainty surrounding the estimates based on EORA (and also in the World Bank (2020) upgrading trajectories)<sup>22</sup>, it seems premature to use the estimates reported here as indicators of upgrading paths for MENA and SSA firms. Assessing upgrading outcomes along

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<sup>20</sup> The four types are: 1. Process upgrading (firms gain in terms of efficiency in producing a given type of output). 2. Product upgrading (firms engage in the production of more sophisticated products). 3. Functional upgrading (firms acquire new functions within a given value chain). 4. Chain upgrading: (firms move into different value chains).

<sup>21</sup> The study highlights the low share of value added that assembly occupies in the production process; less than 5% of the sale value of the iPad remains in the People’s Republic of China.

<sup>22</sup> The World Bank Taxonomy Groupings (WDR 2020, box 1.3) identifies 4 groupings: Commodities, limited manufacturing, advanced manufacturing and services, innovative activities. . Based on this classification, the World Bank reports trajectories over the period 1990–2015 with the following changes in categories for MENA and SSA countries: Ethiopia, Kenya, South Africa and Tanzania moved from commodities into limited manufacturing. No country in the MENA or SSA regions moved into advanced manufacturing, or into innovative activities (countries with threshold shares for IP and R&D expenditures). Jordan and Lesotho, downgraded from limited manufacturing to commodities. Eswatini moved from limited manufacturing to advanced manufacturing and services and then back to limited manufacturing. Botswana and Senegal switched from commodities to limited manufacturing and then back to commodities All other countries remained in the same group over the period covered (see World Bank (2020, box 1.3)).

supply chains will need to await results from firm-level case studies that distinguish the type of supply chain in which firms are engaged, i.e. whether they are in captive or relational GVCs.<sup>23</sup>

## 5. GVC-related trade: trade costs and the quality of data infrastructure

For Africa's generally inhospitable geographical environment, insufficient hard infrastructure, often of poor quality has been singled out as the major culprit for poor integration outcomes in Africa. Africa's road [paved] density of 3.4 [0.7] km per 1000 inhabitants is less than one half [one fifth] of the respective global averages (Gwilliam, 2011).<sup>24</sup> Poor quality hard infrastructure combined with deficient logistic markets resulting in poor-quality soft infrastructure (i.e., high costs for access to broadband services) have resulted in high trade costs. Poor hard and soft-infrastructure have stifled goods trade, and hence, GVC participation across Africa. Both aspects are explored here.

### 5.1 Trade costs

If one is willing to accept that structural gravity holds on the data (including that bilateral trade costs are symmetric and that income and trade are jointly determined), the inverted gravity approach provides an estimate – or rather a calibration - of aggregate bilateral trade costs directly obtained from observable data. The resulting ad-valorem estimate of total bilateral trade costs (including the effects of tariffs, language barriers, currency barriers, the equivalent of NTMs, etc.) has two advantages over common proxies. First, it does not rely on a functional form for trade costs; second, it varies over time while typical proxies in the standard gravity approach (e.g. distance) do not vary over time.

Figure 5 compares the evolution of calibrated bilateral trade costs (with all trading partners) for SSA and MENA countries relative to those of the top 15 largest importers in the sample (simple averages across countries in each grouping). To see more clearly the evolution of trade costs in relative terms during the 20-year period, trade costs in the base year (1995) are normalized to 100. Also, next to each grouping, each panel displays the initial and final

