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Trade networks and the productivity of MENA firms in global value chains

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ABSTRACT

Global Value Chain (GVC) participation is typically associated with a productivity premium, yet similar firms can benefit differently depending on the possibility for creating production linkages offered by their countries' involvement in trade. We show that country-sector intermediate trade network centrality is also positively associated with firms' productivity, suggesting that the connectivity of the business environment may enhance productivity on top of direct firm-level involvement in GVCs. For a large cross-section of MENA countries included in the World Bank Enterprise Surveys (WBES), we find evidence of productivity premia using several firm-level GVC participation measures and network centrality indicators constructed from the EORA input-output tables. Centrality is also positively associated with firms' productivity, adding to the direct effect of GVC participation. Our results are confirmed using OLS, multi-level models, Propensity Score Matching techniques, and a Shift-Share instrumental variable approach which help addressing endogeneity issues.

1. Introduction

This paper investigates how firms' Global Value Chain (GVC) participation and country centrality in the intermediate trade network are associated with firms' productivity in the MENA countries. While GVC participation is typically linked to productivity gains (Antràs and Chor, 2022; World Bank, 2020; Alfaro-Ureña et al., 2022), the role of a country's linkages in channeling firm's productivity gains is less understood. We posit that firms located in different countries may benefit differently depending on the possibility of creating production linkages offered by their countries' involvement in international trade. With enhanced country connectivity and centrality in international trade, firms are more likely to be exposed to a rich international environment, with more opportunities becoming available. In principle, even domestic firms not directly embedded into GVCs or other international activities may indirectly benefit from their internationalized local peers, and from the denser international flows of products, technology, know-how and ideas. While country's trade network aspects are likely to be relevant in providing firms with opportunities to upgrade, they are currently under-investigated, especially where they matter the most, that is in countries that have not yet fully integrated and benefited from trade and GVCs.

The MENA region has a strategic geographical position in the Mediterranean and cost advantages relative to the Northern shore; however, so far, it has not been able to fully integrate in GVCs. The potential for integration exists due to not only its geographical position, but also its human capital and specialization. Integrating into GVCs would benefit the region in different ways. First, the export dynamics of MENA countries have been largely unsatisfactory over the past two decades. Integrating into GVCs could help boost and improve their exports. Second, as highlighted by Jaud and Freund (2015), MENA countries have export superstars but small and medium enterprises (SMEs), with the lion's share of the total number of enterprises in the MENA region, are still excluded from more complex modes of internationalization, such as FDI or GVCs. Indeed, when SMEs enter GVCs, their role is often confined to low value-added phases. GVC participation can be a tool to favor their growth and improve the whole productive structure. Third, the MENA region has several characteristics that can attract foreign investors: relatively low labor costs, an abundance of skilled blue-collar workers (highly demanded in most manufacturing industries, see Aboushady and Zaki, 2021), a central location between European and African markets with several preferential trade agreements (EU association agreements,

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COMESA and African Continental Free Trade Agreement). Fourth, and notably for the MENA region, participation in GVCs, even if in low value-added tasks, like assembly of imported components, has the potential to boost employment contributing to resolve one of the main structural challenges in this region. Furthermore, from a policy perspective, MENA countries are still at the early stages of participation in GVCs (Del Prete et al., 2018), considering that, to trigger international linkages, governments need to pay close attention to education and training policies. The above reasons show that it is worth examining the impact of GVCs on firms in the MENA region.

The country's position in international trade and connectivity with foreign partners contribute to shape firm's opportunities by enriching the business environment in which the firm operates and the potential scope for knowledge transmission and spillovers. Firms in a more connected central country are more likely to be in contact with internationalized peers, which may ease GVC participation and further enhance productivity gains for those already in GVCs; moreover, also non-GVC and purely domestic firms are likely to indirectly benefit from exposure to a richer international environment. The position within the network influences the exposure to foreign ideas, technology and investment (Fagiolo and Santoni, 2015). Two identical firms, equivalently involved in GVCs from a direct firm-level perspective, may benefit differently and produce stronger or weaker productivity-enhancing spillovers, depending on whether the countries involved happen to be more or less central in the intermediate trade network. Centrality is typically associated with higher domestic value added (Amador and di Mauro, 2015) and faster productivity growth (Criscuolo and Timmis, 2018). Firm-level GVC measures cannot capture these broader aspects. Due to data and measurement issues, the role of country's connectivity is understudied in the literature on GVCs. Recently, network analysis has provided a way to move beyond direct bilateral linkages between countries and firms, and to take into account the fact that they are embedded into complex systems of relationships which directly and indirectly influence each other. By looking at the entire structure of the network, rather than at bilateral linkages in isolation, and by accounting for context and indirect effects not captured by direct firm-level measures, network analysis helps to fully characterize possible benefits for productivity.

Our contribution is threefold. First, we contribute to the firm-level empirical literature on GVC participation by providing new evidence for a number of MENA countries included in the World Bank Enterprise Surveys (WBES). Second, using Eora input-output tables, we construct and analyze the intermediate trade network of MENA countries, providing a new perspective on trade linkages within and outside the region. Third, and most importantly, we show that country-sector intermediate trade network centrality may represent an additional channel, not captured by firm-level indicators, contributing to firms' productivity gains.

We describe the network of intermediate trade within the MENA countries and between the MENA countries and the rest of the world, highlighting that heterogeneity is high. We find a positive association between different firm-level GVC participation indices (Dovis and Zaki, 2020) and productivity. Using a multi-level econometric analysis, we introduce sector-country centrality into the analysis, and find that centrality is also positively associated with firms' productivity. Our findings remain robust using a Propensity Score Matching on the full sample of firms from all MENA countries available and an instrumental variable approach with shift shares instruments, which helps addressing the endogeneity between firms' productivity and GVC participation.

The remainder of the paper is organized as follows. Section 2 reviews the literature on the relationship between GVC and productivity, highlighting the role of trade networks. Section 3 presents the data and describes the measures and methods used in the paper. Section 4 gives an overview of the international trade network of the MENA region, and of MENA firms' GVCs participation. Section 5 presents the econometric approach and the results. Section 6 provides the conclusion and discusses the policy implications of our study.

2. Literature review

From a theoretical perspective, the effects of GVC participation on productivity may involve several channels at the industry and at firm level, and the effects can be direct and indirect. An important channel for aggregate productivity gains stems from positive selection effects à la Melitz (2003) in which only the most productive firms are able to afford the internationalization costs and the even larger GVC integration costs. Moreover, once firms self-select into GVC, the high-productivity winners are able to thrive and gain market shares, further increasing aggregate sector productivity. Firms' self-selection into GVC implies further specialization of producers as well as larger scope for economies of scale, with clear efficiency gains. Positive productivity effects also come from the supply-side of GVC participation as not only self-selection is well documented among exporters, but also among input importers; and there is also evidence that firms that start importing inputs tend to become more productive (see Antràs and Chor, 2022, for a review). A reason for this has to do with the possible better quality of foreign inputs. Furthermore, GVC participation also brings about learning effects. A channel could be the exploitation of better organization and management practices as well as know-how and technology transfer, whose effect is stronger inside a long-term relational buyer-supplier GVC relationship rather than in a market-based spot exchange (World Bank, 2020; Alfaro-Ureña et al., 2022). Furthermore, as GVC firms are embedded into the local economy, their upgrading might yield spillover effects on closely linked non-GVC firms (Amendolagine et al., 2019). Thus, not only GVC can directly benefit the firms involved, but they also have the potential to enhance the diffusion of best practices and knowledge through the whole economy.

The empirical literature on the nexus between GVCs and firm productivity is relatively abundant and many different countries and areas are studied in detail, with sectoral or even firm data. Baldwin and Yan (2014) find that Canadian firms that integrated into a GVC benefitted from a rise in productivity by 5 % during the first year and by 9 % four years later. In a recent paper Alfaro-Ureña et al. (2022) investigate the effects on Costa Rica's firms of becoming a supplier to a multinational corporation, finding a causal effect on employment (+26 %) and on total factor productivity (+4–9 %, largely in line with Baldwin and Yan, 2014). Moreover, as highlighted by Baldwin (2013), in a long-term perspective, integrating into GVCs prevents countries and firms from investing decades into the development of a full-range national supply. In the same vein, Ju and Yu (2015) calculate an upstreamness index for all industries measured as the number of stages that the product will go through before reaching the final demand. They find that upstream firms are more capital intensive. The 2020 World Development Report (World Bank, 2020) documents how, not only GVC firms are more productive, but GVC participation is also generally associated at the country level with higher growth in GDP per capita and labor productivity, and higher employment.

