WORKING PAPER

Global Value Chains' Participation and Development Opportunities: hints from the Product Space

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Abstract

The Economic Complexity (EC) approach (Hidalgo and Hausmann, 2009) offers a path-breaking perspective into the study of economic development, by introducing new tools for economic analysis, such as the product space and sophistication indexes. A different strand of international economics literature has studied Global Value Chains (GVCs), highlighting their impact on countries the economic performance of countries. This paper jointly considers these two strands of literature by: i) providing a descriptive analysis on a set of selected chains through updated measures of the product space and of derived indexes; ii) proposing a new EC coherent GVC participation index; iii) applying the former contributions to the analysis of North African countries' GVC performance. From the latter analysis, strong differences between Tunisia, Egypt and Morocco emerge, as far as both current participation and future perspectives are concerned. Overall, the paper, by merging the two strands of literature, for the first time to our knowledge, highlights interesting opportunities for further developments in this direction.

JEL Classification: F14, F43, C80, O10, O57, O55

Keywords: Global Value Chains, Economic Complexity, Product Space, North Africa

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Introduction

Economic and social factors are both important in shaping the scope of a country' productive capacities. Despite the existence of several theoretical models, these empirical tests have often fallen short of completely capturing economic reality: indeed, most of the findings and predictions have been confined to specific case studies or affected by strong prior assumptions.

Against this background, an empirically based approach proposed by Hidalgo and Hausmann (2009) - the economic complexity (EC) approach - is offering interesting insights into the study of country development trajectories. According to this view, the economic performances of countries diverge because of the diversity and the interaction of their own capabilities: the greater the availability of capabilities and, hence, the possible set of interactions, the greater the complexity of potential production and, therefore, the development opportunities for countries.

Indeed, the production of goods is nothing more than assembling a product's specific components aligned with the available capability within a country. To study country developments, the EC approach has introduced innovative and appealing tools as part of its economic analysis. The most used of these are the Economic Complexity Index (ECI) and the Product Complexity Index (PCI), which respectively measure the scope of country diversity and product ubiquity (MIT, 2019).

Another widely used and very illustrative tool is the product space: a network graph whose nodes are products and whose edges represent the degree of proximity between products. Its construction[3] is based on the idea that country trade performance, used as proxies for productive capacities, may reveal the available capabilities within countries. Defining a measure of product proximity, it is possible to build a network representation of the production process, thus evidencing the relatedness between goods and highlighting the best strategies for a country's differentiation and development. In its simplicity, the product space comprises all the virtues of the EC approach: first, relying on trade data, its construction is completely empirical based, hence there are no prior assumptions about the production process; secondly, according to the type of input data used for network construction, the graph may be tailored to specific areas, or countries, as well as being on a global scale and not confined to single specific case studies.

[3] More details on the Methodological section below.

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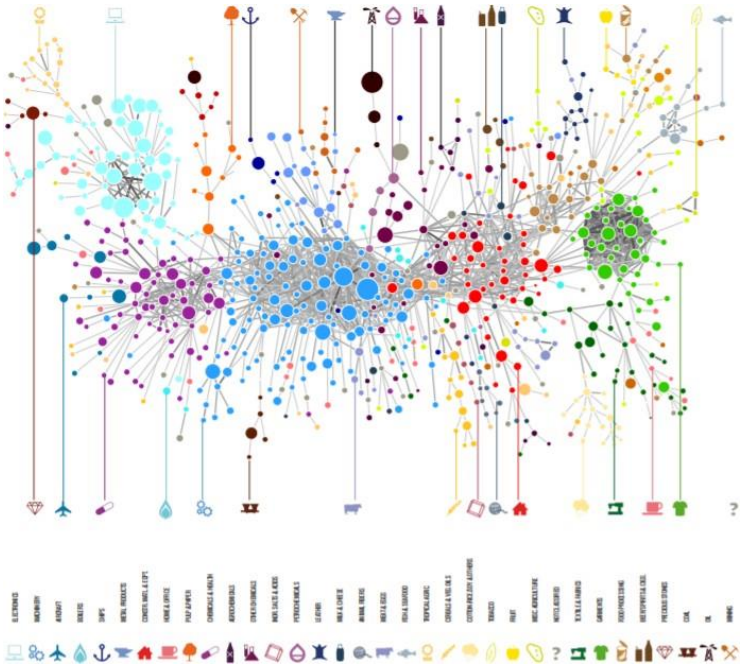
Figure 1: A 4-digits product space representation



Source: Atlas of Economic Complexity, Harvard University

As far as the global production process is concerned, the first representations of the Product Space (Figure 1) have highlighted a core-periphery structure with, at the centre, more sophisticated goods, such as machinery or metallurgy and, on the periphery, less complex products, such as foodstuff or minerals. . Consequently, developing countries, whose production basket is characterised by less sophisticated goods, are mainly positioned externally, with best strategies for development dealing with the individuation of the best routes for moving towards the centre of the network.

Finally, despite the widespread use and popularity of the product space, other interesting instruments also exist for economic analysis proposed under the EC approach. Amongst them is a set of indexes measuring product and country sophistication - the PRODY and EXPY indexes respectively[4] (Hausmann et al., 2007).

This paper has multiple objectives. First, it links the EC approach with the literature on Global Value Chains (GVCs). As put forward by Antràs (2016),

[4] PRODY $=\sum_{j=1}^{J}\frac{(x_{jk}/X_j)}{\sum_{j=1}^{J}(x_{jk}/X_J}\cdot Y_j$; EXPY= $\sum_{k=1}^{K}(x_{jk}/X_j)\cdot PRODY_k$ where j identifies country and k product.

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intense firm to firm interactions, especially of intermediate products, allows the distinguishing of GVC trade from traditional trade. Global production is now structured along GVCs, with two-thirds of world trade flows occurring within GVCs. Moreover, GVCs may offer relevant development opportunities for developing countries in terms of growth, productivity, employment, labour inclusion and poverty reduction (Spence and Antràs, 2017; Spence, 2019; Taglioni and Winkler, 2016; The World Bank, 2019). The main aim of this paper is to evidence the position of a set of key GVCs on the product space. The positioning is complemented by average measures of network centrality and sophistication. Moreover, we present a new index for GVC participation, based on the EC approach, in order to offer new hints and insights into the study of GVCs.

The paper also provides an updated version of the product space, with product disaggregation at 6-digits level providing an updated picture of the global production structure.

Third, it discusses North African (NA) countries' GVC participation and the possibilities for diversifying and developing along the product space. These countries have not yet been studied using the EC approach, although case studies exist for many other developing countries: Ecuador (Hausmann and Klinger 2010), Sub-Saharan Africa (Abdon and Felipe, 2011), East Africa (Hidalgo, 2012), Brazil and Korea (Romero et al., 2015), and Ethiopia (Fortunato et al., 2015). This analysis could prove important for NA countries: understanding their position on the product space may indeed allow the tracking down of the best policies for diversifying their traditional economic structures and, possibly, for upgrading their products.

More specifically, the analysis aims to i) measure the participation of NA countries in a set of selected GVCs, using the new index provided; ii) investigate how the possibilities of increasing the participation in GVCs may be constrained by the current positioning of countries on the product space; iii) discuss the most profitable policies to improve integration in the considered GVCs.

The paper is organised as follows: section 2 describes the construction and the characteristics of a new version of the product space, also providing some product-level descriptions, using the PRODY index; section 3 provides graphical and quantitative results on the relationship between GVCs and EC tools; section 4 discusses NA performance and future perspectives; section 5 provides the conclusion.