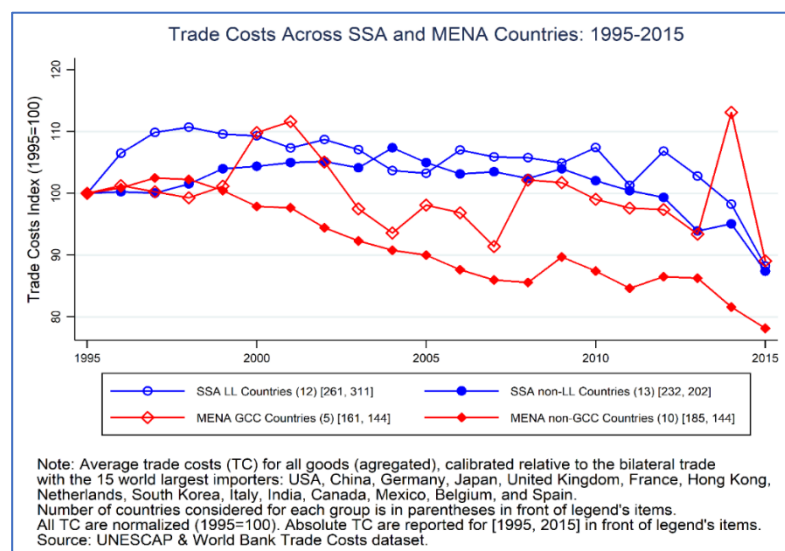
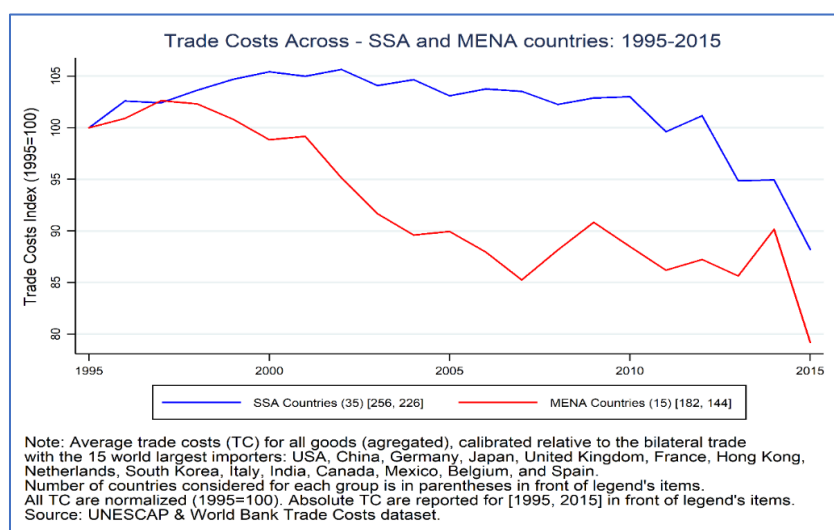
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<sup>23</sup> Banga (2019) shows that among Indian firms, GVCs boosts firm-level product-sophistication, with innovative TC playing a complementary role. However, firms in Captive chains (highly power asymmetrical governance structures) produce significantly less sophisticated goods than firms in Relational chains, which exhibit a balance in power between buyers and suppliers. Similarly, linking into GVCs and GVC embeddedness boosts firm-level TFP.

<sup>24</sup> Using data on roads for 39 African countries combined with geo-referenced data and an extraneous trade-cost elasticity to distance, Jebwab and Storeygard (2018) 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 (2015) 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.

year trade costs relative to the average of the 15 largest importers in the sample of 167 countries. Thus, on average, the 35 SSA 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. According to the gravity view of the world, average bilateral trade costs 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.

Figure 6: Trade Costs by regional groupings and subgroupings



Source: Authors' estimates from Arvis et al. (2017) based on UNESCAP and WB data base



When disaggregated into two sub-groupings in each region, for MENA, bilateral trade costs 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.<sup>25</sup>

In interpreting the patterns in figure 5, accounting for the interconnections among the sources of trade costs comes at a price. First, the inverted gravity approach provides an estimate of trade costs that is consistent with observed trade volumes but not independent of these volumes. In fact, bilateral trade costs are highly sensitive to bilateral trade volumes (e.g. Hummels, 1999, and Fink et al., 2005). Therefore, assessing the determinants of trade costs using a specification that does not account for the influence of trade volumes (suitably instrumented) suffers from omitted variable bias. Second, the strong multi-collinearity across components and the aggregative nature of these proxies is problematic: is it customs, roads, telecoms, or competition among providers that is the major bottleneck? Below we look for patterns of GVC participation across MENA and SSA countries focusing on trade costs and proxies for the quality of national data infrastructure which will be essential for successful digitalization.

## 5.2 Correlates of GVC-related trade: trade costs and data infrastructure

MENA and SSA have participated less than other regions in GVCs as measured by the share of intermediates in gross exports, in particular the average share of imported intermediates in gross exports is about half the corresponding shares in other regions (Melo and Solleder 2022, table 1). Low GVC participation rates could reflect high trade costs that, in turn, could be related to the quality of the national data infrastructure captured by a country's position on a 'ladder' of the quality of national data infrastructure (or by proxies of telecom performance). These channels are examined here with data on bilateral trade for MENA and SSA.

