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Patterns and Correlates of Supply Chain Trade in Sub-Saharan Africa and Middle East and North Africa*

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Abstract

Strong participation in Global Supply Chains (GSCs) indicates the structural transformation at the heart of the 'Africa we want' described in African Union's Agenda 2063 project. We report new input-output based measures at several levels: across countries, regions, and sectors over the period 1995-2016.

On average, for both Sub-Saharan Africa (SSA) and Middle East and North Africa (MENA), exports have a low content of imported intermediates and undergo further transformation in destination countries before reaching consumers. Compared with other regions, SSA and MENA mostly engage in supply chain trade with countries outside their respective regions. In sum, despite regional trade agreements focusing on reducing trade barriers to intra-regional trade, regional value chains have failed to develop in both regions.

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High trade costs hamper bilateral trade. Gravity-based estimates show that average bilateral trade costs for MENA countries were nearly twice those of the 15 largest importers in 1995 (over twice for SSA countries) with a catch-up rate of 21 percentage points by 2015 for MENA (about twice the SSA catch-up rate). The estimates are based on the assumption that bilateral GVC participation depends on bilateral costs which in turn depend on indicators of hard infrastructure (like telecom equipment) and soft infrastructure (like regulatory policies). It finds that the intensity of GVC is positively associated with hard infrastructure and soft infrastructure, both directly and through trade costs.

1 Introduction

All countries participate in Global Value Chains (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 GVCs. Participation in GVCs 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. Furthermore, drawing on a taxonomy of GVCs 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 GVCs is also associated with higher growth.

In this paper, we discuss the challenges of measuring global value chains and report measures at several levels: across countries, regions, and sectors for input-output based measures, focusing on comparisons at the regional level to detect any particularities in MENA and SSA. We also explore the role of two drivers of GVC trade: the availability of hard infrastructure, like access to trade partners through a dense network of telecom links such as submarine cables (SMCs), and the reduction in trade costs through improvements in soft infrastructure proxied by an index of regulatory quality.

Section 2 briefly discusses the development of GVCs. Section 3 gives evidence of participation by MENA and SSA countries in GVCs over the period 1995-2016. 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 3 also documents the weak performance in SSA and MENA on services, a sector that has become an engine of structural transformation across most regions. Section 4 explores linkages between indicators of bilateral GVC trade, bilateral trade costs, and measures of hard and soft infrastructure 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 0.44 and an indirect effect through a reduction in trade costs of 0.23. Section 5 concludes.

2. Developments of Supply Chains

In the early 1960s, trade in intermediates started growing faster than trade in final goods. The importance of GVCs 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 allowed firms to unbundle manufacturing processes, intensifying further trade in intermediates. This first phase corresponded to the period when national policies and multilateralism moved together.

A second turn started with the financial crisis of 2008-09 and was prolonged by 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). During the 2009 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.[1] Trade uncertainty, as measured by perceptions in the press, also increased during 2009-15.[2]

Two other factors, covered in a companion paper (Melo and Solleder, 2022), also contributed to the leveling-off of GVC activity. One is the increased risk of a globalized economy in a world of increasing political tensions.[3] Another is the growth of artificial intelligence, automation and robotics, machine learning and big data analytics, the Internet of Things (IoT), autonomous vehicles, and 3D printing, all driving structural transformation of economies. In other words, digitalization might be a threat to GVC activity. 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.[4]

[1] See https://www.globaltradealert.org/ for the count of trade measures and Evenett and Fritz (2015) on how these measures discriminated most against LDCs.
[2] See Ahir, Bloom, and Furceri (2019) "The Global Economy hit by Higher Uncertainty", VOXEU https://cepr.org/voxeu/columns/global-economy-hit-higher-uncertainty.
[3] 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.
[4] 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.

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.[5] Several caveats apply. 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 of the discussion paper version.

3.1. Regional GVC participation trends

Table 1 displays the evolution of average participation in GVC trade in 1995, 2005, and 2016 for all regions and a selection of countries in MENA and SSA. At the world level, the share of trade in intermediates in GVCs increased until 2010, then stabilized. In SSA, the share of GVC trade remained the same in 2010 and 2016. MENA' GVD participation increased at a constant rate over the three years. Latin America and the Caribbean experienced the most significant increase in GVC participation between 2010 and 2016 while exhibiting one of the most minor participation among the regions at the end of the period.

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, indicating 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.

[5] 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; whereby higher values indicate that the firm is far from the final consumer. Backward GVC or FVA (foreign value-added) is an indicator of backward integration, with higher values meaning that the firm is closer to the final consumer.