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A new product space

The product space, as mentioned above, is a network in which nodes are products and edges identify the degree of similarities between them. Its construction is rooted in the CEPII BACI database for the year 2015. This dataset comprises all trade flows with origin and destination disaggregated at the 6-digits level, using the Harmonised System (HS) classification. The original dataset has a total of more than 7 million observations for 4857 products and 221 countries. To avoid any possible bias in the network construction, due to marginal products or countries with a low share of total trade, we removed all products and countries in the lowest 10th percentile. We end up with a total of 4372 products and 198 countries. Then, we compute RCA at a global level for each country, in each product. Using RCA, it is possible to calculate the level of relatedness between products. For the calculation, we use the formula for product proximity, proposed by Hidalgo, Klinger, et al. (2007):

$$\phi_{i,j} = \min\{P\,(RCA_i|RCA_j),\, P\,(RCA_j|RCA_i)\} \qquad (1)$$

where $\phi_{i,j}$, the proximity between the couple of goods i and j, is the minimum between the conditional probability of having a RCA in goods i given a RCA in goods j and vice-versa. All the measures of proximity between couples of goods are stored in a squared symmetric matrix, with dimensions 4372x4372, which serves as the adjacency matrix for the construction of the network. Figure 2 depicts the product space obtained by the BACI dataset.

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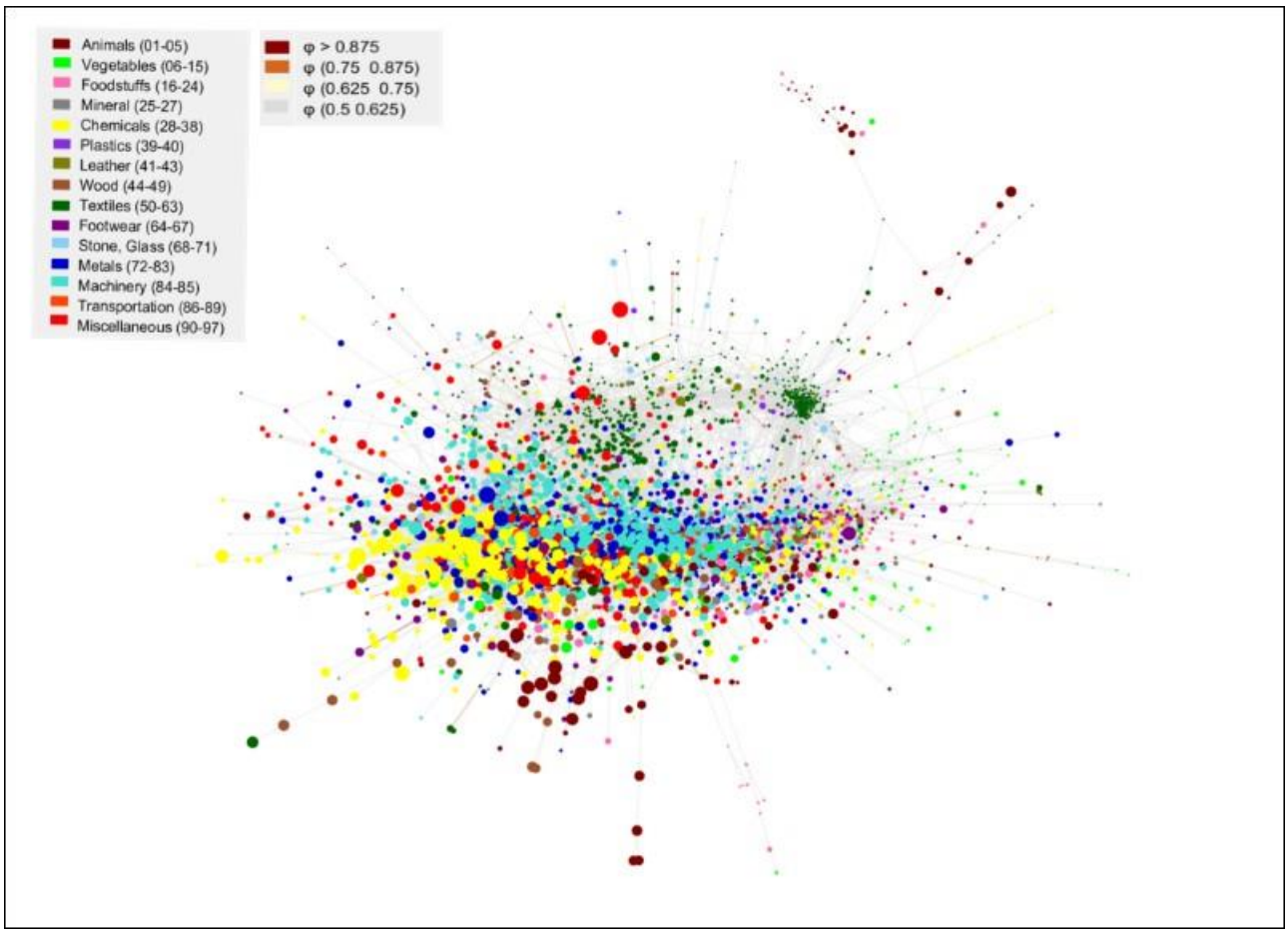
Figure 2: A new 6-digits product space



Notes: Author's elaboration. Node size: PRODY.

For graphical clarity, a threshold at proximity ≤ 0.5 is introduced in the adjacency matrix, thus all the products which exhibit a severely low level of relatedness with any other product are excluded[5].

As in Figure 1, the network shows a clear core-periphery structure. The core is composed of machinery, metals, chemicals, and miscellaneous products. Separately, the periphery includes primary products such as animals, vegetables, and minerals. Interestingly, out of the centre, the network singles out another highly dense part comprising the textile sector. This highlights the

[5] A complete representation of the graph, also comprising the external ring, is reported in Figure 3 to denote GVC products positions.

high within-sector relatedness and, at the same time, its connections with different types of industry, from machinery to primary activities.

Shifting our attention towards the measure of product sophistication, Table 1 presents the products with the largest and smallest PRODY index. PCI of the selected products is also reported, along with the correlation between the two variables. Top products are part of the most advanced sectors, mainly chemicals, metals and miscellaneous, whilst the lowest PRODY is from products of primary activities, overall vegetables, animals and minerals. Besides this, there is a strong positive correlation between the two variables, thus underlining the nexus between high income and complexity.

Table 1: The 2015 PRODY index (Hausmann, Hwang, et al. 2007)

	HS code	Description	Sector	PRODY	PCI
Largest	294130	Tetracyclines, derivatives, in bulk, salts	Chemicals	71415.16	0,417
	741021	Foil of refined copper, backed, t < 0.15mm	Metals	69418.44	0,927
	740990	Plate, sheet, strip, copper alloy nes, t > 0.15mm	Metals	63263.82	1,46
	910111	Wrist-watch, precious metal, battery, with hands	Miscellaneous	62898.97	-0,1
	291242	Ethylvanillin(3-ethoxy-4-hydroxybenzaldehyde)	Chemicals	60444.03	1,618
	290369	Halogenated derivatives of aromatic hydrocarbons, nes	Chemicals	60097.21	0,642
	910221	Wrist-watch, base-metal case, automatic wound	Miscellaneous	59790.98	1,381
	910121	Wrist-watch, precious metal, automatic wound	Miscellaneous	59393.07	0,444
	391530	Polyvinyl chloride waste or scrap	Plastics	59197.37	0,431
	252930	Leucite, nepheline and nepheline syenite	Minerals	58504.82	1,132
Smallest	710121	Pearls cultured unworked	Stone and Glass	159,39	-0,845
	90930	Cumin seeds	Vegetables	183,32	-1,305
	90920	Coriander seeds	Vegetables	393,37	-1,632
	260500	Cobalt ores and concentrates	Minerals	556,73	-2,491
	261590	Niobium, tantalum and vanadium ores and concentrates	Minerals	685,40	-2,748
	80130	Cashew nuts, fresh or dried	Vegetables	762,63	-2,992
	270111	Anthracite, not agglomerated	Minerals	893,68	-1,086
	10420	Goats, live	Animals	907,01	-1,929
	90910	Anise or badian seeds	Vegetables	937,97	-1,036
	531010	Woven fabric of jute/bast fibres, unbleached/bleached	Textiles	948,44	-2,157
	Average	**Std. Deviation**	**Minimum**	**Maximum**	**ρ**
Prody	18685,36	10490,85	159,3895	71415,16	0,7307
PCI	0	1	-4,941	2,734	

Notes: HS classification follows 1992 nomenclature. PRODY index is calculated using World Bank GDP per capita in current $. PCI estimates are from MIT (2019).