Del Prete et al. (2017 and 2018) examine the participation of North African countries into GVCs both from a macro and a micro perspective. The macro analysis exploits the information from input-output tables and suggests that North African countries are not fully integrated into GVCs and there are still unexplored opportunities. As for the firm level analysis, based on WBES, the findings show that participation in GVCs had a positive impact on the firms' performance. Kordalska et al. (2017) analyze the relation between participation in GVCs and sectoral productivity growth, using panel data analysis covering 40 countries and 20 industries in the period from 1995 to 2011. They found that there is a positive relation between TFP growth and involvement of sectors in a GVC. Also, Lu et al. (2016) examined the relation between GVC participation and productivity, using a large Chinese firm-level dataset, with 208,078 firm-year observations for the period from 2000 to 2006, finding that the relation between GVC participation and productivity

had an inverted U-shaped. This implies that participation in GVCs increases firm productivity, but there is a diminishing marginal effect. Along the same lines, Manova and Yu (2016) examined how firms choose to participate in global trade and the effect of this decision on firm performance. They analyzed three export modes: ordinary trade, processing trade with imported inputs, and processing trade via pure assembly, finding that, when financially constrained, firms are more likely to conduct more processing trade and pure assembly, but value-added and profitability increased with ordinary trade. Yu (2015) analyses how reductions in tariffs on imported inputs and final goods have an impact on the productivity of large Chinese trading firms. The study finds that input and output tariffs' reduction in China induces an increase in a firm's productivity, but this impact decreases with the share of a firm's processing imports.

At the SME level, different studies analyzed the effect of participation in GVCs on internationalization. Brancati et al. (2017) focused on Italian SMEs. They found that there is a positive association between the probability of internationalization and a firm's involvement in the supply chain. Using the same dataset, Giovannetti et al. (2015) showed that integrating into a supply chain increases the likelihood of becoming an exporter. OECD (2008) found that GVC participation enhances SMEs internationalization and growth. ADB and ADBI (2015) examine the effects of integrating Asian SMEs into GVCs and find that participation in GVCs would give SMEs in Asia the opportunity to be exposed to a larger customer base and to learn from large firms in global markets. Rasiah et al. (2010) analyze the effect of production networks on productivity, exports and technological upgrading of SMEs in some sectors in Malaysia. The study finds that employment and labor productivity are positively and significantly associated with the participation of firms in GVCs. In other words, highly integrated firms in GVCs are larger and show higher productivity. Finally, OECD (2018) suggests that stronger participation of SMEs in global trade provides opportunities to increase productivity and to scale up. GVCs can also create new opportunities for SMEs to integrate in the international market. The study also indicated that there are internal and external factors affecting the ability of SMEs to participate in the global market. Internal factors are innovation, technology adoption, and management and human capital, whereas the external factors include access to finance, access to information and intellectual property.

As mentioned in the introduction, the existing literature on GVCs has not paid much attention to the role of country's intermediate trade network connectivity as an additional channel for productivity growth; this is mostly due to measurement and data limitations. Relative to the existing literature on GVCs, the literature on networks provides new perspectives as well as new types of indicators capturing centrality within complex systems. In particular, the use of network analysis to characterize international trade and value-added trade is recent. Through visual inspection and several indicators, it adds to the traditional analyses and to our understanding of trade flows. Common firm-level GVC measures are simply based on direct bilateral linkages between firms, while trade network centrality indicators capture the broader connectivity accounting for the entire structure of the network, i.e. direct, indirect, and third party linkages. De Benedictis and Tajoli (2011) were among the firsts to apply network analysis to international trade. More recently, network analysis has been used to investigate trade in value-added as retrieved from aggregate GVC indicators calculated from multi-regional input-output tables (the calculation requires manipulations of the input-output tables and some proportionality assumptions; Taglioni and Winkler, 2016; Criscuolo and Timmis, 2018; Xiao et al., 2020). The literature on input-output linkages, trade in intermediates, and countries integration shows that the stronger the interconnections between sectors and countries, the higher the possibility of "cascade effects" whereby productivity shocks to a sector propagate to its downstream customers and to the rest of the economy (Gabaix 2011 and Acemoglu et al., 2012). In the same vein, Carvalho (2008) shows that the network structure explains significantly the observed sectoral co-movement and aggregate volatility in the U.S. By looking at the entire structure of the network, rather than at bilateral linkages in isolation, and by accounting for context and indirect effects not captured by direct firm-level measures, network analysis helps to fully characterize possible benefits for productivity. Centrality is typically associated with higher domestic value added (Amador and di Mauro, 2015) and faster productivity growth (Criscuolo and Timmis, 2018). The channels through which network centrality may enhance firms' productivity pass through the exposure to foreign ideas, technology and investment (Fagiolo and Santoni, 2015).

In summary, most of the studies corroborated the positive and significant relationship between productivity gains and GVCs, especially for SMEs. This paper, using a set of indices of GVCs, re-examines the relationship for a large pool of firms in the MENA region, with a special focus on the role of intermediate trade networks and centrality.

3. Data, measures and methods

3.1. Data sources

We rely on two main data sources: the World Bank Enterprise Survey (WBES) and the Eora input-output tables.

The WBES includes formal (registered) companies with five or more employees. Firms with 100 % government/state ownership are not eligible to participate in an Enterprise Survey. The survey covers a broad range of business environment topics including access to finance, corruption, infrastructure, crime, competition, and performance measures. The Enterprise Surveys Unit uses two instruments: the Manufacturing Questionnaire and the Services Questionnaire. The standard survey topics include firm characteristics, gender participation, access to finance, annual sales, costs of inputs/labor, workforce composition, bribery, licensing, infrastructure, trade, crime, competition, capacity utilization, land and permits, taxation, informality, business-government relations, innovation and technology, and performance measures. Enterprise Surveys are available for nine MENA countries: Djibouti, Egypt, Israel, Jordan, Lebanon, Morocco, Tunisia, West Bank and Gaza, Yemen – for the year 2013. Therefore, our sample contains 5725 manufacturing and services firms located in eight MENA countries, Djibouti being dropped due to the small number of observations. We use the 2013 survey as all the surveys are harmonized for all countries, allowing comparability.

To obtain a comprehensive view of trade in intermediate goods, we make use of the Eora global multi-regional input-output tables (2012 and 2015). The number of sectors is 26 (see Appendix 1) encompassing goods and services.[1] The advantage of using input-output data lies in the possibility of using the international inter-sectoral exchanges of intermediate goods, which accurately measure the production linkages between countries and sectors. Relative to similar sources, i.e. WIOD and TiVA, the Eora database includes a larger number of countries, most of which are of direct interest here and are not available from other sources. Based on Eora data, we construct the intermediate trade network of the MENA countries at the region, country and country-sector level; and calculate several centrality indicators (further technical detail is provided in the next sections).

3.2. The intermediate trade network

To characterize the relevant type of connectivity at the country-sector level, we focus on trade in intermediate products; that is on the part of trade that is most directly connected with global production and most likely to spur international collaborations and flows of information. We construct and characterize the intermediate trade network

[1] For a list of sectors and the correspondence between Eora and ISIC Rev 3 classification, see Tables A1.1 and A1.2 in Appendix 1.

using the Eora input-output tables. We take a direct approach and look at actual observed flows of intermediate products between industries at the national and international level. The construction of the network follows Damoah et al. (2022) who adopt a similar approach to investigate how trade network centrality is related to Chinese investments in the Belt and Road Initiative.

After having constructed the network, we consider (i) the extra-MENA perspective and (ii) the intra-MENA perspective. For the extra-regional perspective, we consider intermediate trade of the aggregate MENA region as well as of individual countries with the rest of the world. The intra-regional perspective, instead, focuses on intermediate trade within the MENA countries.

Global Value Chains involve many inter-sectoral linkages, also between primary goods, manufactured products and services. To account for this complexity and provide the broad picture, we consider (i) the whole intermediate trade in goods and services as well as (ii) trade in manufacturing products only. Singling out manufacturing is crucial since in the MENA region there are many resource-abundant countries for which trade in primary goods is very relevant, but that are not otherwise very integrated into supply chains. To this end, we consider trade from manufacturing sectors towards all use-sectors, i.e. intermediate exports from manufacturing sectors towards all sectors of importing countries.[2]

3.3. Centrality indicators

Centrality indicators represent the main measure of the importance of countries in the trade network. The concept of centrality aims to capture the connectivity of a country relative to all other countries and their connections: a country is central if it is better connected than other countries that is if it is at the core of the network in such a way that the entire network is strongly characterized by its presence. The network literature has developed different measures of centrality reflecting the different meaning that "being better connected" or "being at the core" can have in different contexts. While the different centrality indicators tend to be correlated, they capture different aspects of network connectivity. In this paper, we calculated and tested several centrality indicators, namely: outdegree, indegree, Pagerank, hubs, authorities, betweenness. The calculations were done in Matlab. For the mathematical formulas we use, see Appendix 2.