Table 1: Trends in GVC participation by region

	Backward (GVC_{bs})			Forward (GVC_{fs})			Total (GVC_s)			
	1995	2005	2016	1995	2005	2016	1995	2005	2016	Trend
	By region									
World	**0.26**	**0.29**	**0.29**	**0.18**	**0.19**	**0.2**	**0.43**	**0.48**	**0.49**	
East Asia & Pacific	0.22	0.25	0.28	0.16	0.18	0.19	0.39	0.43	0.46	
Europe & Central Asia	0.31	0.35	0.37	0.19	0.2	0.2	0.5	0.55	0.57	
L. Am. & Caribbean	0.2	0.2	0.24	0.13	0.13	0.14	0.33	0.33	0.38	
M. East & N. Africa	***0.16***	***0.14***	***0.15***	***0.24***	***0.28***	***0.3***	***0.4***	***0.42***	***0.44***	
North America	0.16	0.18	0.16	0.16	0.17	0.19	0.32	0.35	0.35	
South Asia	0.11	0.14	0.2	0.18	0.19	0.22	0.29	0.34	0.41	
Sub-Saharan Africa	***0.15***	***0.14***	***0.12***	***0.22***	***0.25***	***0.26***	***0.37***	***0.39***	***0.39***	
	By selected countries									
Egypt	0.11	0.14	0.09	0.23	0.24	0.27	0.35	0.38	0.36	
Kenya	0.15	0.17	0.1	0.18	0.2	0.25	0.33	0.37	0.35	
Morocco	0.11	0.12	0.21	0.21	0.27	0.25	0.33	0.39	0.46	
Nigeria	0.11	0.08	0.02	0.25	0.26	0.3	0.36	0.34	0.32	
Rwanda	0.23	0.15	0.19	0.23	0.31	0.36	0.46	0.46	0.55	
Saudi Arabia	0.21	0.16	0.08	0.2	0.24	0.35	0.41	0.4	0.43	
South Africa	0.16	0.17	0.14	0.22	0.25	0.25	0.37	0.41	0.4	

Notes

Estimates from the sample of 148 countries listed in table A1, UAE removed due to data quality. Average weighted by gross trade at the regional level. The trend shows variations between 1995, 2005, and 2016, not yearly variation.

(GVC_{bs}) is the share of imports in gross exports and (GVC_{fs}) is the share of gross exports that enters into exports of destination country. (GVC_s) = (GVC_{bs})+(GVC_{fs}).

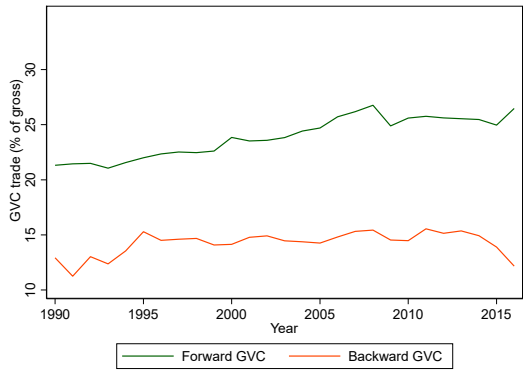
Source: Authors' estimates.

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) and exports from these countries undergo further processing in the importing countries (high GVC_{fs} values). Morocco stands out for increased upstream and downstream participation over the period.

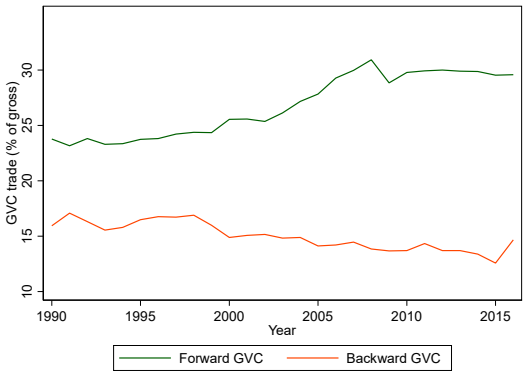
Figure 1 shows the time path of the average indices of backward and forward participation since 1990, the first year of data in the EORA data base. The trends show a sharp increase in forward participation until 2008 for both regions then a decline. Since GVC measures are calculated at current prices, 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 any case, both regions have remained upstream with relatively little rise in participation in the ongoing fragmentation of production.