As a first approximation, bilateral trade depends on bilateral trade costs which in turn depend on policy and other factors including the quality of national data infrastructure. To get a clearer vision of the total impact of our telecom proxy on GVC, we run the following simultaneous equation model follows:

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<sup>25</sup> Initial and terminal year trade costs estimates (percentage above the average trade costs of the 15 countries with the average lowest trade costs) for African countries are: LDCs (273/230), Land-locked (283/263); non-African LDCs (208/198). Melo et al. (2020, figure 10) report trade cost estimates for 3 country groupings over the same period (number of countries in parenthesis followed by initial and terminal trade cost estimates in brackets as in figure 5). The patterns are as expected with the highest trade costs relative to the benchmark falling as one goes up the income groupings and some catch up over the period for each group: LIC (25), [274,238]; LMIC (16)[219,201]; UMIC (9) [203,161].

$$\begin{cases} \log GVC_{o,d,t} = \alpha + \sigma \log TC_{o,d,t} + \sum_m \mu_{o,m} Z_{o,t}^m + \sum_m \mu_{d,m} Z_{d,t}^m + \delta_t + \xi_{o,d,t} & (1a) \\ \log TC_{o,d,t} = \varphi + \beta_o RQ_{o,t} + \beta_d RQ_{d,t} + \sum_m \gamma_m X_{o,d}^m + \sum_m \kappa_{o,m} Y_{o,t}^{o,m} + \sum_m \kappa_{d,m} Y_{d,t}^{d,m} + \delta_t + \epsilon_{o,d,t} & (1b) \end{cases}$$

Where  $(o, d)$  indicate origin and destination partners,  $\delta_t$  is a year fixed effect,  $t=2000, 2005, 2010, 2015$ . Equation (1a) states that, controlling for trade costs, GVC participation is associated with telecom infrastructure and other control variables at origin,  $Z_{o,t}^m$  and destination,  $Z_{d,t}^m$  (list of variables in table 6.1). Equation (1b) links trade costs with the telecom indicators and other control variables. Estimating this system of equations using a multiple equation GMM estimator allows us to estimate the direct effect of our variables of interest on GVCs (telecom indicators) as well as the effect that runs through the trade cost channel.

Start with the trade cost regression (1b). Policy indicators are captured by regulatory quality, RQ, for the origin  $RQ_{o,t}$  and destination  $RQ_{d,t}$  countries. RQ is sourced from the World Governance Indicators (WGI), selecting Regulatory Quality (RQ).<sup>26, 27</sup> The vector  $X_{o,d}^m$  includes time invariant bilateral controls: ‘natural’ (or geographical) factors; the vectors  $Y_{i,t}^m (i \in \{o, d\})$  include time-varying country specific factors: our telecom indicators, and GDP per capita. Time-invariant bilateral characteristics indexed over  $m$  and include the log of distance, common border, and common language. Year fixed effects are added to the regression ( $\delta_t$ ), and  $\epsilon_{o,d,t}$  is an error term.

The GVC equation (1a) includes trade costs ( $TC_{o,d,t}$ ), used as the outcome of the previous regression, a vector containing GDP per capita, FDI per capita, our telecom indicator in origin and destination countries (as in the trade cost regression),  $(Z_{i,t}^m (i \in \{o, d\}))$ , year fixed effects, and an error term  $\xi_{o,d,t}$  correlated with  $\epsilon_{o,d,t}$ . The GVC equation (1a) is estimated for the log of the share of GVC trade in total trade (GVC<sub>s</sub>) the share of backward GVC trade (GVC<sub>bs</sub>), and the share of forward GVC trade (GVC<sub>fs</sub>).

<sup>26</sup>The WGI reports six institution indicators on a yearly basis since 1996: control for corruption; government effectiveness, political stability, rule of law, voice and accountability, and regulatory quality (RQ). Each is a composite of several sub-indices. As the correlation across these six indicators is high (in the range  $(0.47 < \rho < 0.98)$ ) resulting in high multicollinearity, we only include one indicator, RQ, keeping in mind that similar results would obtain with anyone of the other indicators.

<sup>27</sup> Estimates not reported here with each one of the 6 indicators returns significantly negative coefficients for each one of the indicators when entered separately, an indication that these indices all capture similar aspects of governance.