In summary, the new version of the product space, which enlarges to 6-digits level previous estimates and updates RCA calculation using 2015 CEPII BACI dataset, evidences a similar structure with respect to previous representations. It also highlights how the core of the global production

structure is characterised by highly sophisticated products. Hence, widening the production base and increasing its sophistication and complexity, is fundamental for developing countries in order to reach a more central position in the network.

The analysis of this issue is discussed, introducing into the debate the concept of GVC participation. Empirical results, findings and considerations are shown in the rest of this work.

GVC participation and the Economic Complexity approach

Studying GVC structure and the related performance of countries is a central issue in international economics, as well as in development economics, for the opportunities that GVCs provide for developing countries to enter into the International Production Network.

The recent literature has proposed many ways to assess such performance. Most widely used measures of GVC participation (Johnson and Noguera, 2012; Antràs et al., 2012; Wang et al., 2017a,b; Borin and Mancini, 2016, 2019), focused on evaluating both the quantitative (as the share of GVC related trade in gross exports) and the qualitative (upstream vs downstream positioning) extent of country engagement in GVCs.

We propose a new way to assess country performance in order to encompass the economic complexity approach into the GVC literature.

Rather than looking at country statistics, this analysis starts from the composition of specific GVCs. Understanding the whole set of intermediate and final goods of a specific chain may be quite a delicate and complex operation, since there can be many types of products. Furthermore, their attribution to a chain may not be objective. Hence, this paper builds on the contribution of the Centre on Globalization, Governance & Competitiveness at Duke University, that has thoroughly reconstructed some of the most developed and recognised GVCs with a complete indication of single products at the 6-digits level. For the geographic focus of this analysis, we study the automotive, aerospace, shipbuilding, and electronics GVCs (Bamber et al., 2016; Frederick and Gereffi, 2016; Sturgeon et al., 2016; Frederick and Brun, 2017). Indeed, these chains have a key relevance for NA: aerospace and automotive leading companies, such as Boeing, Airbus, and Renault, are actually important investors in the region; shipbuilding, especially for Egypt, has always been a leading sector in NA; finally electronics, one of the fastest growing global sectors, may constitute a precious high value added direction of diversification.

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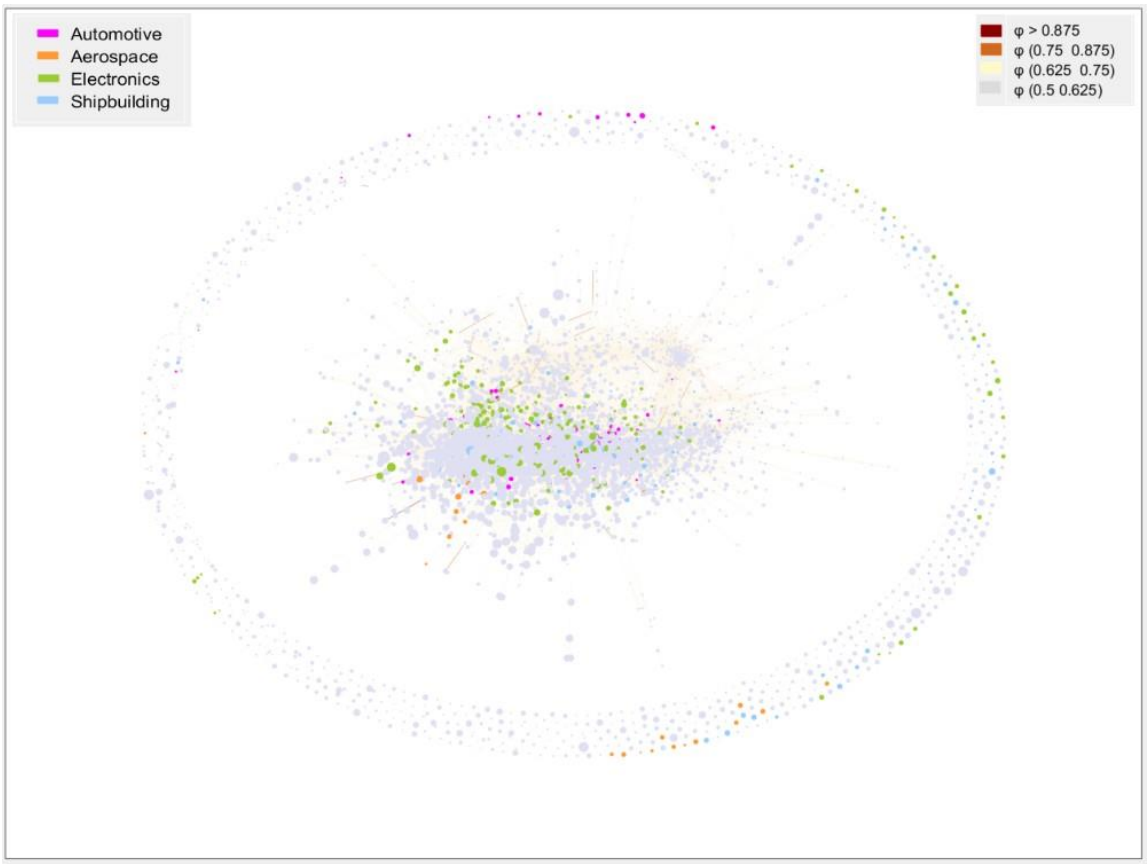
The first attempt to investigate GVCs using EC approach instruments is given by a graphical representation that depicts the positioning of the selected GVCs on the product space, Figure 3. Table 2 reports some statistics.

Figure 3: GVCs on the product space



Notes: Author's elaboration. Node size: PRODY. Node colour: belonging to one of the selected chains. Grey nodes do not belong to any of the selected chains.

The bulk of the products of these chains are situated in the central part of the network, with just a minority of products on the outer ring. Electronics is the largest chain, with 269 products, whilst aerospace is the smallest, with 27. The average sophistication of the four chains is slightly above the mean PRODY, Table 1, with electronics and aerospace showing a PRODY about 4000 dollars higher than automotive and shipbuilding. Automotive and electronics are by far the most central chains, whilst aerospace has a very low value of centrality, 965.41, due to the presence of a certain share of products on the outer ring. Besides this, the chains appear to be quite well connected to each other; indeed, all of them are located in the central part of the network, with

products of different chains very closely positioned. This is especially the case for the electronics and automotive chains.

Table 2: GVCs, Sophistication and Network Centrality

GVC	# of products	Average PRODY ($)	Total PRODY ($)	Average Centrality
Automotive	85	18480.21	1570818.02	5503.36
Aerospace	27	22195.19	599270.13	965.41
Electronics	269	22022.86	5924149.87	5375.52
Shipbuilding	136	17794.10	2419997.38	3021.00

Notes: Weighted betweenness centrality has been used. The average PRODY index for all the products is 18685.36. The average value of centrality for all the products in the network is 4781.70.

In addition to the graphical representation in Figure 3, we also compute an index combining the quantitative and qualitative perspectives of GVC participation measures. The quantitative participation is assessed through the number of RCAs detained by a country in GVC products, whilst the qualitative one is measured through the use of PRODY index, as a proxy for value added. The Participation Index (PI) for the i_{th} country in the j_{th} GVC can be written as:

$$PI_{ij} = \frac{\sum_1^K PRODY_k}{\sum_1^n PRODY_n} \quad with \qquad 0 \leq k \leq n \qquad (2)$$

where k identifies the 6-digits level products of the j_{th} GVCs in which the country i_{th} has RCA, whilst n identifies all the 6-digits level products of the j_{th} GVCs. By construction, the index, that ranges between 0 and 1, is characterised by the following properties:

- a country participates in a specific GVC if it has RCA in at least one good comprised in that specific GVC
- the higher the number of a country's RCAs in products of a specific GVC, the higher the participation of that country in that specific GVC (Quantitative perspective)
- for the same number of RCAs in a specific GVC, the higher the sophistication, proxied with PRODY, of the products with RCAs, the higher the participation (Qualitative perspective)

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NA countries, economic complexity and GVCs

Despite a strategic geographical position in the Mediterranean Sea, closed to Europe, and in between America and East Asia, NA has not been able to fully develop and improve its living conditions. Indeed, political and social unrest and failed development policies have confined the area into middle-income status, with a strong need for a restructuring of domestic economies (Arezki et al., 2018). In this context, NA countries have not been able to fully integrate into international markets. Algeria, thanks to gas, is the region's first exporter, accounting for a 0.23% share of world trade, followed by Egypt, 0.18%, Morocco, 0.15%, Tunisia, 0.01%, and Libya, 0.01% (MIT 2019). However, regardless of these very low percentages, the decomposition of gross trade flows into value added reveals that the GVC participation of NA countries, in terms of share of gross trade, is good (Del Prete et al., 2018): the average for the area in 2013 matches the European level, with all the countries also outperforming China, India and NAFTA countries. Such a result is mainly attributed to high shares of indirect value added (Koopman et al., 2014), that is domestic value added embodied as intermediate inputs in other countries' exports, revealing a specialisation in the upstream stages of production, often with low value added.