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

(a) SSA



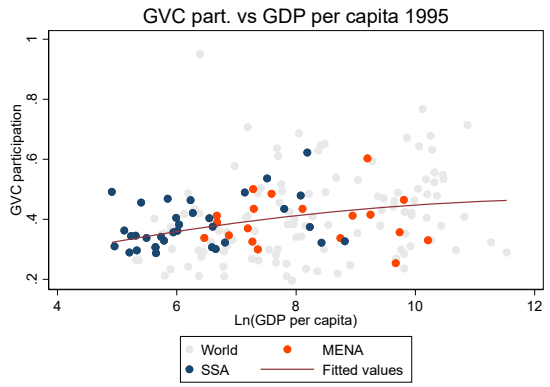
(b) MENA

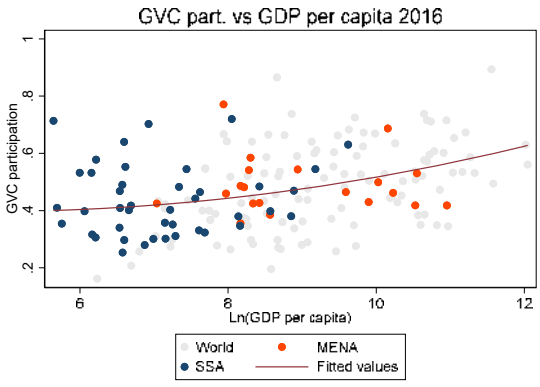


Notes: Gross refers to the gross exports of the whole region. List of countries in annex A1, UAE removed due to data quality.
Source: Authors' calculations from EORA data base.

Figure 2 compares GVC participation for MENA and SSA countries along the fitted line linking GVC participation with per capita income for the whole sample. Countries are dispersed around the fitted line with a larger share of MENA countries under-performing, especially in 2016. Comparing the 1995 and 2016 graphs for SSA countries suggests a growing disparity in GVC participation across countries with the lowest GDP per capita.

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





Notes: The sample includes 40 SSA and 20 MENA countries (see the list in annex A1). GVC participation is captured by GVC_s defined in table 1.
Source: Author's calculations from EORA data base.

Figure 3 contrasts the evolution of supply-chain trade across regions over 1990-2015. Figure 3a displays three distinct patterns. First is the very low regional supply chain trade growth for SSA and MENA. Second, is the divergent experience of MENA and SSA. In both regions,

supply chain trade grew outside of the defined regional blocs while the other regions experienced their supply chain growth mostly within the defined regional blocs.[6] These patterns may reflect a weak governance and regulatory environment that hamper the development of Regional Value Chains (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 developing 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 foreign direct investment (FDI). Other trade facilitation measures include simple and transparent rules of origin to facilitate regional cross-border trade (Cadot and Ing, 2016). Third is the importance of institutions captured by high indicator values for the Asia and Pacific region.[7]

MENA and SSA have mainly developed supply chain trade outside the region rather than regionally, i.e., the GVC_s indicator (defined as $GVC_s = GVC_{bs}+GVC_{fs}$, encompassing both forward and backward GVC trade) 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_s (35.6% of exports in 2015) than all regions except MENA. Even though these estimates should be interpreted cautiously, the magnitude of differences across regions is large enough to strongly suggest that MENA and SSA stand apart from other regions.

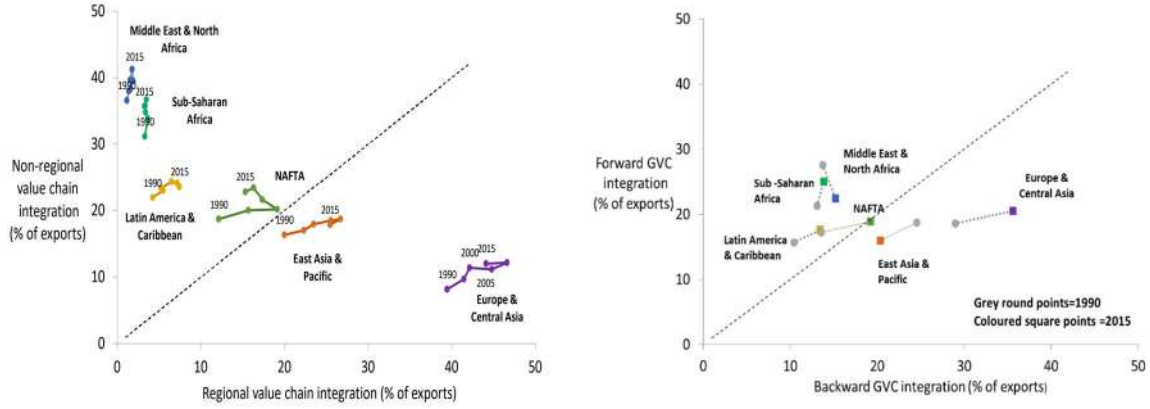
Figure 3b shows a move towards greater intra-regional trade in intermediate inputs in the 'factory economies' of East Asia and Pacific and Europe and Central Asia where countries are both makers and buyers of components and parts. This suggests that goods were moving seamlessly across borders. By contrast, for both SSA and MENA most trade in value-added has been forward (i.e., selling its exports that undergo further processing indicates that SSA exports primarily raw materials) rather than backward (i.e., exports have a low share of imported inputs). The downstream pattern of intermediates SSA and MENA exports are destined outside the region.