3.4. Firm's GVC participation

In order to see whether firms in the MENA region have exploited the opportunities of GVCs and whether this has enhanced their productivity, we use different definitions of GVCs. While there is a recent literature using input-output models to define GVC (Koopman et al., 2014; Wang et al., 2017 and Meng and Ye, 2020), such data are only available at the macroeconomic and sectoral level, not the firm level. This is why we rely on four variables identified in the WBES to create different firm-level GVC participation indices (Dovis and Zaki, 2020; Taglioni and Winkler, 2016). A first definition (GVC1) includes firms that export (directly or indirectly) or import intermediate inputs. Second, a stricter definition combines the two criteria together: a firm that exports and imports intermediate goods (GVC2). Third, two stricter definitions are related to firms that are simultaneously exporters and importers and have either an international certification (GVC3), or a share of its capital owned by a foreign firm (GVC4). The strictest definition combines the four criteria altogether (GVC5). Summing up, firms are classified as in GVC according to the following conditions:

- GVC1: exporter (direct or indirect) or importer (of intermediates)
- GVC2: exporter and importer (of intermediates)
- GVC3: GVC2 + certification
- GVC4: GVC2 + foreign owned
- GVC5: GVC3 + GVC4

Our preferred definitions are GVC2, two-way intermediate trade, and GVC5, the strictest one, namely exporting, importing, with a foreign certification and foreign owned, since these definitions are most likely to capture weaker and stronger forms of GVC participation. This is why, in the empirical part, we just focus on these two measures.

3.5. Firm's productivity

We estimate both labor productivity and total factor productivity. The former is measured as value-added per employee directly calculated from the available data, while the latter is estimated econometrically taking into account both labor and capital, as well as other inputs, and is thus more likely to reflect overall firm's technical efficiency following the World Bank revenue-based approach (Francis et al., 2020). In what follows we mainly refer to TFP as our preferred productivity measure, but similar results[3] are also obtained using labor productivity. However, it must be noted that both measures have advantages and limitations. For instance, labor productivity is easier to compute, but it also reflects adjustments on other factors such as capital; estimation of TFP, on the other hand, requires assumptions, needs more data, and presents non-trivial econometric challenges. We estimate the TFP using a Cobb-Douglas function, where the dependent variable is sales and the independent ones are wages, inputs and capital payments. Given that we rely on a cross-sectional dataset of 2013, we were not able to apply other techniques such as Olley (1996) or Levinsohn and Petrin (2003) to estimate TFP. The main issue is that of endogeneity of input choices or simultaneity bias arising from the fact that the firm may chose inputs based on its productivity (past or expected), so that a positive productivity shock may induce firm to use more inputs. Furthermore, there can be other empirical issues related to the absence of information on firm-level prices or to the possible selection bias stemming from entry and exit of firms (Van Beveren, 2012). We acknowledge these data-imposed limitations of our study; nonetheless, TFP still seems preferable to labor productivity.

4. Descriptive evidence

4.1. The intermediate trade network of the MENA region

Let us now investigate the intermediate trade network of the MENA region, considering the extra- and intra-regional trade perspectives. Manufacturing represents about 46 % of all trade in intermediates of the MENA countries; and the manufacturing share for imports (63 %) is almost twice that for exports (33 %), indicating that the region is a net importer of processed intermediates (for details, see Table A2.1 in Appendix 2).

Our analysis shows that the MENA region is heterogeneous and that its role in the manufacturing supply chain is focused on imports of intermediate goods from outside the region, while few resource-abundant countries have important non-manufacturing export linkages outside the region. Yet, the network of intermediate trade in goods and services and manufacturing trade share similar structural characteristics regarding the main, most central, countries.

Fig. 1 displays the full intermediate trade network of MENA countries and their main external linkages.[4] Each country is a node (MENA

[2] This definition considers international exports of manufacturing industries towards all sectors of importing countries; this is standard and corresponds to the way in which customs data is recorded. This definition keeps track of actual international flows of manufacturing intermediate products.

[3] Available on request from the authors.

[4] For more details on trade in intermediate goods, see Figures A3.1 to A3.6 in Appendix 3.

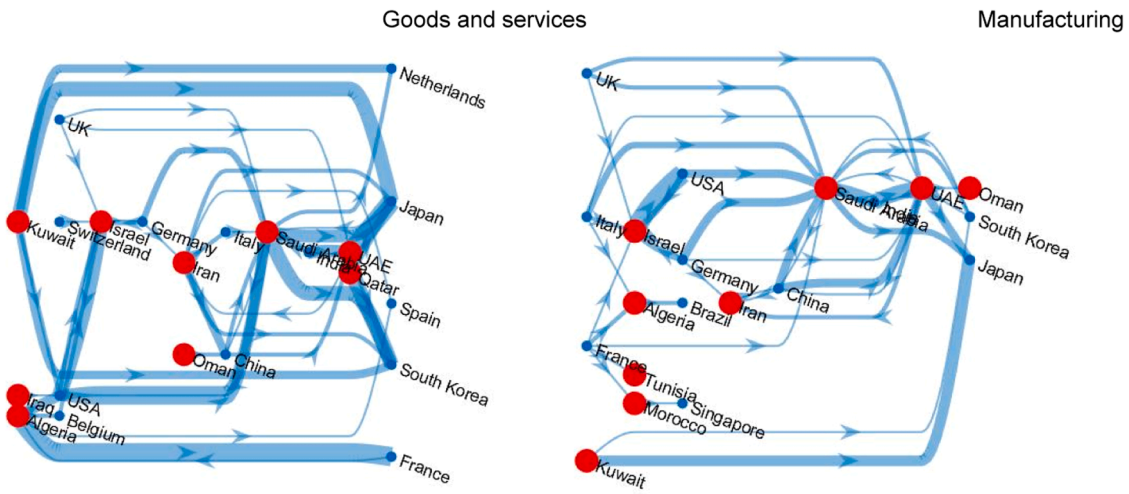

Fig. 1. Intermediate trade network of MENA countries (flows above 0.5 %)
Note: The spokes are proportional to trade value (in dollars).
Source: Original elaborations using EORA dataset.

countries are highlighted), the spokes are proportional to trade value, the arrows indicate the direction of the trade flow, countries on the left tend to be net exporters while those on the right tend to be importers, more connected countries with two-way linkages tend to occupy central positions. The value of overall intermediate trade (sum of imports and exports) of MENA countries is very heterogeneous across countries. Saudi Arabia, UAE, Iran and Israel are the top traders, with a value of over $100 billion; whilst the smaller traders account for a fraction of that value, with smaller countries, such as Yemen and Bahrain, trading less than $10 billion. The largest traders, i.e. Saudi Arabia, UAE, Iran, are very central. Among non-MENA countries, US and Germany are also very central and have a role in connecting some MENA countries. For instance, Algeria is clearly an extra-MENA supplier of intermediates and is connected to other MENA countries only through third-party countries, namely US, Belgium and Spain, thus being an indirect supplier of intermediate goods. The manufacturing intermediate trade network does not change greatly relative to the intermediate trade in goods and services, as regards to the main country-nodes of the network, namely Saudi Arabia, UAE, Iran and Israel. However, three things stand out: first, the direction of trade flows is, in many cases, inverted; second, the role of France is now much more evident; third, some countries, such as Morocco and Tunisia, gain importance and are now included in the network (which only shows the main flows for clarity). Take, for instance, Algeria. Considering goods and services, it is a net exporter to France, US, Belgium and Spain, but, considering manufacturing only, one sees that it imports from France and Italy in order to export to Brazil. For non-manufacturing intermediates, the link between Algeria and France is France's only important link with the region. Yet, in manufacturing, France is much more central and has many intermediate export links that include Algeria, Israel, Tunisia and Morocco, the latter further exporting to Singapore.

Considering the entire intermediate trade networks, including both intra- and extra-regional linkages, provides the overall picture and highlights the role of the countries in international productions. Further detail is gained by considering the two perspectives separately as some countries tend to trade more outside the region while others are more inward oriented. Among the four top traders whose trade is worth more than $100 billion (Saudi Arabia, UAE, Iran and Israel), only Iran is a net exporter of intermediate goods, i.e. has a positive normalized intermediate trade balance. The most outward oriented countries are Israel, Algeria and Morocco, for which more than 98 % of intermediate trade involves non-MENA countries.

In Fig. 2, we show the intra- and extra-MENA normalized intermediate trade balances. There are countries that mostly operate as suppliers within the MENA region (intra-MENA exporters), whilst others are mainly buyers (intra-MENA importers). Interestingly, some countries seem to operate as regional hubs of inward or outward connections with the rest of the world: they operate as buyers from the MENA region, while they are suppliers to the rest of the world, and vice versa. This evidence suggests an underlying network structure in which different countries play different roles, with some of them being important gateways connecting the region to the rest of the world.