Therefore, NA countries need to improve their gross participation in international markets, as well as improving their position towards higher value added activities. Indeed, their geographic position, historical ties and capabilities offer valuable opportunities to gain international relevance and become important players in international trade transactions.

In trying to shed more light on the area's performance, we compute the new index for GVC participation. We are not considering Libya and Algeria because of their reduced number of RCAs, due to their large specialisation in primary activities, as well as their serious social and political challenges in the most recent years. Hence, our sample comprises Tunisia, Morocco and Egypt.

Table 3 provides the estimation of the PI calculated for the selected GVCs. Tunisia is by far the most engaged in the four GVCs considered, with a total PI of 15.25%, more than double the results of Morocco and Egypt. Taking into account single GVCs, it has the highest PI in electronics - almost 20% - followed by automotive, aerospace and shipbuilding. In particular, with the exception of the latter GVC, Tunisia is the country with the highest PI in all the chains compared to the other two countries.

On the contrary, Morocco, even after attracting an important share of FDI, especially in the automotive sector, does not lead any chain in terms of PI: its total PI is 7.10%, with a peak in automotive of 10.36%. Electronics is the

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second chain in terms of PI, 7.27%, whilst shipbuilding and aerospace PI does not reach 6%. Country participation in the four chains is fairly uniform, thus allowing for future development in more than one chain.

Finally, Egypt GVC participation results come out the lowest. The total PI accounts for 6.39%, resulting largely from heterogeneous figures in single chains. The country's highest PI is in the shipbuilding GVC, which is also the highest for the area, reflecting the country's significant historical tradition in the sector. However, apart from this chain, the results are very disappointing: the second PI is in electronics, with a very small PI of 4.45%, then auto- motive, 2.19%, and finally aerospace, with no product in the chain where Egypt has a RCA. However, despite the low PI, country integration is expected to increase over the next few years, in light of large FDI inflows, especially in the electronics sector.

Figures 7, 8, 9 in the Appendix provide country positioning on the product space, along with GVC participation, offering a graphical representation of the quantitative results just presented.

As far as average results for the area are concerned, we find a total PI of 9.58%. The variability of the index for the four chains is quite small: the PI for automotive, shipbuilding and electronics, the most developed, is almost equal across the area. As the exception, the aerospace chain despite substantial investment in the area from multinationals - such as Airbus - is a step behind with a PI of 5.18%.

Table 3: NA GVC participation

GVC		Morocco	Tunisia	Egypt	PI mean
Automotive	# of RCAs	10	15	3	9.21%
	PI	10.36%	15.09%	2.19%	
Aerospace	# of RCAs	2	3	0	5.18%
	PI	5.71%	9.82%	0.00%	
Shipbuilding	# of RCAs	7	13	26	10.07%
	PI	5.90%	9.57%	14.73%	
Electronics	# of RCAs	24	58	18	9.90%
	PI	7.27%	17.97%	4.45%	
Total	# of RCAs	40	86	46	9.58%
	PI	7.10%	15.25%	6.39%	

The analysis of the PI index, provided in Table 3, highlights strengths and weaknesses for each of the countries considered in the different chains. A key message emerging is that clear differences exist between their level of

integration into the selected GVCs. These differences require investigation into and discussion about possible future trajectories and related policy interventions, looking at each country one at a time. To provide such a country specific assessment, we use two concepts from the EC approach: average proximity and PRODY. The first is estimated as the average of the proximity between the set of non-RCA products, comprised into the selected GVCs, and the basket of country RCAs; this value is then associated with the PRODY index of the non-RCA product under consideration, in a scatter plot that depicts a sort of "development space" for each country. Establishing such a relationship provides useful instruments for policy makers to understand in which direction to devote interests, investment and industrial policies in order to increase GVC participation. The most related products are, indeed, the ones which each country should find easiest to reach a RCA. Moreover, accompanying this identification with the PRODY index, could allow us to assess the profitability of investing and specialising in each specific product or chain.

Figures 4, 5, 6 report the development space for Morocco, Tunisia and Egypt respectively, whilst Tables 4, 5, 6 in the Appendix list the top 30 products, in terms of average proximity.

Morocco's development space highlights that the country's most related goods belong to the electronics and shipbuilding chains. In fact, products from these two chains occupy the first ten positions, in terms of average proximity, Appendix, Table 4.

At this very disaggregated level (6 digits), the most related products are HS 730630 and HS 853810, respectively "Pipes etc nes, iron/steel welded nes,diameter <406.4m" and "Electrical boards, panels, etc, not equipped" from the shipbuilding and electronics chains. The average proximity of these two goods is higher than 0.25, meaning that the average probability that each of these two goods and the RCA goods of the country are co-exported with RCA is higher than the 25%. With average proximity in the range of 0.25-0.23 there are 7 other goods, again all belonging to the shipbuilding or electronics chains. The first good belonging to a different chain, automotive, is HS 940120 "Seats, motor vehicles", with an average proximity of 0.226. Furthermore, there are three other goods from the automotive chain in the top 30, with an average proximity close to 0.22. No good in the aerospace GVC appears in the top 30 related products.

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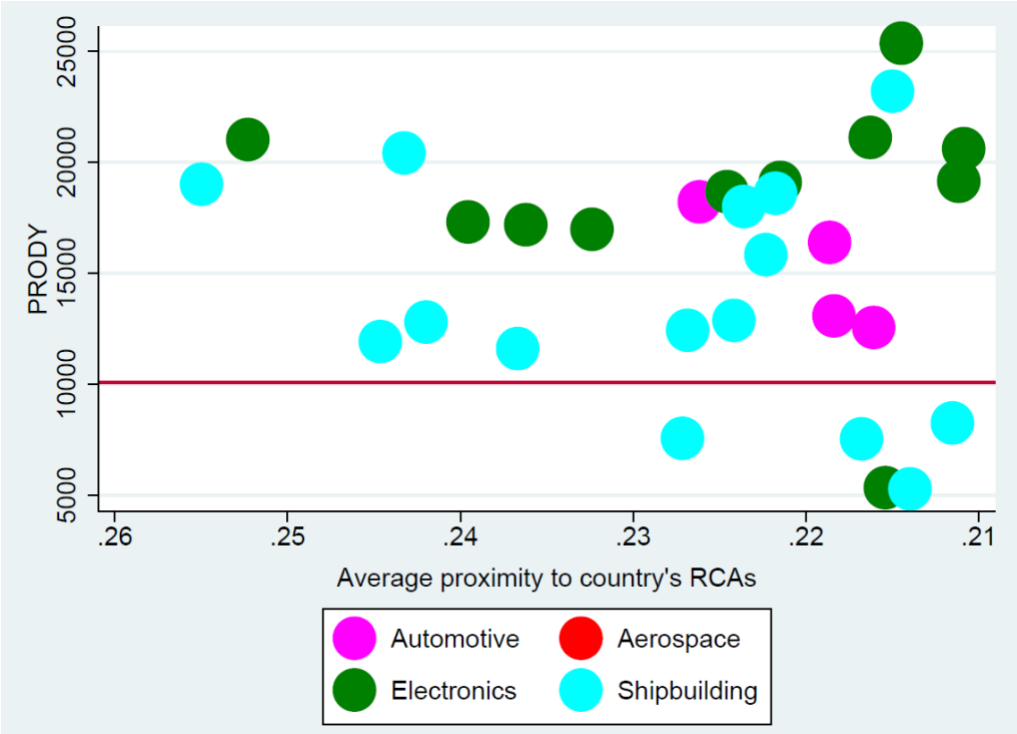
Figure 4: Morocco development space into GVCs