A move towards RVCs would be expected if transaction costs associated with border crossings fell more rapidly within regions than across regions. This pattern is followed by all regions in figure 3a except for SSA and MENA. Other geopolitical and economic factors,

[6] 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.
[7] 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.

like the absence of conflicts, also contribute to GVCs usually developing along geographically proximate production chains.

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



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

3.2. Sector-level participations: Manufacturing vs. Services

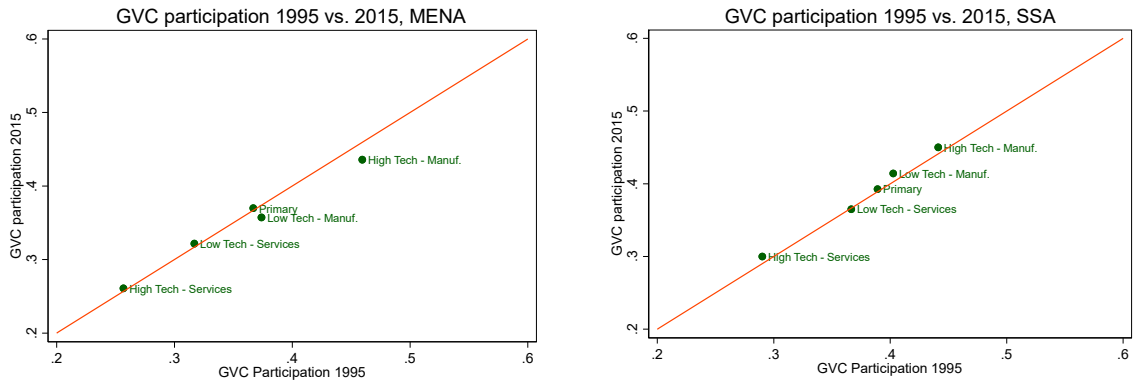
Evidence is growing that services and goods activities are complementary (Ariu et al. 2020). Countries with high growth rates in services also display high growth rates in goods trade. The slow growth of participation in GVCs could reflect slow growth in trade in services and low levels of GVC participation 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. Ariu and Ogliari (2022, figure 1) report that over 1980-99, services in Africa grew on average by less than 10% per year (compared to the world average of 15%) and, despite some acceleration 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.

As a final check on GVC patterns, figure 4 compares GVC participation rates for MENA and SSA for a sector classification that distinguishes between high- and low-tech manufacturing and high and low-tech services to see if any ongoing digitalization in MENA and SSA has been reflected in the measures of supply chain trade. High-tech services include health and education, two activities with low shares of value-added that are least traded. Low-tech services include retail, and transport, which are traded more intensely. Both manufacturing categories have greater engagement in supply chain trade.

Participation rates are higher in SSA than in MENA across all sectors. For both regions, the ranking of sectors is identical at the beginning and end periods, displaying very little change over the period. In interpreting these trends, recall that EORA has no national 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 (see Lenzen et al. (2013) for a discussion of how missing IO tables were estimated).

Figure 4: 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.

The similarities between SSA and MENA and the stark difference with other regions begs for a search of underlying factors. This search is beyond the scope of this paper, though contributing factors must include high trade costs due to geography inhospitable to trade (i.e., artificial borders, a high share of landlocked countries) and/or policy-imposed barriers (high tariffs and non-tariff barriers)[8]. In this paper, we look for linkages between measures of supply chain trade, high trade costs and/or weak governance and regulatory environments.[9]

4. GVC-related trade: trade costs and the quality of 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 African integration outcomes. 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,

[8] 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%) Dovis and Zaki (2020, figure 8).
[9] 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.

2011).[10] Telecom and data infrastructure are also likely to be key in trade costs reduction in the context of GVCs as supply chain trade requires international coordination between agents.

After investigating the structure of trade costs in MENA and SSA in paragraph 4.1, hard and soft infrastructure's impact on trade costs will be the focus of paragraph 4.2.