The normalized trade balances also highlight the differences between goods and services as compared to manufacturing. The aggregate intermediate trade balance for goods and services is positive, whilst the balance for manufacturing is negative. This means that the region is a net exporter of non-manufacturing intermediates (i.e. primary goods and services) and a net importer of intermediate manufacturing products. Fig. 2 (right panel) shows that Egypt imports from outside the region, but exports to other MENA countries; while Morocco has a positive trade balance with respect to both areas, with a much larger intra-MENA surplus. Kuwait, Bahrain and Morocco are the only countries with a positive trade balance outside the region; all other countries import manufacturing intermediates from the rest of the world, and many countries are net regional manufacturing exporters.

Outward linkages of the region are more clearly observed if we consider the MENA aggregate (see Figures A3.7, A3.8 and A3.10 in Appendix 3). The main regional trading partners are China, US, Germany, France, South Korea, Japan and Italy. The region is a supplier of manufacturing intermediates to many countries, especially to South Korea, Japan and US. China, France, Germany, Italy and UK are among the main exporters of manufacturing intermediate products to the MENA region. Looking at intra-regional linkages (see Figures A3.9 and A3.11 in Appendix 3), the centrality of UAE, Saudi Arabia and Iran within the region becomes apparent.

A more detailed description of the role of each country within the region is obtained by looking at the (weighted) centrality indexes.[5] The top ten most central countries are reported in Table 1 together with the percentiles of the several centrality measures we have computed. The

[5] We have computed several centrality measures, both directed and undirected and both unweighted and weighted. Here we present the results for weighted ones, which are preferable as they account for the value of the trade flows. For details on the weighted and unweighted measures, see Appendix 3 Tables A3.2-A3.8.

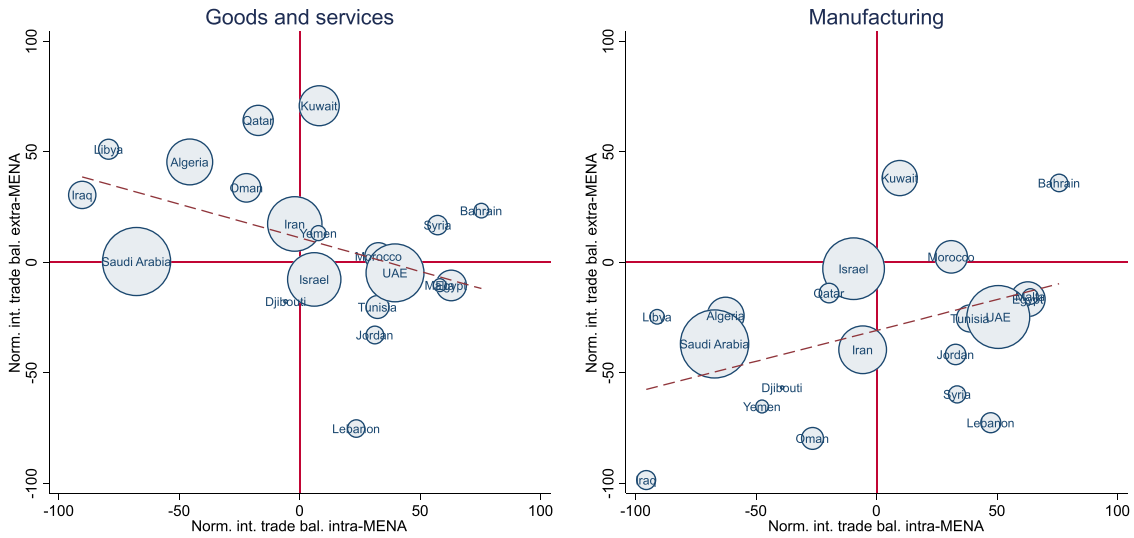

Fig. 2. Intra and extra-MENA intermediate trade balances
Note: Numbers represent normalized trade balance (exports-imports)/(exports+imports) on a scale −100 to +100.
Source: Original elaborations using EORA dataset.

Table 1
Country centrality in intra-regional intermediate trade network (top 10).

	PageRank	Hubs	Authorities	Outdegree	Indegree	Betweenness
Goods and services (percentiles; sorted by PageRank)						
Saudi Arabia	100	83	89	72	100	100
UAE	94	100	78	100	89	94
Iran	89	78	100	94	94	89
Oman	83	67	94	89	83	83
Iraq	78	22	67	11	78	56
Jordan	72	61	67	78	67	78
Qatar	67	50	83	50	72	0
Tunisia	61	28	17	44	28	72
Libya	56	0	17	0	44	61
Lebanon	50	39	56	67	61	44
Manufacturing (percentiles; sorted by PageRank)						
Saudi Arabia	100	83	89	72	100	100
Iran	94	61	100	94	94	72
UAE	89	100	72	100	83	94
Iraq	83	28	61	6	78	61
Oman	78	67	94	89	89	83
Qatar	72	56	83	56	72	0
Jordan	67	78	78	78	67	89
Kuwait	61	72	44	39	61	0
Lebanon	56	44	56	67	56	0
Tunisia	50	33	22	44	22	67

Source: Original elaborations using EORA dataset.

PageRank measures the number of times a given country is encountered when moving within the network: Saudi Arabia, UAE and Iran are the most central countries. Our results indicate that there is a probability of randomly encountering one of these three countries of about 27 % (unweighted) to 43 % (weighted). Hubs and authorities are recursive-connected measures. Hubs represent countries who export to many important destinations, whilst authorities represent countries that import from many important sources. These measures are more sophisticated than outdegree and indegree, but the intuition is similar. UAE is by far the most important hub in the region and the one with the largest (weighted) outdegree. Authorities are less concentrated; Iran, Oman and Saudi Arabia being the main ones. UAE is not a particularly important authority, despite having a high in degree. Finally, Saudi Arabia and UAE are the most central countries in terms of betweenness, a measure that indicates the frequency with which the shortest path between two countries passes through a given country.

The bottom part of Table 1 shows the intra-regional centrality measures for the intermediate manufacturing network. Saudi Arabia, Iran and UAE are the most central countries, according to the PageRank index. On the export side, UAE is the most important country within the region (Hub), whilst on the import side we have Iran, Oman and Saudi Arabia (Authorities). This is also confirmed by the outdegree and indegree. In terms of betweenness, the most central countries are Saudi Arabia and UAE. The centrality measures for the intra-region intermediate trade network in manufacturing are all highly correlated with the corresponding measures for goods and services (correlations are above 0.87), confirming that the network structures largely overlap in terms of country centrality.

The analysis of the position in networks of intermediates can drive our choice (amongst the countries for which we have data available) of countries to check as to whether entering a GVC can help improve the performance of small firms. An increase in productivity, due to entering a value chain, is likely to have a positive impact on the country's competitiveness and could trigger a virtuous micro-macro-micro circle.

In the following sections, we will focus mainly on countries with an emerging or a well-established manufacturing sector, whose economy is not strongly characterized by the oil sector. Hence, the focus will be on North African countries (Egypt, Morocco and Tunisia) as well as several countries in the Middle East region (Jordan, Israel, Lebanon, Palestine and Yemen).

4.2. GVC participation and productivity of MENA firms

Table 2 shows the distribution of firms by country and by size using the five different definitions. We note that the number of firms in a GVC, as expected, falls the more restrictive the criteria (dropping from 68.1 % in GVC1 to only 3 % in GVC5). At the country level, whilst Egypt has the highest share of firms that export and/or import (GVC1 and GVC2 respectively), Tunisian and Moroccan firms are ranked first in GVC5. Indeed, Morocco experienced significant improvements in integrating GVCs and upgrading its exports, particularly in the automobile sector. Moroccan firms also understood the importance of certifications for entering GVCs (see Del Prete et al., 2017). Second, at the sectoral level, the stricter the definition, the more complex the sectors. For instance, in GVC1 and GVC2, leather, rubber, printing, and paper and chemicals have a large share of firms being part of a GVC. By contrast, electrical equipment, machinery and equipment are amongst the sectors that have a large share of firms being part of GVC5. These sectors have a higher value-added and are more technology intensive. At the firm size level, Table 2 shows that the stricter the definition, the more likely small firms will not be part of a GVC. To reach this result, we interact our variable of interest (GVC) with firm size. For instance, in GVC2, the share of small, medium and large firms integrating into a GVC is 8.3 %, 20.1 % and 46 % of the respective total number of firms. These shares decline drastically in GVC5, being the most restrictive definition, to reach 0.4 %, 1.6 % and 9 % respectively. This conclusion is crucial to our understanding of the link between SMEs and GVCs since, whilst firms can benefit enormously from entering a GVC, they are still excluded because of several impediments that hinder their sustainability and growth (going from financial, to technological, infrastructural and procedural barriers).