Table 3: Correlates of trade Costs and GVC participation

Main	(1) log(GVC <sub>s</sub> )	(2) log(GVC <sub>bs</sub> )	(3) log(GVC <sub>fs</sub> )
log(TC)	-2.718*** (0.0859)	-2.784*** (0.0879)	-2.605*** (0.0870)
log(FDI pc) Orig.	-0.191*** (0.0461)	-0.0443 (0.0471)	-0.311*** (0.0465)
log(FDI pc.) Dest.	-0.0782 (0.0486)	-0.130*** (0.0497)	-0.0151 (0.0490)
log(GDP pc.) Orig.	0.122** (0.0538)	-0.0912* (0.0551)	0.276*** (0.0543)
log(GDP p.c.) Dest.	0.219*** (0.0743)	0.186** (0.0760)	0.246*** (0.0751)
log(Tel. Subs.) Orig.	0.442*** (0.0266)	0.420*** (0.0273)	0.474*** (0.0269)
log(Tel. Subs.) Dest.	0.443*** (0.0238)	0.409*** (0.0243)	0.467*** (0.0240)
Constant	1.348 (1.086)	3.354*** (1.111)	-2.182** (1.101)
<b>log(TC)</b>			
log(Dist)	0.258*** (0.0118)	0.258*** (0.0118)	0.258*** (0.0118)
log(Tel. Subs.) Orig.	-0.0832*** (0.00550)	-0.0832*** (0.00550)	-0.0832*** (0.00550)
log(Tel. Subs.) Dest.	-0.126*** (0.00475)	-0.126*** (0.00475)	-0.126*** (0.00475)
Com. Lang.	-0.307*** (0.0247)	-0.307*** (0.0247)	-0.307*** (0.0247)
Com. Border	-0.422*** (0.0578)	-0.422*** (0.0578)	-0.422*** (0.0578)
log(GDP pc) Orig.	-0.0599*** (0.0100)	-0.0599*** (0.0100)	-0.0599*** (0.0100)
log(GDP pc.) Dest.	-0.0570*** (0.0140)	-0.0570*** (0.0140)	-0.0570*** (0.0140)
log(Reg. Qual.) Orig.	-0.0218** (0.0101)	-0.0218** (0.0101)	-0.0218** (0.0101)
log(Reg. Qual.) Dest.	0.00106 (0.0140)	0.00106 (0.0140)	0.00106 (0.0140)
Constant	7.642*** (0.212)	7.642*** (0.212)	7.642*** (0.212)
FE	Year	Year	Year
Observations	1847	1847	1847

Standard errors in parentheses.

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ 

Source: Authors' estimates

Table 3 reports the results from estimating the system (1a and 1b) for the whole sample of MENA and SSA countries with all their partners for years 2000, 2005, 2010, and 2015.<sup>28</sup> The upper part of the table reports results of the regression on GVC indicators and the bottom part, the results of the regression on trade costs. Note that the regression results on trade costs are the same across the three columns since only the GVC dependent variable is altered in (1a).

Start first with the results from the trade cost regression (1b). Distance has the expected positive sign. A one percent increase in distance increases trade costs by about 0.2%. All other geographical variables are significant with expected signs. Sharing a common language, or a common border, reduces bilateral trade costs. A one percent higher per capita GDP at origin or at destination is associated with a reduction in bilateral trade costs of about -0.06%. Regulatory quality is significant, but only in the origin. Lastly, the number of fixed and mobile subscriptions, our proxy for data infrastructure is statistically significant and negative, as expected. The size of the effect is statistically significantly different at origin and destination, though the difference between the two is small. The estimate suggests that an increase in the number of telecom subscription by 1% is associated with a decrease of trade costs by about 0.1% for both coefficients.

Turn now to the GVC estimates in the top part (1a). Column 1 reports results for GVC share in total exports ( $GVC_s$ ) columns 2 on the share of imported intermediates in gross exports ( $GVC_{bs}$ ), and column 3 on the share of exports undergoing further transformation at destination ( $GVC_{fs}$ ). The impact of trade costs on all three GVC indicators is negative, as expected. The coefficient estimate suggests a decrease of about -2.7% in GVC trade for each 1% increase in trade costs. The FDI per capita indicator in the origin country is generally negative though insignificant in the case of the backward GVC for the total and forward GVC indicators. In the destination country, the effect is reversed and the only significant FDI per capita coefficient is the one associated with ( $GVC_{bs}$ ). These findings, while surprising as we would expect FDI to be associated with greater GVC trade, are in line with earlier studies (see for example Melo and Twum (2021)). GDP per capita,  $GDP_{pc}$ , has a statistically significant and positive coefficient in all regressions except for the backward GVC at origin where the coefficient is negative, relatively small and weakly significant. Finally, the telecom proxy yields statistically significant and positive coefficients for all regressions. The impact is relatively stable for both destination and origin with coefficients ranging from 0.409 to 0.474.