4.1. Trade costs

Arvis et al. (2016) calibrate aggregate bilateral trade costs by inverting an estimated gravity model. The resulting ad-valorem estimate of total bilateral trade costs (including the effects of tariffs, language barriers, currency barriers, the equivalent of non-tariff measures, 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 B1 in annex compares the evolution of these calibrated bilateral trade costs (across 167 trading partners) for SSA and MENA countries relative to those of the top 15 largest importers in the sample. They estimate that, on average, the 35 SSA countries had bilateral trade costs of 256% above those of the top importers in 1995 and 226% in 2015, showing catch-up during the period but less than for the 15 MENA where trade costs fell from 182% in 1995 to 144% in 2015. According to this 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%, almost twice that for SSA at 12%.

When disaggregated into two sub-groupings in each region, for MENA, bilateral trade costs fall faster for non-members of the Gulf Cooperation Council (GCC) 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.

4.2. Correlates of GVC-related trade: trade costs and infrastructure

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

[10] Using data on roads for 39 African countries combined with geo-referenced data and an extraneous trade-cost elasticity to distance, Jedwab 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.

$$\begin{cases} \log GVC_{o,d,t} = \alpha + \sigma \log TC_{o,d,t} + \beta_o RQ_{o,t} + \beta_d RQ_{d,t} + \sum_m \mu_{o,m} Z^m_{o,t} + \sum_m \mu_{d,m} Z^m_{d,t} + \delta_t + \xi_{o,d,t} \; (1a) \\ \log TC_{o,d,t} = \varphi + \beta_o RQ_{o,t} + \beta_d RQ_{d,t} + \sum_m \gamma_m X^m_{o,d} + \sum_m \kappa_{o,m} Y^{o,m}_{o,t} + \sum_m \kappa_{d,m} Y^{d,m}_{d,t} + \delta_t + \epsilon_{o,d,t} \; (1b) \end{cases}$$

Where subscripts (o, d) indicate origin and destination partners, δ_t is a year fixed effect, t=2000, 2005, 2010, 2015. Equation (1a) states that, controlling for trade costs, GVC participation is associated with indicators of infrastructure and other control variables at origin, $Z^m_{o,t}$ and destination, $Z^m_{d,t}$. Equation (1b) links trade costs with the infrastructure 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 as well as the effect that runs through the trade cost channel.

Start with the trade cost regression (1b). Soft infrastructure indicators are captured by regulatory quality at origin $RQ_{o,t}$, and destination $RQ_{d,t}$. RQ is sourced from the World Governance Indicators (WGI), selecting Regulatory Quality (RQ).[11] The vector $X^m_{o,d}$ includes time invariant bilateral controls: 'natural' (or geographical) factors[12]. The vectors $Y^m_{i,t} (i \in \{o, d\})$ include time-varying country specific factors: our hard infrastructure indicator, the number of telecom lines in the country, and GDP per capita. The number of telecom lines has been selected as a proxy for hard infrastructure as it has been shown to be correlated with GVC growth and has the advantage of being available for a large set of countries and years, unlike many other potential proxies for hard infrastructure. Furthermore, two different indicators (number of telecom subscriptions and number of submarines lines connecting countries) allow to distinguish between the 'extensive margin' (number of telecom subscription, which tells how the hard infrastructure reaches the population) and 'intensive margin' (number of submarines lines, which measures the bandwidth and resilience of the hard infrastructure), a distinction that would be hard to attain with other proxies of hard infrastructure. Finally, year fixed effects are added to the regression (δ_t), and $\epsilon_{o,d,t}$ is an error term.

The GVC equation (1a) includes trade costs $\left(TC_{o,d,t}\right)$, used as the outcome of the previous regression, a vector containing GDP per capita, FDI per capita, our soft indicator of infrastructure (at origin $RQ_{o,t}$, and destination $RQ_{d,t}$) and hard infrastructure indicator ($Z^m_{i,t} (i \in \{o, d\})$, year fixed effects ($\delta_t$), and an error term $\xi_{o,d,t}$ correlated with $\epsilon_{o,d,t}$. The GVC

[11]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< ρ<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. Estimates not reported here with each one of the 6 indicators return significantly negative coefficients for each one of the indicators when entered separately, an indication that these indices all capture similar aspects of governance.

[12] The log of distance, common border, and common language.

equation (1a) is estimated for the log of the value of GVC trade (GVC_s), the value of backward GVC trade (GVC_{bs}), and the value of forward GVC trade (GVC_{fs}).