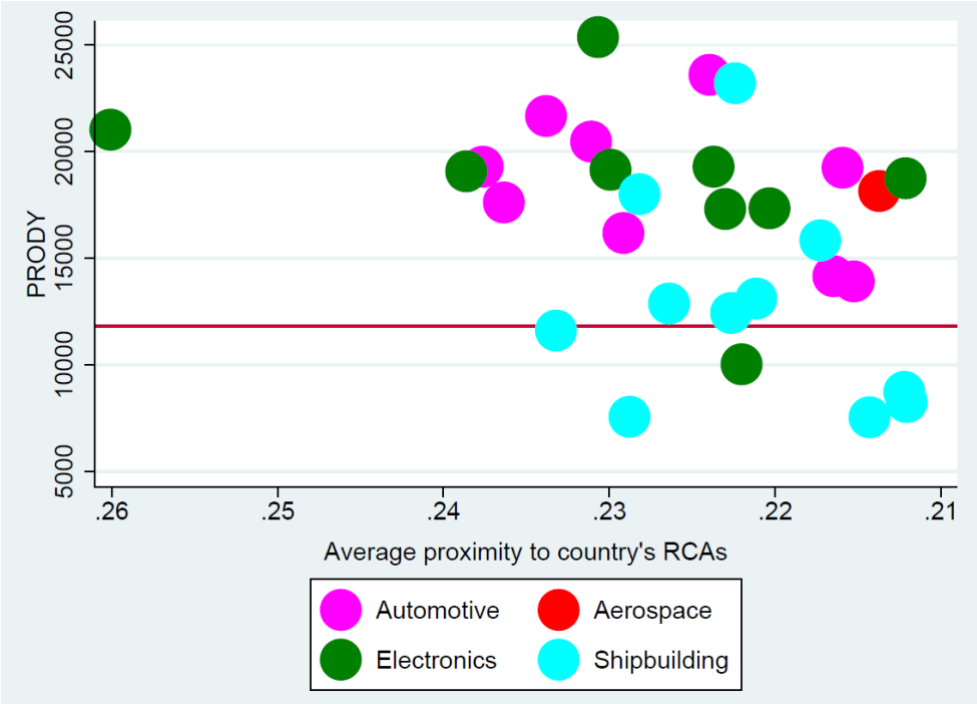
Notes: The red horizontal line identifies the country sophistication level, calculated as the EXPY Index.

Looking at the sophistication of the most related products, it is easy to notice that the large majority has a PRODY index larger than the country average, the so called EXPY index (Hausmann, Hwang, et al. 2007) (red horizontal line in the graph). This is true, on average, for all the three chains appearing in Morocco's development space, with exceptionally high values for the electronics chain. Measuring the EXPY index country average of sophistication, increasing integration in the aforementioned chain would considerably increase both the quality and quantity of the country's productive capacity.

In summary, Morocco's development into selected GVCs appears to be directed towards the shipbuilding and electronics GVCs. Indeed. these are the chains comprising the majority of the most related products. However, the possibilities for upgrading into the automotive chains exist and Morocco should pursue such an objective, since this is the chain that has the highest PI amongst those under consideration (Table 3). As far as sophistication is concerned, increasing participation in these chains would, in any case, allow the country to increase its EXPY index. If so, Morocco would have different solutions for improving its GVC performance, all of them being characterised by net profitability for the country.

Figure 5 reports the development space for Tunisia. The product with the highest average proximity is HS 853810 "Electrical boards, panels, etc, not equipped" from the electronics GVC, with a value of 0.26 and a PRODY, of about $21000, almost doubling the country's EXPY. Despite the high proximity of this good, the next related products exhibit much lower relatedness, with values lower than 0.24. These products, positioning in the 0.24- 0.22 range, belong to different chains: amongst a set of other electronics products, there is a rump of highly sophisticated automotive goods, such as HS 870839 "Brake system parts except linings for motor vehicles", HS 700711 "Safety glass (tempered) for vehicles, aircraft, etc", and HS 870892 "Mufflers and exhaust pipes for motor vehicles", with a PRODY index of around $20000. Also, in the shipbuilding chain, Tunisia has a set of quite closely related goods which reveal reduced sophistication, however, with respect to other chains' products. Interestingly, differently from Morocco, in the top 30 related goods, Tunisia also has a good from the aerospace chain, HS 401210 "Retreaded Tyres".

Figure 5: Tunisia development space into GVCs



Notes: The red horizontal line identifies the country sophistication level, calculated as the EXPY Index.

The results, just presented, allow the expectation of an improvement for Tunisian GVCs. Despite the majority of products being concentrated in the medium distance range (0.24-0.22), with HS 853810 as the only exception, the

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country has really good possibilities for increasing its participation in all the chains under consideration. Electronics and automotive appear the best solutions, both for reasons of proximity and sophistication which could encourage an increase in the respective PI of up to the 20%. Increasing participation in the shipbuilding chain should also be assessed: on one hand, it would allow the enlargement of its PI which, at the moment, is the lowest for the country; on the other hand, given the low sophistication of the related goods from this chain, devoting investment in other directions could be productive. Finally, there is different rationale for the aerospace chain: even if only one good is comprised in the top 30, devoting investment to in this chain could, initially, increase the already high PI, thus positioning Tunisia as a leading actor in the chain, and, secondly, it could allow the benefits arising from the aerospace chain's high sophistication to spread to the domestic economy.

Table 3 clearly reports that Egypt's GVC participation is the lowest for the area. Indeed. apart from a remarkable result in the shipbuilding chain, the country has a very low PI in the other chains being considered.

Looking at the country's development space (Figure 6), Egypt's perspectives appear to be less positive than those for Morocco and Tunisia. Indeed, their whole set of products has a lower average level of proximity, with almost two thirds of the top 30 related products showing an average proximity that is lower than 0.22.

The products with the highest level of average proximity are positioned in the range 0.24-0.23: HS 840999 "Parts for diesel and semi-diesel engines" and HS 730630 "Pipes etc nes, iron/steel welded nes,diameter <406.4m", both of them belonging to the shipbuilding chain, which is by far the most represented. Unfortunately, despite the relative high proximity, if we leave aside these two aforementioned goods, the average sophistication of the goods from this chain is just slightly above the country EXPY index. As far as other chains are concerned, there are also some automotive and electronics chains' products that are attainable by Egypt. Amongst them, those with the highest average proximity are HS 853080 "Electric signal, safety & traffic controls, nes" in the electronic chain and HS 700721 "Safety glass (laminated) for vehicles, aircraft, etc" in the automotive chain. Mirroring the shipbuilding chain, the lower values of the average proximity of these products is characterised by high values of PRODY. Finally, as Table 3 suggested, no aerospace goods appear in the top 30 related products.