Looking at the total effect of our telecom proxy, we find that a 1% increase in telecom subscriptions will lead to a direct effect on total GVC trade of 0.44% and an indirect effect of  $(-0.0829 \times -2.718) = 0.23\%$  through a decrease in trade costs. This yields a total effect of 0.67% increase in GVC trade for a one percent increase in telecom subscriptions.

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<sup>28</sup> Results are similar when the sample is reduced only to MENA or SSA countries.

Telecom subscriptions serves as a first indicator of how the telecom infrastructure reaches the population, a proxy for the “extensive margin” of the telecommunication infrastructure. Adding the number of submarine connections (SMCs) in each country can serve as a proxy of the “intensive margin”. This variable is more likely to be correlated with the total throughput of the country’s connection but says little about how this throughput is distributed to the population.

Table 4 reports the results with SMC connections instead of the number of telephone subscriptions, excluding non-coastal countries. First, looking at trade costs, all coefficients display similar effects to those in columns (1) to (3) of table 3, except for common border, and GDP. The common border coefficient estimate is likely to be affected by the fact that non-coastal countries have been removed from the sample. The impact of GDP at destination is now non-significant. Turning to the GVC regressions, the impact of trade costs increases – in absolute terms – in all specifications to reach a value of about -3.4. FDI is now negative and statistically significant in all regressions. GDP at origin increase the trade for total and forward GVC but decreases it for backward GVC. The total impact of SMC lines is of  $(-3.424*-0.116+0.349)$  0.74, with the direct effect being less than half of the total effect.

Columns (4) to (6) shows the results with both SMC and telecom subscriptions as explanatory variables. In the trade costs regression, coefficients keep the same order of magnitude as in columns (1) to (3), except for SMC at destination which drops by an order of magnitude but remains significant. Our second “extensive margin” variable, the number of telecom subscriptions, displays a similar order of magnitude to the one in table 3.

Turning to the regression on GVC trade levels, the effect of the number of lines at destination remains significant but the effect at origin is now negative and weakly significant for total and backward GVC. In contrast, the coefficient on the number of subscriptions exhibits now a larger value, reaching about 0.6 for all regressions while it was about 0.4 previously. The total effects are  $(0.604+-2.82*-0.0730)$  0.80 for the telecom subscriptions and  $(-0.0969*-2.82-0.18)$  0.09 for the SMC.