Table 2: Correlates of trade costs and GVC participation

Main	(1) log(GVC_s)	(2) log(GVC_{bs})	(3) log(GVC_{fs})
log(TC)	-2.741***	-2.788***	-2.651***
	(0.0858)	(0.0872)	(0.0871)
log(FDI p. capita) Orig.	-0.217***	-0.0808*	-0.328***
	(0.0458)	(0.0466)	(0.0464)
log(FDI p. capita) Dest.	-0.102**	-0.134***	-0.0588
	(0.0493)	(0.0501)	(0.0499)
log(GDP p. capita) Orig.	0.0291	-0.215***	0.212***
	(0.0555)	(0.0564)	(0.0561)
log(GDP p. capita) Dest.	0.172**	0.202**	0.131
	(0.0804)	(0.0818)	(0.0814)
log(Tel. Subs.) Orig.	0.457***	0.441***	0.483***
	(0.0265)	(0.0270)	(0.0268)
log(Tel. Subs.) Dest.	0.434***	0.405***	0.451***
	(0.0238)	(0.0242)	(0.0241)
log(Reg. Qual.) Orig.	0.282***	0.371***	0.201***
	(0.0464)	(0.0472)	(0.0469)
log(Reg. Qual.) Dest.	0.107*	-0.0155	0.236***
	(0.0647)	(0.0658)	(0.0655)
Constant	3.483***	4.822***	0.743
	(1.224)	(1.246)	(1.245)
log(TC)			
log(Dist)	0.258***	0.258***	0.258***
	(0.0118)	(0.0118)	(0.0118)
log(Tel. Subs.) Orig.	-0.0832***	-0.0832***	-0.0832***
	(0.00550)	(0.00550)	(0.00550)
log(Tel. Subs.) Dest.	-0.126***	-0.126***	-0.126***
	(0.00475)	(0.00475)	(0.00475)
log(GDP p. capita) Orig.	-0.0599***	-0.0599***	-0.0599***
	(0.0100)	(0.0100)	(0.0100)
log(GDP p. capita) Dest.	-0.0570***	-0.0570***	-0.0570***
	(0.0140)	(0.0140)	(0.0140)
log(Reg. Qual.) Orig.	-0.0218**	-0.0218**	-0.0218**
	(0.0101)	(0.0101)	(0.0101)
log(Reg. Qual.) Dest.	0.00106	0.00106	0.00106
	(0.0140)	(0.0140)	(0.0140)
Com. Lang.	-0.307***	-0.307***	-0.307***
	(0.0247)	(0.0247)	(0.0247)
Com. Border	-0.422***	-0.422***	-0.422***
	(0.0578)	(0.0578)	(0.0578)
Constant	7.642***	7.642***	7.642***
	(0.212)	(0.212)	(0.212)
Observations	1847	1847	1847
FE	Year	Year	Year

Standard errors in parentheses.

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

Source: Authors' estimates.

Table 2 reports the results from estimating the system (equations 1a and 1b) for the whole sample of MENA and SSA countries with all their partners for years 2000, 2005, 2010, and 2015.[13] 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 (1b) 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 hard 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 exports (GVC_s) columns 2 on the value of imported intermediates in gross exports (GVC_{bs}), and column 3 on the value 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 negative in all three cases. In the destination country, the effect is negative for total and backward GVC indicators, but not significant for the forward GVC participation (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 most regressions except for the backward GVC at origin where the coefficient is negative. 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 0.405 to 0.483.

Looking at the total effect of our hard infrastructure proxy, we find that a 1% increase in telecom subscriptions in origin country will lead to a direct effect on GVC trade of 0.44% (log(2.741)=0.44) and an indirect effect of (0.0832*2.741=) 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. Turning to the soft infrastructure, an increase of one percent of the regulatory quality index in origin country increases GVC trade by 0.28%

[13] Results are similar when the sample is reduced only to MENA countries or to SSA countries.

directly and (0.0218*2.741=) 0.05%, yielding a total effect of about 0.28% increase in GVC trade for an 1% increase in regulatory quality.

Telecom subscriptions serves as a first indicator of how the telecom infrastructure reaches the population, a proxy for the "extensive margin" of our hard infrastructure proxy. 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 3 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 2, 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 in origin country is ((-3.443)*(-0.116)+0.423=) 0.82, with the direct effect being slightly more than half of the total effect. The total impact of our soft infrastructure measure is now about (3.443*0.0237+0.251=) 0.33, increasing from the previous estimates but remaining below the level of the effect of the hard infrastructure.