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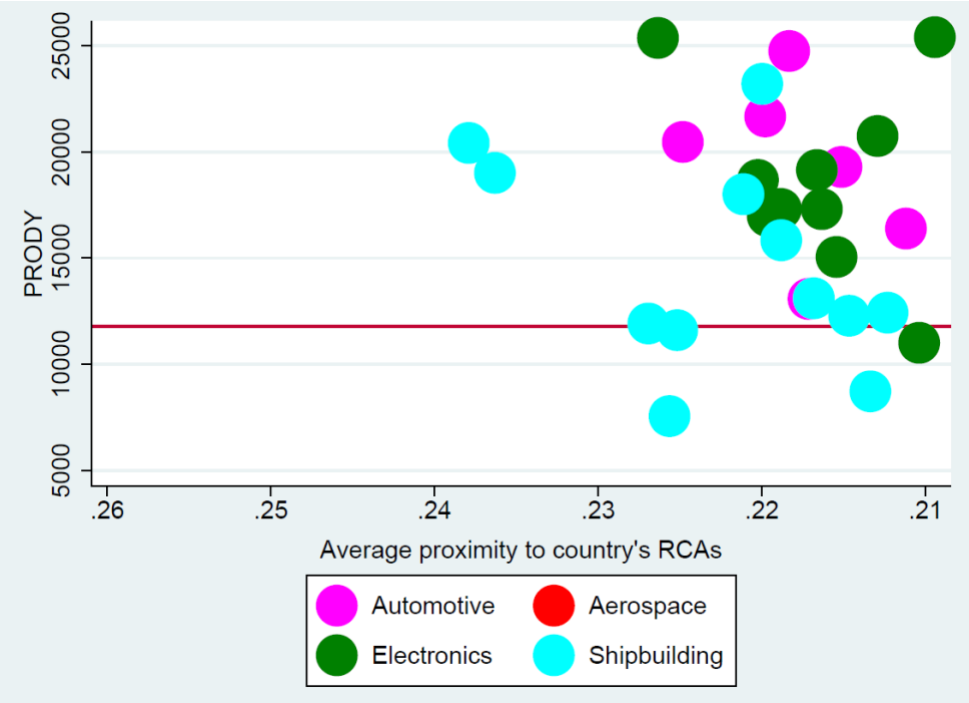
Figure 6: Egypt development space into GVCs



Notes: The red horizontal line identifies the country sophistication level, calculated as the EXPY Index.

In summary, Egyptian development space identifies challenges facing the country's improvement in GVCs. First, increasing the PI in the shipbuilding chain, the most straightforward objective, would allow the country to position itself as a leader in this sector but, at the same time, it would not encourage great improvement in the country's EXPY index. Second, investing in order to improve participation in the electronics and automotive chains, that would enable a substantial increase in the country's EXPY where the country currently has very low values of PI, seems to be constrained by their higher distance. For these reasons, empowering participation in the shipbuilding chain in the very near future and, meanwhile, trying to approach the other two chains could be the best, if not completely satisfactory, solution for the country. There appear to be very few possibilities for increasing participation in the aerospace chain.

Conclusions

The economic development of countries consists of a dynamic process, in which both purely economic and social factors have a prominent role. The

diversity of available capabilities, as well as the scope of their interactions, together shape country growth and performance. The EC approach, proposed by Hidalgo and Hausmann (2009), is routed along this idea and offers many interesting and recent tools. Recognising the simultaneous role of internationalisation, particularly in the way that integration into GVCs has in shaping a country's development, this paper tries to encompass these two strands of literature by examining GVC characteristics and country performance, using the approach of EC.

The analysis is conducted by using a broad set of advanced descriptive statistics, both in graphical and quantitative form. In addition, we propose a new EC coherent index to measure GVC participation at the country level. The main findings are as follows.

Selecting a specific group of GVCs - automotive, aerospace, electronics and shipbuilding - differences in terms of average sophistication and centrality emerge between them, with electronics excelling in both measures.

By focussing on the assessment of NA countries performances - Morocco, Tunisia and Egypt - the analysis shows qualitative and quantitative differences in terms of GVC integration, with Tunisia outperforming the other two countries in the selected chains. Moreover, an evaluation of these countries' development space relating to the selected GVCs is provided and possible country specific trajectories are discussed.

To conclude, the main contribution of the paper consists of an attempt to interact GVCs and EC studies: further research in this direction could offer interesting insights for the enlargement and the development of both strands of literature. We recognise there are limitations regarding the bounded scope of this analysis, both from the geographical and chain selection side, as well as regarding the structure of the proposed GVC participation index. We believe, however, that it is a starting point for future improvements, which could be extremely beneficial for the development literature.

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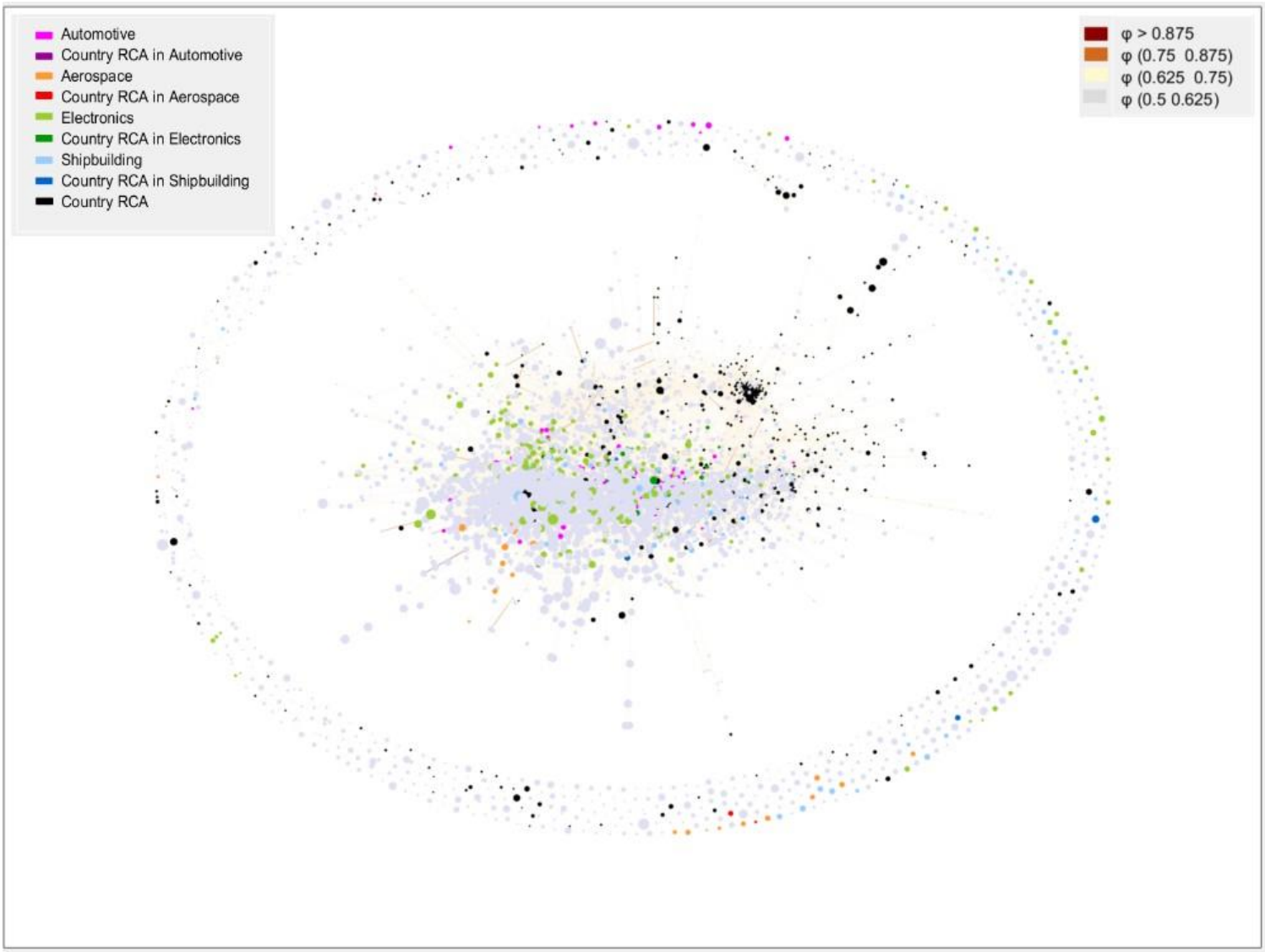
Appendix

Figure 7: Morocco positioning and GVC participation on the product space



Notes: Author's elaboration. Node size: PRODY. Node colour: belonging to one of the selected chains. Darker shades identifies GVCs products in which the country as a RCA. Black nodes denote country RCA out of the selected GVCs. Grey nodes do not belong to any of the selected chains nor to country RCA basket.