Table 2
Share of firms in GVCs by country, sector, and size.

(share of firms)		GVC1	GVC2	GVC3	GVC4	GVC5
By country	Egypt	0.60	0.13	0.08	0.03	0.02
	Israel	0.76	0.25	0.22	0.05	0.04
	Jordan	0.76	0.42	0.15	0.10	0.04
	Lebanon	0.82	0.39	0.17	0.03	0.02
	Morocco	0.83	0.28	0.12	0.09	0.06
	Tunisia	0.90	0.45	0.17	0.16	0.06
	West B.	0.82	0.28	0.08	0.01	0.01
	Yemen	0.49	0.09	0.04	0.01	0.01
By sector	Food and Bev.	0.62	0.17	0.10	0.04	0.03
	Textiles	0.72	0.22	0.11	0.04	0.01
	Apparel	0.76	0.42	0.13	0.14	0.05
	Leather	0.81	0.19	0.06	0.04	0.01
	Pub. Printing	0.76	0.15	0.05	0.02	0.02
	Chemicals	0.78	0.29	0.17	0.07	0.05
	Rubber	0.77	0.23	0.10	0.03	0.02
	Non-met.	0.38	0.13	0.05	0.01	0.00
	Base Met.	0.67	0.13	0.10	0.02	0.02
	Fab. Metals	0.66	0.18	0.10	0.04	0.02
	Machinery	0.76	0.29	0.17	0.06	0.05
	Electrical	0.88	0.26	0.26	0.07	0.07
	Furniture	0.68	0.13	0.06	0.02	0.01
	Other	0.71	0.25	0.13	0.07	0.05
By size	Small (<20)	0.54	0.08	0.01	0.01	0.00
	Medium (20–99)	0.70	0.20	0.07	0.03	0.02
	Large (>100)	0.87	0.46	0.30	0.14	0.09
Total		0.68	0.22	0.11	0.05	0.03

Source: Authors' own elaborations using the WBES.

In what follows, we enquire about a possible positive association between GVCs and productivity. Fig. 3 shows that productivity (whether measured by total factor productivity or by labor productivity) is positively correlated to GVC (no matter what definition is used). The next section will examine this nexus by estimating the relationship.

4.3. GVCs, productivity and networks

In order to link the network analysis with our GVC indicators, we report the main descriptive figures in Table 3.[6] Along the rows, we report TFP, the GVC and the centrality indicators. In the columns, we compare firms (i) with TFP above (high) and below (low) average, (ii) with centrality (PageRank[7]) above (high) and below (low) average, and (iii) by GVC participation (we refer to the more restrictive definition, namely GVC5). Looking at the first columns, we see that highly productive firms are clearly both more likely to be in a GVC and more central in the trade networks (i.e. more precisely, they belong to countries that occupy a more central position in the sectoral networks). These findings are very consistent, since they apply to all five GVC indicators, as well as to all six centrality indicators. Whilst comparing high and low productivity firms yields very clear results, the evidence is somewhat weaker when we compare either central firms with peripheral firms, or GVC firms with the rest. Firms in central countries (fourth column) are more productive, but they are only slightly more involved in GVCs. Similarly, consistently with the baseline econometric results, GVC firms display much higher productivity (seventh column), while GVC participation is slightly associated with higher centrality except than for in and out degrees. These results corroborate the idea that centrality, at least at the available level of disaggregation, matters for firms' TFP and captures an aspect of GVC participation that cannot be gauged with simple firm level indicators, such as GVC1 to GVC5. Based on this finding, including centrality into our regressions enables us to allow for an additional (multilateral) dimension of GVCs, which is neglected in our baseline estimates.

5. Methodology and empirical results

5.1. Econometric approach

5.1.1. Benchmark specification

To examine the relationship between productivity and GVC, we use the 2013 World Bank Enterprise Surveys and rely on the following specification:

$$Y_{ijs} = \beta_0 + \beta_1 X_{ijs} + \beta_2 GVC_{ijs} + \beta_3 NWC_{ijs} + \beta_4 GVC_{ijs} NWC_{js} + \gamma_j + \gamma_s + \varepsilon_{ijs.}$$

where Y is productivity of firm i in country j operating in sector s. X includes a vector of control variables, amongst which are firm age, legal status, share of female workers, location, and firm size. Age is calculated as the difference between 2013 and the date of the firm establishment. The share of females is defined as the share of women within the number of workers. Location is a dummy variable that takes the value of 1, if the firm is located in the country capital and zero otherwise. Firm size is measured by the natural logarithm of the total number of employees. The legal form is a categorical variable for different types of the firm (publicly listed, privately held limited liability, sole proprietorship, partnership, limited partnership). Our variable of interest is GVC, measured by our preferred definitions discussed above (GVC2 and GVC5); γ_i and γ_s are country and sector dummies, respectively, and ε is the error term. *NWC* is the network variable measured by the Pagerank

[6] In order to introduce network centrality into the firm-level econometric analysis, the centrality indicators are computed at the country-sector level for the year 2012 that is one year before the WBES.

[7] Using other centrality indicators produces similar results.

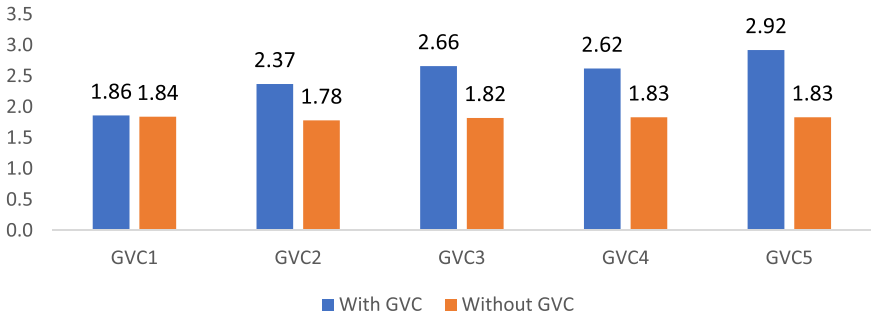

Fig. 3. GVC and TFP Level
Note: Figures represent the level of estimated TFP measured as the Solow's residual from a Cobb-Douglas production function.
Source: Authors' own elaborations using the WBES.

Table 3
Averages of relative productivity, centrality and GVC participation.

	TFP		Delta	Centrality*		Delta	GVC5		Delta
	High*	Low*		High*	Low*		Yes	No	
Firm's productivity (%, relative to mean)									
TFP	142.3	51.0	91.3	104.9	97.0	7.9	136.9	99.0	37.9
Global Value Chain indicators (% of firms)									
GVC1	73.3	55.4	17.9	70.9	66.6	4.3	100	67.2	32.8
GVC2	26.0	12.4	13.5	24.5	20.8	3.7	100	19.7	80.3
GVC3	13.1	5.2	7.9	11.8	10.3	1.5	100	8.1	91.9
GVC4	6.6	1.7	4.9	5.4	5.1	0.3	100	2.3	97.7
GVC5	3.9	0.8	3.1	3.0	3.0	0.0	100	0	100.0
Network centrality indicators (%, relative to mean)									
Pagerank	105.0	97.7	7.3	177.1	58.3	118.8	105.3	99.8	5.5
Hubs	102.9	92.8	10.1	125.6	86.2	39.4	108.5	99.7	8.8
Authorities	107.4	81.7	25.7	144.2	76.1	68.1	105.6	99.8	5.8
Outdegree	103.5	91.4	12.1	143.2	76.7	66.5	94.7	100.2	−5.5
Indegree	107.5	81.4	26.1	171.2	62.0	109.2	99.4	100.0	−0.6
Betweenness	111.8	70.8	41.0	260.8	13.1	247.7	104.6	99.9	4.7

* High = above average, low = below average; centrality refers to country-sector PageRank.

and betweenness and ε is the error term.

From an empirical perspective, we must account for two issues. On the one hand, all local currencies have been converted to USD to guarantee the comparability of different countries. On the other hand, the possible existence of a reverse relationship between GVC and productivity must be taken into consideration, to avoid biased estimates of the effect of GVCs on productivity.[8] Although related literature based on panel data for North African firms supports a causal interpretation as participation in GVCs is found to have a positive impact on the firms' performance (Del Prete et al., 2017 and 2018), we must be cautious to interpret our results in a causal way. This issue is also due to data limitations. With panel data, our GVC definitions could be extended to capture joining or exiting from a GVC relationship, which would allow for a more robust identification strategy. As our data is however cross-sectional, GVC participation indicates the current status of the firm; this prevents us from identifying the within-firm component of GVC, and constitutes a possible source of endogeneity. To partially address this issue, as explained in the next sections, we also use Propensity Score Matching (PSM) technique for all MENA countries and an instrumental variable approach where the instrument is a shift-share variable. Future research, with new panel data for all MENA countries, is needed to further address this is issue.