Table 4: Correlates of trade Costs and GVC participation: Robustness checks

Main	(1) log(GVC <sub>s</sub> )	(2) log(GVC <sub>bs</sub> )	(3) log(GVC <sub>fs</sub> )	(4) log(GVC <sub>s</sub> )	(5) log(GVC <sub>bs</sub> )	(6) log(GVC <sub>fs</sub> )
log(TC)	-3.424*** (0.102)	-3.472*** (0.102)	-3.373*** (0.105)	-2.828*** (0.100)	-2.915*** (0.102)	-2.736*** (0.102)
log(FDI pc.)	-0.305*** (0.0554)	-0.128** (0.0557)	-0.450*** (0.0569)	-0.288*** (0.0517)	-0.121** (0.0527)	-0.420*** (0.0526)
Orig.						
log(FDI pc.)	-0.273*** (0.0531)	-0.316*** (0.0533)	-0.221*** (0.0544)	-0.0547 (0.0539)	-0.112** (0.0550)	0.00268 (0.0548)
Dest.						
log(GDP pc.)	0.124* (0.0658)	-0.125* (0.0661)	0.297*** (0.0675)	0.121* (0.0644)	-0.108* (0.0656)	0.275*** (0.0654)
Orig.						
log(GDP pc.)	0.343*** (0.0828)	0.309*** (0.0832)	0.371*** (0.0851)	0.161* (0.0833)	0.133 (0.0849)	0.196** (0.0848)
Dest.						
Ln(Nb. lines)	0.349*** (0.0880)	0.368*** (0.0884)	0.385*** (0.0904)	-0.181* (0.0944)	-0.171* (0.0962)	-0.148 (0.0959)
Orig.						
Ln(Nb. lines)	0.663*** (0.0611)	0.623*** (0.0614)	0.657*** (0.0627)	0.289*** (0.0692)	0.296*** (0.0705)	0.246*** (0.0703)
Dest.						
log(Tel. Subs.)				0.604*** (0.0429)	0.595*** (0.0437)	0.629*** (0.0437)
Orig.						
log(Tel. Subs.)				0.445*** (0.0316)	0.398*** (0.0322)	0.480*** (0.0321)
Dest.						
Constant	19.16*** (1.066)	20.19*** (1.071)	16.96*** (1.100)	0.477 (1.440)	2.541* (1.467)	-2.870* (1.474)
<b>log(TC)</b>						
log(Dist)	0.218*** (0.0123)	0.218*** (0.0123)	0.218*** (0.0123)	0.289*** (0.0115)	0.289*** (0.0115)	0.289*** (0.0115)
Ln(Nb. lines)	-0.116*** (0.0180)	-0.116*** (0.0180)	-0.116*** (0.0180)	-0.0969*** (0.0185)	-0.0969*** (0.0185)	-0.0969*** (0.0185)
Orig.						
Ln(Nb. lines)	-0.178*** (0.0124)	-0.178*** (0.0124)	-0.178*** (0.0124)	-0.0387*** (0.0131)	-0.0387*** (0.0131)	-0.0387*** (0.0131)
Dest.						
Com. Lang.	-0.333*** (0.0282)	-0.333*** (0.0282)	-0.333*** (0.0282)	-0.375*** (0.0258)	-0.375*** (0.0258)	-0.375*** (0.0258)
Com. Border	-0.194*** (0.0656)	-0.194*** (0.0656)	-0.194*** (0.0656)	-0.127** (0.0573)	-0.127** (0.0573)	-0.127** (0.0573)
ln(GDP pc.)	-0.0476*** (0.0115)	0.0476*** (0.0115)	-0.0476*** (0.0115)	0.0107 (0.0121)	0.0107 (0.0121)	0.0107 (0.0121)
Orig.						
ln(GDP pc.) Dest.	-0.00852 (0.0162)	-0.00852 (0.0162)	-0.00852 (0.0162)	-0.00945 (0.0161)	-0.00945 (0.0161)	-0.00945 (0.0161)
ln(Reg. Qual.)	-0.0237*** (0.00803)	0.0237*** (0.00803)	-0.0237*** (0.00803)	-0.0639*** (0.0103)	-0.0639*** (0.0103)	-0.0639*** (0.0103)
Orig.						
log(Reg. Qual.)	-0.0171 (0.0138)	-0.0171 (0.0138)	-0.0171 (0.0138)	-0.0108 (0.0136)	-0.0108 (0.0136)	-0.0108 (0.0136)
Dest.						
log(Tel. Subs.)				-0.0730*** (0.00801)	-0.0730*** (0.00801)	-0.0730*** (0.00801)
Orig.						
log(Tel. Subs.)				-0.129*** (0.00568)	-0.129*** (0.00568)	-0.129*** (0.00568)
Dest.						
Constant	4.452*** (0.228)	4.452*** (0.228)	4.452*** (0.228)	6.210*** (0.264)	6.210*** (0.264)	6.210*** (0.264)

FE	Year	Year	Year	Year	Year	Year
Observations	1644	1644	1644	1427	1427	1427

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

Source: Authors' estimates

## 6. Summary and conclusions

The paper uses two standard measures of supply chain to evaluate the integration of MENA and SSA in supply chains: the share of gross exports that embodies imported value-added [the backward participation share ( $GVC_{bs}$ )]; and the share of gross exports that is not fully absorbed in the importing country [the forward-participation share ( $GVC_{fs}$ )] which is the share of imports that undergoes further processing before final consumption. The sum of these two shares,  $GVC_s$ , is then the estimate of outsourcing/dispersion across countries in supply chains.

Based on these measures, both MENA and SSA started low and stayed low on backward shares indicating relatively lower increases in imported inputs over the 20 year period than for other regions. This pattern is consistent with high policy-imposed trade barriers, or at least with trade barriers falling less rapidly than in other regions. On average, according to these measures, exports from MENA and SSA embody fewer intermediate imports than other regions. On the forward side, both regions have the highest shares throughout the period, an indication of exports concentrated in raw materials and agricultural products with little transformation. For other regions, the share of further processing of exports in destination countries has either remained constant or decreased.

Contrasting the patterns of supply-chain trade across regions over the longest time-period possible, 1990-2015, reveals three distinct patterns. First is the very low growth of regional supply chain trade (or Regional Value Chains (RVCs) for SSA and MENA. Second, is the divergent experience between MENA and SSA and other regions. In MENA and SSA most supply chain trade is non-regional, i.e. it takes place outside of the defined regional blocs. Third, East Asia and Europe, already emerging hubs in the 1990s, had a rapid growth over 1990-2015 around RVCs. This pattern is a challenge for the AFCFTA. In 2015, only 3.5% of total SSA exports were connected to supply chain trade within SSA, an RVC rate almost 8 times short of the 25.5% RVC rate for East Asia and the Pacific.