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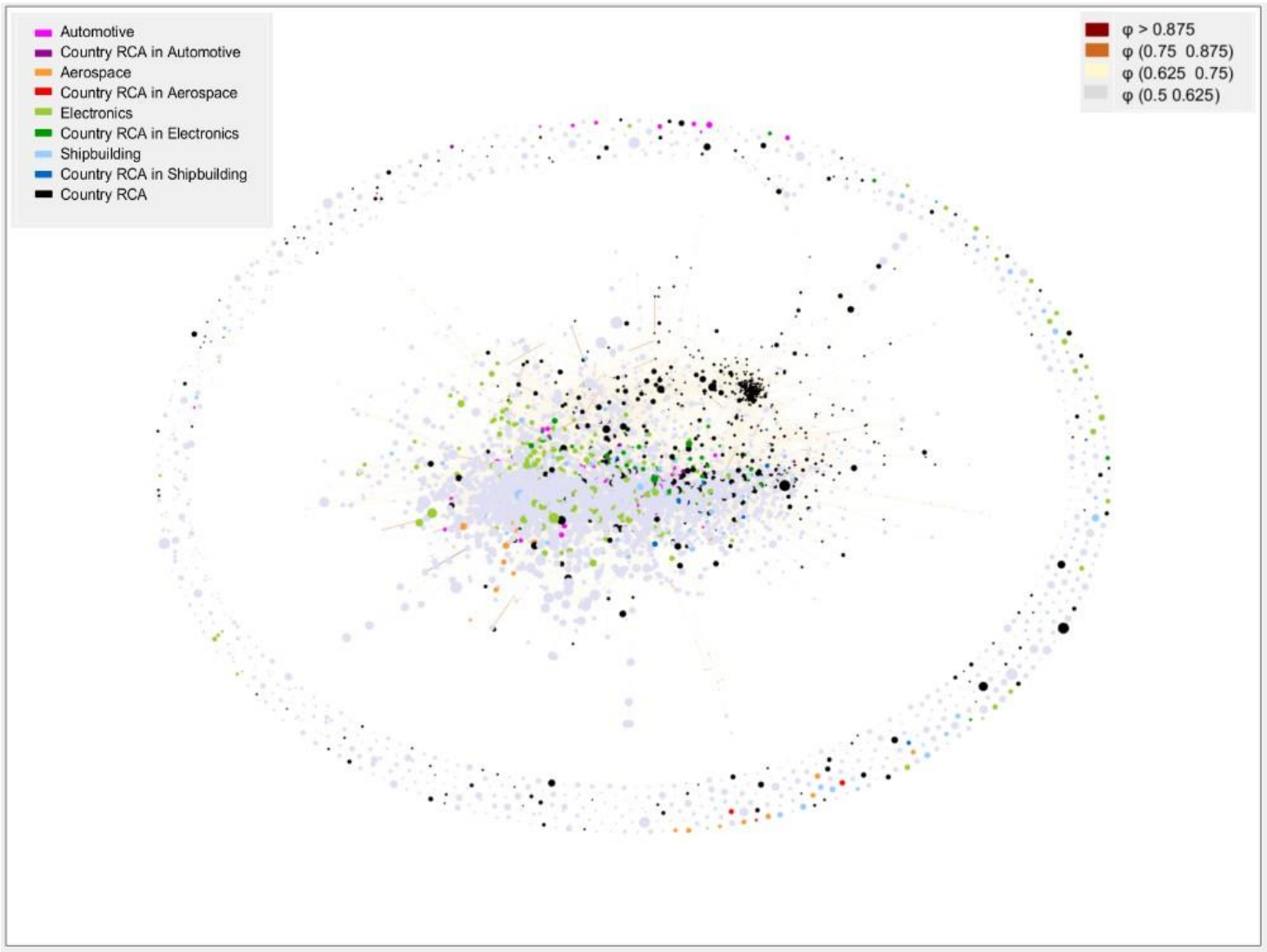
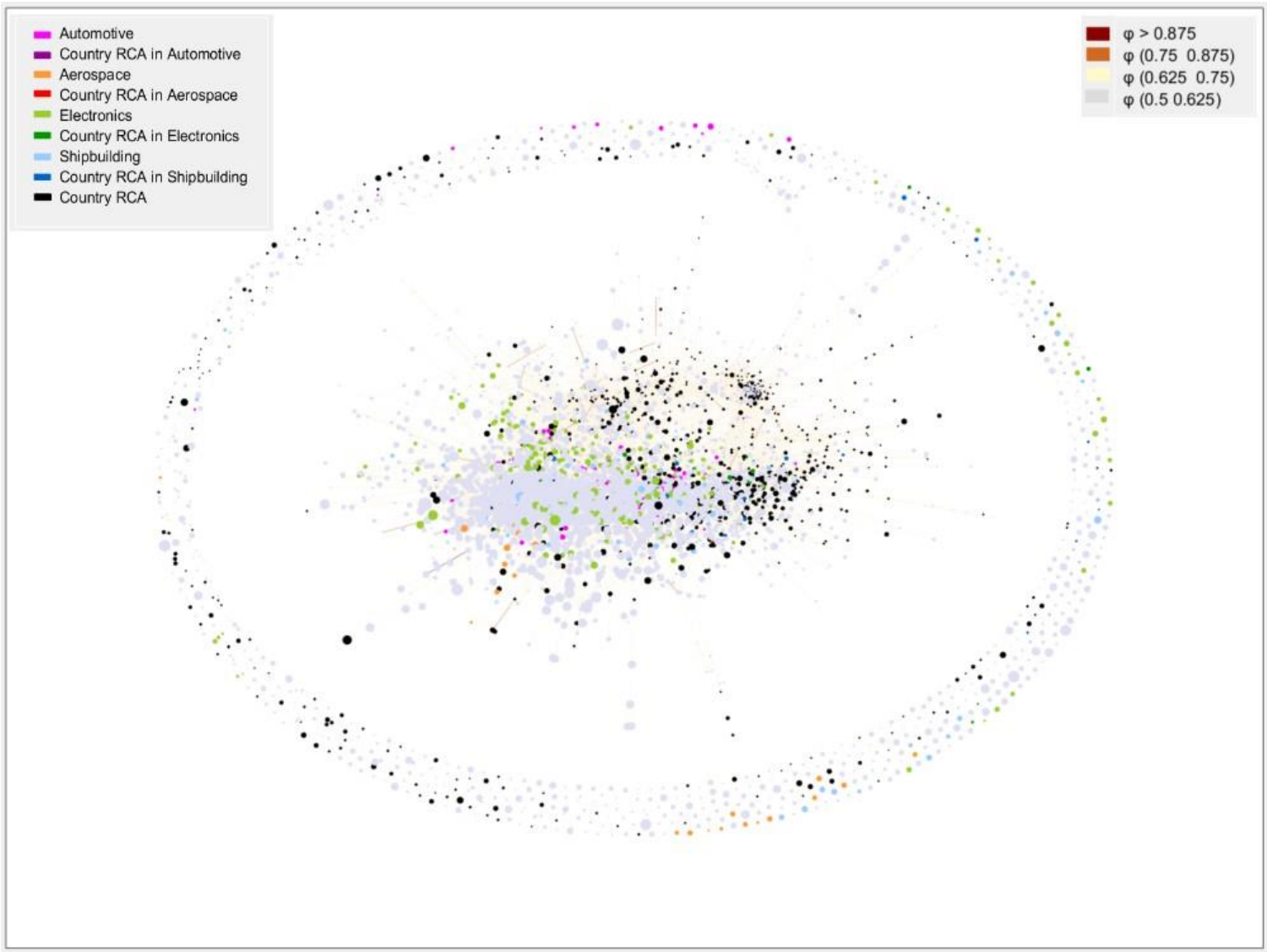
Figure 8: Tunisia positioning and GVC participation on the product space



Notes: Author's elaboration. Node size: PRODY. Node colour: belonging to one of the selected chains. Darker shades identifies GVCs products in which the country as a RCA. Black nodes denote country RCA out of the selected GVCs. Grey nodes do not belong to any of the selected chains nor to country RCA basket.