5.1.2. *Multi-level analysis*

In order to include trade network centrality into the analysis, we merge our firm-level dataset with the centrality indicators, computed at the country-sector level for the year 2012 that is one year before the WBES.[9] The merging applies to the manufacturing sector and is based on the sector correspondence table, reported in Appendix 1. Due to data constraints, i.e. Eora sectors are more aggregate, we lose some detail on the sector of firms. After the merging, our sample includes 3581 firms.

The final sample includes variables defined at two different levels: firm-level variables and the newly added centrality indicators that capture country centrality in sectoral trade networks. In this situation, performing a regression analysis, ignoring the hierarchical structure of data, e.g. simply adding the centrality indicators in OLS estimations, produces biased estimates (Burstein et al., 1978; Aitkin and Longford, 1986). Specifically, Moulton (1990) shows that including aggregate variables in micro-level OLS estimations results in downward biased standard errors; however, clustering alone may not solve the issue (Cheah, 2009). To avoid bias, we employ a (linear) multi-level model or mixed effects model (Snijders, 2011; Rabe-Hesketh and Skrondal, 2010; Searle et al., 1992). Our specification includes two different levels: we allow firm productivity to depend on firm characteristics (first level), as well as on country-level characteristics, namely country centrality in the trade network (second level). In another specification, we also include a third level, sector. A similar approach has been used, for instance, by Giovannetti et al. (2013) to investigate how firm-level characteristics and context factors (defined at the province level) affect the propensity of Italian firms to export.

The main difference between a multi-level and a standard linear

[8] For the distribution of firms by country and sector, see Appendix 1.

[9] In the regressions, we use standardized centrality indicators to facilitate the interpretation.

model lies in the less restrictive treatment of the error terms. Standard regression models rely on the assumption that observations (firms) are uncorrelated between themselves, whilst the productivity levels of firms operating in the same country (or sector) are likely to be correlated and, we maintain, especially so if the country (and its firms) occupy more central positions in the trade network, which possibly reflects stronger firm-to-firm linkages and scope for spillover effects. Although, for instance, OLS with clustered errors allows us to consider that correlation is not constant across units, they assume homogeneous correlation within each cluster, thus neglecting the hierarchical structure of the data and producing biased estimates. In multi-level models, instead, the error part of the model may include a random intercept and/or a random slope and is structured so to allow for correlation between subjects (firms) within the same cluster (country). Relative to an OLS with clustered errors, this approach allows for systematic differences among groups (countries, in our case). We estimate the multi-level models through maximum likelihood.

5.1.3. Propensity score matching

In order to partially address the endogenous relationship between productivity and GVC participation, at least for what concerns the observable variables, we use a PSM where we compare a treated group (firms belonging to a GVC) to a control group (firms who do not, but have similar characteristics). Hence, our treatment here will be the likelihood of integrating into a GVC. PSM should provide good estimates of the association between GVC and TFP. More specifically, we first run a probit where the dependent variable takes the value of 1 if the firm participates in a GVC and zero otherwise. We can hence obtain the propensity score measuring the predicted probability (p). We then match each participant to one or more nonparticipants on propensity score, using the "Kernel matching method" (using age, the female share, firm size legal form, the firm's location and the sector where it operates).[10] The choice of these variables pertains to how well the observed characters determine the integration into GVCs. Among the observables, we use the size of the firm, as large firms are more likely to be part of GVCs. We also control for female workers share given that several industries in developing countries (such textiles, ready-made garments and electronics) are female-intensive and are more likely to be part of GVCs (ITC, 2015, and Karam and Zaki, 2021). Third, we use the legal ownership as publicly listed companies are generally larger, have different sources of finance and more likely to be part of GVCs. We also use the age, as younger firms are more likely to innovate and be part of GVC. Finally, we control for the firm location as agglomerations play an important role to benefit from externalities (Badr et al., 2019). Moreover, to reduce the bias from unobserved characteristics, we control for country dummies and we also run the PSM regressions by adding the network variables to the list of variables used in the matching procedure. Finally, we cluster the error by country and sector as we merge Eora data with firm-level data.

5.1.4. Instrumental variable approach with shift shares

While the PSM approach can control for endogeneity due to observables, unobservables can bias our results. This is why we opt for an instrumental variable approach where the instrument is the shift-share of GVC. The latter (*GVC* Sec.*Reg*) is measured as the share of firms in the same industry and in the same region and country – less the firm in question – that are part of GVC. The rationale behind this instrument is that, in the same agglomeration (measured by the industry in a specific region), the existence of other firms that are part of GVC might increase the likelihood a specific firm to integrate a value chain thanks to the externalities that are generated, which in turn can affect firm's productivity. By removing the firm in question, we reduce the likelihood for endogeneity of GVC with TFP simultaneous periods (cf. Edgar S. Dunn 1960 in Chun-Yun and Yang 2008). This instrument, hence, follows the principle that a valid instrument induces changes in the explanatory variables but has no 'independent' effect on the dependent variable. This exclusion restriction also implies that there are no spillover effects, i.e. that GVC participation does not directly affects the productivity of non-GVC firms. Thus, to guarantee the validity of our instrument, we run a regression where the dependent variable is TFP and the regressors include the shift-share variables in addition to the other controls. Table A4.1 shows that the shift-share variables do not exert a direct effect on TFP as they are all insignificant. Therefore, this instrument influences our outcome variable solely through another explanatory variable – here through the GVC participation of the firm in question.

5.2. Empirical results

Table 4 presents our main empirical findings. First, amongst our control variables, while location is insignificant, age and gender have a significant association with TFP. While age points out that older firms, despite having a long experience, history with suppliers and consumers, tend to be less productive, the share of females positively correlates with firms' productivity, possibly because of less gender disparity. This is in line with Said et al. (2022) and Karam and Zaki (2021) who show that females positively affect firms' performance. The firm size variable measured by the level of employment has a significant positive association with TFP. Indeed, larger firms (endowed with more workers and, in most cases, more capital) have a higher TFP. This result shows how smaller firms face several impediments in the MENA regions. First, they are specialized in traditional products with a low value-added. Second, their lifetime is very short. Indeed, since they do not have a high value-added, their activity is not sustainable and, hence, they disappear rapidly from the market. Third, and as a consequence of this, they do not have any potential to expand, leading to the so-called "Missing Middle".

As per our main variables of interest, Tables 4 and 5 show that all the GVC proxies are positively and significantly correlated with productivity. Moreover, the stricter the definition (moving from GVC2 to GVC5[11]), the higher the value of the coefficient. This shows to what extent international certification and foreign capital increase the association of GVC with productivity. Indeed, they are conducive to higher productivity through improved management practices and business organization. Recall that GVC5 is the most restrictive definition that takes into consideration all the criteria of integrating a GVC (the firm is exporting, importing, has foreign capital and international certification). From a policy standpoint, this finding is interesting, since TFP, as a measure of technological advancement, is likely to improve when the firm is part of a GVC.

Let us now investigate the role of trade network centrality. By considering the multilateral links of each country and its position relative to others, centrality indicators take into account a dimension of GVC that is neglected by simple firm-level indicators and, thus, might represent another potential channel through which firm productivity can be enhanced.

Recall that the centrality indicators are defined at the country-sector level, hence, all firms of the same country operating in the same sector share the same value of the centrality indicators. In other words, centrality is measured at a more aggregate level, relative to our firm-level dataset and, by construction, variability in centrality cannot capture variability in firm-level outcomes within countries and sectors. However, a high country-level centrality is necessarily the outcome of firms of that country holding more important positions in the trade network. In addition, more central firms may display a higher average productivity and be in a better position to benefit from GVC participation. We

[10] We use also other matching techniques (radius and Kernel matching) and the results remain robust.

[11] Results for the other GVC indicators are consistent and available upon request.

Table 4
TFP, GVC and Networks – OLS Results (1).