Adding both SMC and telecom subscriptions as explanatory variables (not represented here) yields same order of magnitude as in table 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 2.

Table 3: Correlates of trade costs and GVC participation: Robustness checks

Main	(1) log(GVC_s)	(2) log(GVC_{bs})	(3) log(GVC_{fs})
log(TC)	-3.443***	-3.463***	-3.421***
	(0.101)	(0.100)	(0.104)
log(FDI p. capita) Orig.	-0.369***	-0.220***	-0.491***
	(0.0555)	(0.0552)	(0.0571)
log(FDI p. capita) Dest.	-0.328***	-0.350***	-0.298***
	(0.0537)	(0.0535)	(0.0552)
log(GDP p. capita) Orig.	0.0689	-0.201***	0.260***
	(0.0652)	(0.0650)	(0.0671)
log(GDP p. capita) Dest.	0.224**	0.254***	0.184**
	(0.0879)	(0.0876)	(0.0906)
Log(SMC) Orig.	0.423***	0.475***	0.431***
	(0.0874)	(0.0870)	(0.0899)
Log(SMC) Dest.	0.644***	0.610***	0.632***
	(0.0602)	(0.0600)	(0.0619)
log(Reg. Qual.) Orig.	0.251***	0.353***	0.165***
	(0.0394)	(0.0393)	(0.0405)
log(Reg. Qual.) Dest.	0.259***	0.140**	0.382***
	(0.0658)	(0.0656)	(0.0677)
Constant	22.27***	22.79***	20.71***
	(1.181)	(1.177)	(1.221)
log(TC)			
log(Dist)	0.218***	0.218***	0.218***
	(0.0123)	(0.0123)	(0.0123)
Log(SMC) Orig.	-0.116***	-0.116***	-0.116***
	(0.0180)	(0.0180)	(0.0180)
Log(SMC) Dest.	-0.178***	-0.178***	-0.178***
	(0.0124)	(0.0124)	(0.0124)
Com. Lang.	-0.333***	-0.333***	-0.333***
	(0.0282)	(0.0282)	(0.0282)
Com. Border	-0.194***	-0.194***	-0.194***
	(0.0656)	(0.0656)	(0.0656)
log(GDP p. capita) Orig.	-0.0476***	-0.0476***	-0.0476***
	(0.0115)	(0.0115)	(0.0115)
log(GDP p. capita) Dest.	-0.00852	-0.00852	-0.00852
	(0.0162)	(0.0162)	(0.0162)
log(Reg. Qual.) Orig.	-0.0237***	-0.0237***	-0.0237***
	(0.00803)	(0.00803)	(0.00803)
log(Reg. Qual.) Dest.	-0.0171	-0.0171	-0.0171
	(0.0138)	(0.0138)	(0.0138)
Constant	4.452***	4.452***	4.452***
	(0.228)	(0.228)	(0.228)
FE	Year	Year	Year
Observations	1644	1644	1644

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5. 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 in Africa (compared to the world average of 15%) and, despite 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. Poor performance in both infrastructures result in high trade costs for transit of goods and for transit of data packets. Gravity-based estimates of average bilateral trade

costs were over twice (for SSA) or close to twice (for MENA) than those for the 15 largest importers in the world in 1995.

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, a proxy for the development of hard infrastructure, with a direct elasticity of 0.44 and indirectly through a reduction in trade costs of 0.23.

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ANNEX A

This annex describes the selection of countries for the GVC analysis in section 3 and the classification of countries by region. It also provides 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 (Casella et al., 2019), we drop the following countries because of issues with their 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.

Table A1 Countries in the analysis and their memberships across regional categories