The slow growth of participation in GVCs could reflect slow growth in trade in services and low levels of GVC participation in services sectors. Recent estimates show that over 1980-99, services grew on average by less than 10% per year (compared to the world average of 15%) and, in spite of some catching up during the 2000-2014 (13% annual growth compared with the world average of 16%), the gap with the rest-of-the-world has been increasing. Could digitalization help close this gap?

Hard infrastructure to transport goods and digital connectivity to transport data, are both necessary to participate fully in supply-chain trade. So is soft infrastructure: trade facilitation measures, and affordable broadband access to transport data. Poor performance in both infrastructures result in high trade costs for transit of goods and for data packets. Gravity-based estimates of average bilateral trade costs were over twice (SSA) or close to twice (MENA countries) those of the 15 largest importers in the world in 1995. For data, people living in SSA pay over 6% of their monthly income for access to broadband, twice the worldwide average.<sup>29</sup>

To pull the threads together, the bilateral GVC participation measures are regressed on bilateral trade costs, indicators of the quality of national data infrastructure, time-varying country-specific factors and time-invariant bilateral characteristics in a large panel. A two-equation system is postulated: in a first equation, GVC measures are regressed on trade costs and other indicators of GVC participation; in a second equation trade costs are regressed on policy indicators for origin and destination countries. The results suggest that the intensity of GVC is positively associated with telecom subscriptions with a direct elasticity of 0.4 and indirectly through a reduction in trade costs of 0.25. Replacing telecom subscriptions with the number of SubMarine Cables (SMCs) as an indicator of hard infrastructure, raises the direct elasticity estimate of telecom subscriptions to 0.8 and of 0.09 for SMCs.

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<sup>29</sup> The gap in average bilateral trade costs relative to trade partners with the lowest costs fell by 21 percentage points for MENA about twice the rate for SSA. The Broadband Commission estimates that in 2019, 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)



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## ANNEXES to Patterns and Correlates of Supply Chain Trade in MENA and SSA

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

Global Input-Output (IO) are used to calculate multipliers that give estimates of value-added trade flows across countries. Because very few countries have IO tables that distinguish between the domestic and foreign origin of intersectoral flows, bilateral trade flows assume that the same combination of inputs is used regardless of the destination of sales of a country's industry's output. In practice, however, firms selling output to different markets use very different combinations of input sources. This has implications for the GVC measures computed from global IO tables which should be kept in mind when interpreting the measures reported in the paper.<sup>30</sup>

Next comes the choice of IO data base. Three data bases are used to estimate GVC trade (i.e. Foreign Value-Added (FVA) shares and domestic value-added (VAX) shares in gross exports): the OECD trade in value-added (OECD-TiVA) data base (64 countries), the WIOD annual (1995-2011) data base (43 countries) and the EORA MRIO annual (1990-2015) data base (189 countries). We use EORA because it 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 WIOD and TiVA data sets.

EORA uses national IO tables for more countries (74 countries at various time intervals) and balances these all the while extrapolating or intrapolating values through cross-entropy methods for countries that do not have an IO table. Kowalski et al. (2015) give the example of Lao PDR that has poor quality trade statistics and no IO table so that the EORA project uses its algorithms for filling in the table values and instead 'generates' this information for this country.<sup>31</sup> Lanzen et al. (2015) discuss the philosophy of the EORA project: develop "a method for rapid, timely, and at the same time low labor and time intensive construction and updating of high-resolution MRIO tables by focusing on standardisation, automation, and advance computation". Based on Montecarlo simulations showing that errors on small flows do not affect multiplier estimates justifying using all available information and the observation that that MRIO tables are dominated by elements of \$10,000 or less, they argue that the methodology allows to obtain 'holistic' accuracy.<sup>32</sup>

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<sup>30</sup> Gortari (2019) shows exports to the US embody 30% of US imported components while applying the standard IO techniques would estimate an import share of 17%. See Johnson (2018) and World Bank (2020, box 1.4) for further discussion of this shortcoming which was already pointed out in the early days of single-country CGE models. Catalayud and Rochina (2021) show implications of relaxing the assumption of same use of imports across sales to different destinations

<sup>31</sup> For WIOD reconciliation of conflicting data relies on balancing national accounts and for TiVA on balancing trade. EORA is not so much a data collection but a complicated automated data imputation exercise.