	TFP	TFP	TFP	TFP	TFP	TFP
Ln(age)	−0.123**	−0.121**	−0.102*	−0.124**	−0.124**	−0.104*
	(0.0555)	(0.0550)	(0.0580)	(0.0562)	(0.0562)	(0.0591)
Females	0.298***	0.295***	0.304**	0.300***	0.300***	0.308**
	(0.0922)	(0.0940)	(0.1290)	(0.0921)	(0.0920)	(0.1280)
Location	−0.223	−0.220	−0.211	−0.225	−0.225	−0.216
	(0.1530)	(0.154)	(0.1530)	(0.1520)	(0.1520)	(0.1510)
Employment	0.149***	0.144***	0.145***	0.158***	0.159***	0.158***
	(0.0418)	(0.0409)	(0.0406)	(0.0402)	(0.0403)	(0.0404)
Pagerank	0.261**	0.235**	0.00671	0.267**	0.268**	0.0306
	(0.1140)	(0.1150)	(0.0709)	(0.1150)	(0.1140)	(0.0744)
GVC2	0.145**	0.128*	0.117*			
	(0.0640)	(0.0701)	(0.0665)			
GVC2*Pagerank		0.120**	0.120**			
		(0.0463)	(0.0480)			
GVC5				0.280**	0.284**	0.313**
				(0.1260)	(0.1130)	(0.1290)
GVC5*Pagerank					−0.0136	−0.0224
					(0.1160)	(0.1270)
Constant	1.626***	1.646***	1.485***	1.602***	1.601***	1.430***
	(0.2080)	(0.2040)	(0.2300)	(0.2060)	(0.2070)	(0.2350)
Legal status	Yes	Yes	Yes	Yes	Yes	Yes
Country dum.	Yes	Yes	Yes	Yes	Yes	Yes
Sector dum.	No	No	Yes	No	No	Yes
Observations	2190	2190	2190	2190	2190	2190
R-squared	0.123	0.124	0.155	0.122	0.122	0.154

Robust standard errors in parentheses clustered at the country-sector level.
*** $p < 0.01$,.
** $p < 0.05$,.
* $p < 0.1$.

Table 5
TFP, GVC and Networks – OLS Results (2).

	TFP	TFP	TFP	TFP	TFP	TFP
Ln(age)	−0.120**	−0.115**	−0.099*	−0.122**	−0.121**	−0.104*
	(0.0542)	(0.0538)	(0.0586)	(0.0549)	(0.0553)	(0.0597)
Females	0.310***	0.311***	0.306**	0.313***	0.314***	0.307**
	(0.1100)	(0.1110)	(0.1290)	(0.1100)	(0.1090)	(0.1270)
Location	−0.213	−0.207	−0.208	−0.215	−0.215	−0.217
	(0.154)	(0.1580)	(0.1560)	(0.1530)	(0.153)	(0.152)
Employment	0.149***	0.141***	0.140***	0.160***	0.159***	0.156***
	(0.0425)	(0.0422)	(0.0420)	(0.0403)	(0.0407)	(0.0411)
Betweenness	0.105	0.0739	0.0285	0.108	0.106	0.0649
	(0.0905)	(0.0906)	(0.0678)	(0.0915)	(0.0897)	(0.0777)
GVC2	0.157**	0.149*	0.131*			
	(0.0693)	(0.0847)	(0.0756)			
GVC2*Betweenness		0.130***	0.139***			
		(0.0485)	(0.0381)			
GVC5				0.268**	0.252*	0.289**
				(0.1280)	(0.127)	(0.141)
GVC5*Betweenness					0.0738	0.0660
					(0.0723)	(0.0866)
Constant	1.613***	1.640***	1.523***	1.588***	1.593***	1.468***
	(0.1980)	(0.1930)	(0.2360)	(0.1960)	(0.1980)	(0.2420)
Legal status	Yes	Yes	Yes	Yes	Yes	Yes
Country dum.	Yes	Yes	Yes	Yes	Yes	Yes
Sector dum.	No	No	Yes	No	No	Yes
Observations	2190	2190	2190	2190	2190	2190
R-squared	0.113	0.115	0.157	0.112	0.113	0.154

Robust standard errors in parentheses clustered at the country-sector level.
*** $p < 0.01$,.
** $p < 0.05$,.
* $p < 0.1$.

now investigate whether being more central is associated with higher productivity (TFP).

Since centrality is defined at an aggregate level (country-sector) relative to the unit of observation (firms), results might be biased. One possible correction is to use clustered standard errors. Results from OLS estimations performed by simply adding the centrality indicators to the baseline regression (and clustered errors) produce positive and significant coefficients for the centrality indicators we consider, namely Pagerank and betweenness (in Tables 4 and 5, respectively). GVC participation always remains significant. Interestingly, when we interact GVC participation with the network variables, the interaction term is positive and significant for GVC2 and the two networks variables

(Pagerank and betweenness) pointing out to what extent centrality amplifies the positive association of GVC participation with TFP. Yet, while GVC5 is significant, its interaction with the network variable is not. This might be attributed to the limited variability of GVC5 (as only a handful of firms have the four characteristics). Results are consistent across specifications. GVC participation is positive and significant in all cases, confirming the previous results. Moreover, occupying more central positions in the trade network is also associated with a productivity premium in most cases.

Tables 6 and 7 produce highly similar results when we run the multilevel analysis. Recall that the advantage of this approach pertains to the fact that, relative to an OLS with clustered errors, this approach allows for systematic differences among groups (countries or countries sectors). The centrality indicators remain significant, confirming that GVC participation and centrality tend to be associated with higher productivity. While network variables are positively linked to GVC participation, Tables 6 and 7 confirm our two previous findings: first, GVC positively correlates firms' productivity and second, this association is stronger with more restrictive definitions (especially GVC5). These results hold for all the network variables we use. In addition, the interaction term between GVC2 and network variables is positive, showing that GVC participation at the firm level and the country centrality are complementary.

5.3. Robustness checks

As it was mentioned before, to check the robustness of our results and to control for the endogeneity between productivity and GVC, we run a battery of sensitivity analysis, namely a PSM and an instrumental variable approach. Unfortunately, we do not have the panel data for all the countries and different years,[12] this is why we did not opt for panel regressions.

First, for PSM, our treatment is the likelihood of integrating into a GVC. More specifically, we first run a probit where the dependent variable takes the value of 1, if the firm participates in a GVC and zero otherwise (see Table A4.2 in Appendix 4). Table A4.3-A4.5 show the balance tests for PSM and confirm that there is a high level of common support for the two definitions of GVC (with a few observations that are off-support pointing out that their propensity scores (PS) did not align with those of another observation in the opposite treatment category). The density plots (Figure A4.1 in Appendix 4) for the matched sample are nearly indistinguishable (for our main variable of interest, namely the network variables), implying that matching on the estimated propensity score balanced the covariates. Table 8 shows that being in a GVC (using the two definitions) exerts a positive and statistically significant effect on TFP, with a stronger effect for GVC5 compared to GVC2 (confirming our previous results on the importance of international certification and foreign capital). It is worthy to note here that centrality variables are included among our matching variable we can introduce only one treatment, which is GVC participation.

Second, as PSM controls for endogeneity that is due to observables, we run an instrumental variable approach where the instrument used is the shift-share of GVC by region, sector and country less the GVC status of the firm in question. Table 9 shows that while GVC2 remains positive and statistically significant, GVC5 loses its significance. Yet, Pagerank remains also positive and significant, confirming the importance of centrality to TFP.

These two approaches can infer a causal link between GVC and TFP, which is line with the well documented literature on this issue. Finally, a conservative estimate is that GVC participation is associated with a TFP premium of at least 10–15 % (even more according to PSM and IV), and that a 1 standard deviation increase in centrality might add up to another 10 % (centrality indicators are standardized).

6. Conclusion and policy recommendations

This paper examines the trade opportunities of MENA countries, their position in the network of world trade in manufacturing and the nexus between firm productivity and participation in Global Value Chains (GVCs). It contributes to the literature in several respects: it provides a network analysis of the links and centrality of the different MENA countries highlighting an important heterogeneity. Using several GVC indices, the paper analyses GVC participation within a subset of countries and, therefore, the ways in which GVC participation can affect the relation between firms and productivity. Our main findings show that there is a positive and significant association between TFP gains and GVCs participation in the MENA region. This association remains relatively robust after we control for endogeneity (based on either observables or unobservables). Furthermore, if a firm is located in a sector/country that is well connected (i.e. more central in the intermediate trade network), its TFP is likely to be higher. Hence, connectivity at the sector/country level matters and can amplify the GVC gains at the firm level.