East Asia & Pacific	Europe & Central Asia	Sub Saharan Africa	Middle East and North Africa
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	Eswatini	Qatar
New Caledonia	France	Ethiopia (◊)	Saudi Arabia(●)
New Zealand	Georgia	Gabon	Syria
Papua	Germany	Gambia	Tunisia
New Guinea	Greece	Ghana	UAE(●)
Philippines	Greenland	Guinea	**North America**
South Korea	Hungary	Kenya	Bermuda
Samoa	Iceland	Lesotho(◊)	Canada
Singapore	Ireland	Liberia	Mexico
Taiwan	Italy	Madagascar	USA
Thailand	Kazakhstan	Malawi (◊)	
Vanuatu	Kyrgyzstan	Mali (◊)	**South Asia**
Latin America & Caribbean	Latvia	Mauritania(◊)	Afghanistan
Antigua	Liechtenstein	Mauritius	Bangladesh
Argentina	Lithuania	Mozambique	Bhutan
Aruba	Luxembourg	Namibia	India
Bahamas	Monaco	Niger(◊)	Maldives
Barbados	Montenegro	Nigeria	Nepal
Belize	Netherlands	Rwanda(◊)	Pakistan
Bolivia	Netherlands Antilles	Sao Tome and Principe	Sri Lanka
Brazil	Norway	Senegal	
British Virgin Islands	Poland	Seychelles	
Cayman Islands	Portugal	Sierra Leone	
Chile	Moldova	Somalia	
Colombia	Romania	South Africa	
Costa Rica	Russia	South Sudan(◊)	
Cuba	San Marino	Sudan	
Dominican Republic	Serbia	Togo	
Ecuador	Slovakia	Uganda (◊)	
El Salvador	Slovenia	Tanzania	
Guatemala	Spain	Zambia (◊)	
Guyana	Sweden	Zimbabwe (◊)	
Haiti	Switzerland		
Honduras	Tajikistan		
Jamaica	North Macedonia		
Nicaragua	Turkey		
Panama	Turkmenistan		
Paraguay	Former USSR		
Peru	Ukraine		
Suriname	UK		

Notes: Countries in MENA & SSA that are landlocked are denoted (◊) and belonging to GCC are marked with (●)

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

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

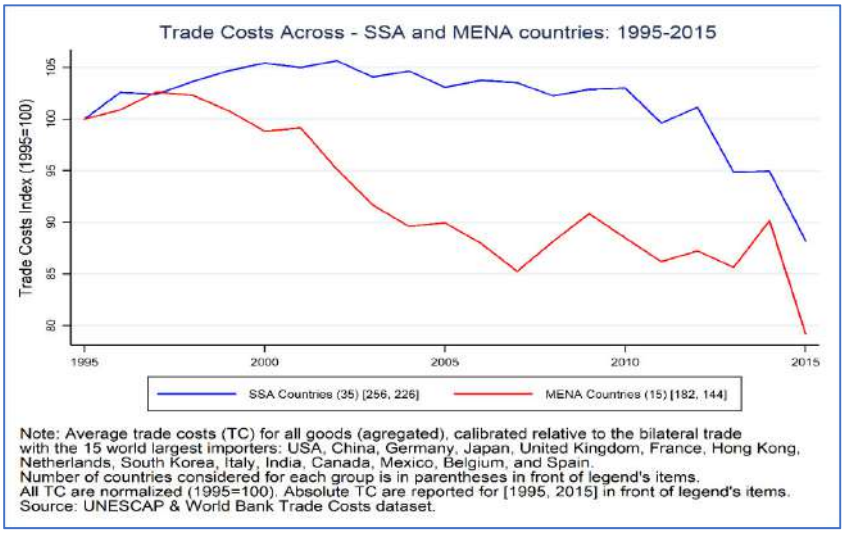
Source: Foster-McGregor, N., F. Kaulich and R. Steher (2015, table A1).

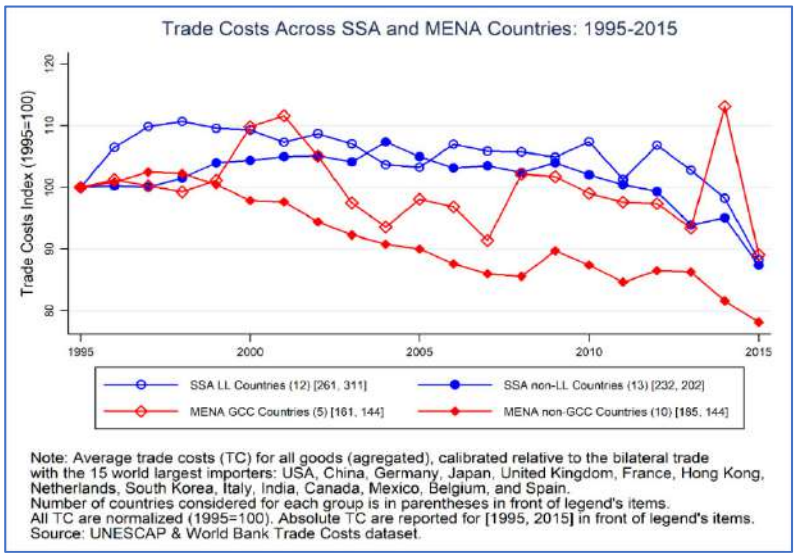
ANNEX B

Figure B1 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 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 B1: Trade Costs by regional groupings and subgroupings





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

"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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