<sup>32</sup> Holistic accuracy results from the observation that a large number of small elements in an IO table can be removed before multipliers show a significant change (Jensen (1980)). Unreliable elements in the MRIO tables result from the choices to deal with the interplay of data conflict that create 'tensions' and lack of information that create 'dustbins'. Lanzen et al. state that construction choices emphasized representing large data items and fulfilling balancing conditions for large countries.

From a comparison of EORA-based GVC shares with those of the TiVA data base, Aslam et al. (2017) conclude that EORA-based estimates are relatively close<sup>33</sup> Kowalski et al. go further: they compare the aggregate forward and backward measures for EORA, WIOD and TiVA for common countries. Unfortunately, these estimates which are for countries with relatively accurate IO tables, do not include any country from Africa nor from Arab States (see figure D, p.158).

Kowalski et al. (2015) carry out a more 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.<sup>34</sup> Large discrepancies in estimates also hold for the GVC estimates reported in section 4.2. Annex 2 states the criteria used to reduce the sample to 148 countries.

## A2: 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.

### Selection of countries 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.

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.

<sup>33</sup> Their comparisons reported in tables 7-13 at 5-year intervals over the period 1995-2010 show a reasonably close fit between estimates from the two data bases for those countries that are common to both data bases.

<sup>34</sup>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.



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, 14]
Brunei		Angola	Algeria
Australia	Albania	Benin	Bahrain(●)
Cambodia	Andorra	Botswana(◇)	Djibouti
China	Armenia	Burkina Faso (◇)	Iran
North Korea	Austria	Burundi (◇)	Iraq
Fiji	Azerbaijan	Cameroon	Israel
French Polynesia	Belarus	Cape Verde	Jordan
Hong Kong	Belgium	Central African Republic(◇)	Kuwait(●)
Indonesia	Bosnia and Herzegovina	Chad (◇)	Lebanon
Japan	Bulgaria	Congo	Libya
Laos	Croatia	Cote d'Ivoire	Malta
Macao SAR	Cyprus	DR Congo	Morocco
Malaysia	Czech Republic	Egypt	Gaza Strip
Mongolia	Denmark	Eritrea	Oman(●)
Myanmar	Estonia	Ethiopia (◇)	Qatar
New Caledonia	Finland	Gabon	Saudi Arabia(●)
New Zealand	France	Gambia	Syria
Papua	Georgia	Ghana	Tunisia
New Guinea	Germany	Guinea	UAE(●)
Philippines	Greece	Kenya	Yemen
South Korea	Greenland	Lesotho(◇)	
Samoa	Hungary	Liberia	<b>North America</b>
Singapore	Iceland	Madagascar	Bermuda
Taiwan	Ireland	Malawi (◇)	Canada
Thailand	Italy	Mali (◇)	Mexico
Vanuatu	Kazakhstan	Mauritania(◇)	USA
Viet Nam	Kyrgyzstan	Mauritius	
	Latvia	Mozambique	<b>South Asia</b>
<b>Latin America &amp; Caribbean</b>	Liechtenstein	Namibia	Afghanistan
Antigua	Lithuania	Niger(◇)	Bangladesh
Argentina	Luxembourg	Nigeria	Bhutan
Aruba	Monaco	Rwanda(◇)	India
Bahamas	Montenegro	Sao Tome and Principe	Maldives
Barbados	Netherlands	Senegal	Nepal
Belize	Netherlands Antilles	Seychelles	Pakistan
Bolivia	Norway	Sierra Leone	Sri Lanka
Brazil	Poland	Somalia	
British Virgin Islands	Portugal	South Africa	
Cayman Islands	Moldova	South Sudan(◇)	
Chile	Romania	Sudan	
Colombia	Russia	Swaziland	
Costa Rica	San Marino	Togo	
Cuba	Serbia	Uganda (◇)	
Dominican Republic	Slovakia	Tanzania	
Ecuador	Slovenia	Zambia (◇)	
El Salvador	Spain	Zimbabwe (◇)	
Guatemala	Sweden		
Guyana	Switzerland		
Haiti	Tajikistan		
Honduras	TFYR Macedonia		
Jamaica	Turkey		
Nicaragua	Turkmenistan		
Panama	Former USSR		
Paraguay	Ukraine		
Peru	UK		
Suriname	Uzbekistan		
Trinidad and Tobago			

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) .



*“Sur quoi la fondera-t-il l’économie du monde qu’il veut gouverner? Sera-ce sur le caprice de chaque particulier? Quelle confusion! Sera-ce sur la justice? Il l’ignore.”*

Pascal



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