From a policy standpoint, several conclusions can be withdrawn from our empirical analysis, for both GVCs and connectivity. GVCs should be perceived as a tool that can help MENA countries overcome some of their structural problems. On the one hand, GVC participation can improve the structure of exports and not just increase the level of exports (Aboushady and Zaki, 2021). In fact, since MENA countries have been confined into exporting traditional goods for a long period, integrating into a GVC is likely to increase their productivity and allow them to export new and relatively non-traditional goods (Del Prete et al., 2017 and 2018). On another front, since connectivity at the macroeconomic and sectoral levels matters for firm productivity, it is important to improve trade in intermediaries at the national level. This can take place by several measures. First, connectivity in MENA countries is still hampered by several barriers related to the efficiency of customs, where lengthy procedures negatively affect the clearance of intermediate goods. Tariff reductions and trade facilitation on imported and final goods can contribute to firms' productivity growth (Yu, 2014). Hence, trade facilitation is a key issue in improving the connectivity of MENA countries. Second, deficient infrastructure (in terms of ports and roads) reduces the likelihood of developing trade networks that are sensitive to time and speed of delivery (Coşar and Demir 2016). Investing in a well-developed infrastructure will affect trade networks and, hence, help firms improve their productivity (Criscuolo and Timmis, 2018). Finally, it is worth noting that there is a large potential to develop deeper networks between the two shores of the Mediterranean due to geographical proximity and complementarity in terms of know-how and wages, demography, and resource endowment (Ayadi et al., 2021). Indeed, after more than twenty years of shallow regional integration and limited impact, the integration into a GVC becomes vital to improve export performance and to boost SMEs in the Southern shore of the Mediterranean (OECD, 2018). This is of particular importance in a period where supply chain disruptions might lead to a nearshoring (where companies transfer business processes to nearby countries) or friendshoring (transferring to geopolitical allies) (Goldberg and Reed, 2023; Giovannetti et al., 2023).

Author statement

All persons who meet authorship criteria are listed as authors, and all

[12] We had some checks on the Egypt panel (2013 and 2016 surveys), but then we decided to concentrate on a larger sample of countries. This decision was based on data limitations and on the specific research question of the work. While results are qualitatively consistent, the number of observations is low (especially for firms observed both in 2013 and 2016) and, since we are only focusing on a single country, we cannot properly interpret network centrality. Moreover, since centrality is defined at the country-sector level, it is also captured by the firm-level dummies, again limiting its meaningfulness.

Table 6
TFP, GVC and Networks – Multilevel Results (1).

	TFP	TFP	TFP	TFP	TFP	TFP
Ln(age)	−0.120***	−0.118***	−0.0983***	−0.121***	−0.121***	−0.0992***
	(0.0384)	(0.0396)	(0.0356)	(0.0388)	(0.0388)	(0.0366)
Females	0.298***	0.296***	0.313***	0.301***	0.301***	0.316***
	(0.0803)	(0.0822)	(0.0963)	(0.0813)	(0.0816)	(0.0969)
Location	−0.216***	−0.215***	−0.204***	−0.219***	−0.219***	−0.206***
	(0.0689)	(0.0685)	(0.0613)	(0.0640)	(0.0641)	(0.0586)
Employment	0.148***	0.143***	0.142***	0.158***	0.158***	0.152***
	(0.0134)	(0.0142)	(0.0169)	(0.00715)	(0.00703)	(0.0131)
Pagerank	0.225***	0.201***	0.106	0.233***	0.233***	0.140**
	(0.0329)	(0.0353)	(0.0686)	(0.0341)	(0.0340)	(0.0682)
GVC2	0.151*	0.135**	0.109**			
	(0.0769)	(0.0659)	(0.0445)			
GVC2*Pagerank		0.112***	0.0901**			
		(0.0404)	(0.0377)			
GVC5				0.277***	0.280***	0.283***
				(0.0835)	(0.0902)	(0.0846)
GVC5*Pagerank					−0.0118	−0.0551
					(0.0342)	(0.0395)
Constant	1.893***	1.907***	1.743***	1.892***	1.892***	1.729***
	(0.240)	(0.2410)	(0.2470)	(0.2350)	(0.2340)	(0.2360)
Legal status	Yes	Yes	Yes	Yes	Yes	Yes
Levels	2	2	3	2	2	3
Observations	2190	2190	2190	2190	2190	2190
Number of groups	8	8	8	8	8	8

(i) Robust standard errors in parentheses clustered at the country level. (ii) In 2-level model firms are nested into countries. In 3 level models, firms are nested into sectors into countries. (iii).
*** $p < 0.01$,.
** $p < 0.05$,.
* $p < 0.1$.

Table 7
TFP, GVC and Networks – Multilevel Results (2).

	TFP	TFP	TFP	TFP	TFP	TFP
Ln(age)	−0.121***	−0.115***	−0.097***	−0.122***	−0.121***	−0.099***
	(0.0370)	(0.0398)	(0.0366)	(0.0379)	(0.0384)	(0.0373)
Females	0.296***	0.299***	0.312***	0.301***	0.303***	0.313***
	(0.1030)	(0.1010)	(0.0972)	(0.1040)	(0.1030)	(0.0985)
Location	−0.205***	−0.199***	−0.201***	−0.208***	−0.208***	−0.207***
	(0.0585)	(0.0598)	(0.0613)	(0.0535)	(0.0537)	(0.0574)
Employment	0.148***	0.140***	0.139***	0.160***	0.160***	0.151***
	(0.0139)	(0.0175)	(0.0195)	(0.00769)	(0.00860)	(0.0155)
Betweenness	0.104*	0.0720*	0.133**	0.108*	0.105*	0.177***
	(0.0582)	(0.0388)	(0.0661)	(0.0591)	(0.0564)	(0.0682)
GVC2	0.167**	0.159**	0.117***			
	(0.0827)	(0.0713)	(0.0452)			
GVC2*Betweenness		0.132***	0.105***			
		(0.0363)	(0.0287)			
GVC5				0.269***	0.252**	0.265***
				(0.0812)	(0.1010)	(0.0920)
GVC5*Betweenness					0.0776	0.0164
					(0.0501)	(0.0532)
Constant	1.853***	1.871***	1.758***	1.851***	1.855***	1.746***
	(0.2490)	(0.2500)	(0.2580)	(0.2460)	(0.247)	(0.2560)
Legal status	Yes	Yes	Yes	Yes	Yes	Yes
Levels	2	2	3	2	2	3
Observations	2190	2190	2190	2190	2190	2190
Number of groups	8	8	8	8	8	8

(i) Robust standard errors in parentheses clustered at the country level. (ii) In 2-level model firms are nested into countries. In 3 level models, firms are nested into sectors into countries. (iii).
*** $p < 0.01$,.
** $p < 0.05$,.
* $p < 0.1$.

authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication.

CRediT authorship contribution statement

Rym Ayadi: Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Giorgia Giovannetti:** Conceptualization, Formal analysis, Investigation, Methodology, Resources, Supervision,

Table 8
TFP, GVC and Networks – PSM Results.

	GVC2	GVC2	GVC2	GVC2	GVC5	GVC5	GVC5	GVC5
GVC	0.2306**	0.1743	0.1638	0.1684	0.4431***	0.4408***	0.4893***	0.4756***
	(0.113)	(0.130)	(0.132)	(0.127)	(0.147)	(0.142)	(0.140)	(0.134)
Constant	2.2260***	2.2791***	2.2847***	2.2684***	2.3370***	2.3393***	2.2907***	2.3044***
	(0.082)	(0.104)	(0.116)	(0.110)	(0.139)	(0.134)	(0.148)	(0.152)
Observations	2198	2196	2194	2188	2132	2132	2132	2132
R-squared	0.007	0.004	0.003	0.004	0.029	0.029	0.036	0.034
Matching	Kernel	Kernel	Kernel	Kernel	Kernel	Kernel	Kernel	Kernel
Network	Pagerank	Between	Pagerank	Between	Pagerank	Between	Pagerank	Between

(i) Robust standard errors in parentheses clustered at the country-sector level. (ii) Different controls are added to the regressions including age, employment, location, legal status, female employment and country dummies. (iii) *$p < 0.1$.
*** $p < 0.01$,.
** $p < 0.05$,.

Table 9
TFP, GVC and Networks – IV with Shift Shares.

	TFP	TFP	TFP	TFP
GVC2	0.7343*	0.8992*		
	(0.409)	(0.459)		
GVC5			−2.0078	−1.7822
			(4.829)	(4.410)
Ln(age)	−0.1081**	−0.1014**	−0.1533**	−0.1487**
	(0.048)	(0.046)	(0.070)	(0.068)
Females	0.2735***	0.2808***	0.3349***	0.3441***
	(0.095)	(0.108)	(0.086)	(0.105)
Ln(Emp)	0.0957*	0.0802	0.2053**	0.2023***
	(0.050)	(0.055)	(0.084)	(0.075)
Pagerank	0.2296*		0.2599**	
	(0.117)		(0.115)	
Betweenness		0.0840		0.1104
		(0.090)		(0.093)
Constant	1.6205***	1.6179***	1.6646***	1.6407***
	(0.209)	(0.198)	(0.367)	(0.339)
Observations	2162	2162	2162	2162
R-squared	0.094	0.069	0.049	0.054

Robust standard errors in parentheses clustered at the country-sector level.
*** $p < 0.01$,.
** $p < 0.05$,.
* $p < 0.1$.

Validation, Writing – original draft, Writing – review & editing. **Enrico Marvasi:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Chahir Zaki:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Writing – original draft, Writing – review & editing.

Data availability

Data will be made available on request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.strueco.2023.11.014.

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