Figure 9: Egypt positioning and GVC participation on the product space



Notes: Author's elaboration. Node size: PRODY. Node colour: belonging to one of the selected chains. Darker shades identifies GVCs products in which the country as a RCA. Black nodes denote country RCA out of the selected GVCs. Grey nodes do not belong to any of the selected chains nor to country RCA basket.

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Table 4: Morocco top 30 related products

	HS Code	Product Description	GVC	PRODY ($)	Av. proximity
1	730630	Pipes etc nes, iron/steel welded nes,diameter <406.4m	Shipbuilding	19016.471	0.2550
2	853810	Electrical boards, panels, etc, not equipped	Electronics	21030.797	0.2523
3	721440	Bar/rod, iron or non-alloy steel, hot formed <0.25%C, nes	Shipbuilding	11922.298	0.2446
4	840999	Parts for diesel and semi-diesel engines	Shipbuilding	20424.266	0.2433
5	721711	Wire, iron or non-alloy steel, not plated or coated, <0.25%C	Shipbuilding	12801.557	0.2420
6	850432	Transformers electric, power capacity 1-16 KVA, nes	Electronics	17316.465	0.2396
7	721660	Sections, nes, iron or non-alloy steel, nfw than cold formed/finished	Shipbuilding	11606.913	0.2367
8	850300	Parts for electric motors and generators	Electronics	17189.941	0.2362
9	902890	Parts, accessories for gas, liquid, electricity meter	Electronics	16982.256	0.2324
10	721590	Bar/rod, iron or non-alloy steel, nes	Shipbuilding	7559.0229	0.2271
11	730660	Hollow pro les/tubes,iron/steel,non-circular, welded	Shipbuilding	12431.923	0.2268
12	940120	Seats, motor vehicles	Automotive	18219.996	0.2262
13	850422	Liquid dielectric transformers 650-10,000KVA	Electronics	18679.977	0.2246
14	721011	Flat rolled iron or non-alloy steel, coated with tin, w >600mm, t >0.5m	Shipbuilding	12876.497	0.2242
15	730490	Iron or steel tubes, pipes or hollow pro les, nes	Shipbuilding	18007.953	0.2236
16	721690	Angles/shapes/sections, iron or non-alloy steel, nes	Shipbuilding	15839.757	0.2223
17	730711	Pipe fittings of non-malleable cast iron	Shipbuilding	18603.342	0.2218
18	853720	Electrical control and distribution boards, > 1kV	Electronics	19096.693	0.2215
19	851290	Parts of cycle & vehicle light, signal, etc, equipment	Automotive	16392.576	0.2186
20	870899	Motor vehicle parts nes	Automotive	13080.942	0.2184
21	730690	Tube/pipe/hollow pro le, iron/steel,riveted/open sea	Shipbuilding	7536.271	0.2168
22	853649	Electrical relays for 60 - 1,000 volts	Electronics	21123.28	0.2163
23	850710	Lead-acid electric accumulators (vehicle)	Automotive	12556.96	0.2161
24	902830	Electricity supply, production and calibrating meters	Electronics	5332.99	0.2154
25	721230	Flat rolled iron or non-alloy steel, <600mm, coated with zinc, nes	Shipbuilding	23211.32	0.2150
26	853080	Electric signal, safety & traffic controls, nes	Electronics	25372.17	0.2145
27	721712	Wire, iron or non-alloy steel, plated or coated with zinc <0.25%C	Shipbuilding	5279.784	0.2140
28	721331	Hot rolled bar/rod, iron or non-alloy steel, coiled width <14mm, C<.25%	Shipbuilding	8251.904	0.2115
29	850164	AC generators, of an output > 750 kVA	Electronics	19148.87	0.2112
30	851690	Parts of electro-thermic apparatus, domestic, etc	Electronics	20616.17	0.2109

Table 5: Tunisia top 30 related products

	HS Code	Product Description	GVC	PRODY ($)	Av. Proximity
1	853810	Electrical boards, panels, etc, not equipped	Electronics	21030.797	0.2601
2	850490	Parts of electrical transformers and inductors	Electronics	19075.238	0.2386
3	870839	Brake system parts except linings for motor vehicles	Automotive	19293.17	0.2376
4	700711	Safety glass (tempered) for vehicles, aircraft, etc	Automotive	17615.869	0.2364
5	870892	Mufflers and exhaust pipes for motor vehicles	Automotive	21672.855	0.2338
6	721660	Sections, nes, iron or non-alloy steel, nfw than cold formed/ finished	Shipbuilding	11606.913	0.2332
7	700721	Safety glass (laminated) for vehicles, aircraft, etc	Automotive	20472.654	0.2311
8	853080	Electric signal, safety & traffic controls, nes	Electronics	25372.174	0.2307
9	850164	AC generators, of an output > 750 kVA	Electronics	19148.873	0.2299
10	851190	Parts of electrical ignition or starting equipment	Automotive	16183.183	0.2292
11	721590	Bar/rod, iron or non-alloy steel, nes	Shipbuilding	7559.0229	0.2288
12	730490	Iron or steel tubes, pipes or hollow pro les, nes	Shipbuilding	18007.953	0.2282
13	721011	Flat rolled iron or non-alloy steel, coated with tin, w >600mm, t >0.5m	Shipbuilding	12876.497	0.2264
14	870829	Parts and accessories of bodies nes for motor vehicles	Automotive	23603.852	0.2240
15	854620	Electrical insulators of ceramics	Electronics	19293.303	0.2237
16	850423	Liquid dielectric transformers > 10,000 KVA	Electronics	17309.982	0.2230
17	730660	Hollow pro les/tubes,iron/steel,non-circular, welded	Shipbuilding	12431.923	0.2227
18	721230	Flat rolled iron or non-alloy steel, <600mm, coated with zinc, nes	Shipbuilding	23211.32	0.2224
19	853225	Electric capacitors, fixed, paper/plastic dielectric	Electronics	10023.945	0.2220
20	721070	Flat rolled iron or non-alloy steel, painted/plastic coated,width >600mm	Shipbuilding	13109.096	0.2211
21	850990	Parts of domestic appliances with electric motor	Electronics	17341.84	0.2203
22	721690	Angles/shapes/sections, iron or non-alloy steel, nes	Shipbuilding	15839.76	0.2173
23	401110	Pneumatic tyres new of rubber for motor cars	Automotive	14156.44	0.2165
24	830230	Motor vehicle mountings, fittings, of base metal, nes	Automotive	19245.58	0.2159
25	870891	Radiators for motor vehicles	Automotive	13911.96	0.2153
26	730690	Tube/pipe/hollow pro le, iron/steel,riveted/open sea	Shipbuilding	7536.271	0.2143
27	401210	Retreaded tyres	Aerospace	18153.12	0.2137
28	720845	Hot rolled iron or non-alloy steel, at,width >600mm, t <3mm, nes	Shipbuilding	8726.391	0.2122
29	850434	Transformers electric, power capacity > 500 KVA, nes	Electronics	18751.31	0.2121
30	721331	Hot rolled bar/rod, iron or non-alloy steel, coiled width <14mm, C<.25%	Shipbuilding	8251.904	0.2121

Table 6: Egypt top 30 related products

	HS Code	Product Description	GVC	PRODY ($)	Av. proximity
1	840999	Parts for diesel and semi-diesel engines	Shipbuilding	20424.266	0.2379
2	730630	Pipes etc nes, iron/steel welded nes,diameter <406.4m	Shipbuilding	19016.471	0.2363
3	721440	Bar/rod, iron or non-alloy steel, hot formed <0.25%C, nes	Shipbuilding	11922.298	0.2269
4	853080	Electric signal, safety & tra c controls, nes	Electronics	25372.174	0.2263
5	721590	Bar/rod, iron or non-alloy steel, nes	Shipbuilding	7559.0229	0.2256
6	721660	Sections, nes, iron or non-alloy steel, nfw than cold formed/ finished	Shipbuilding	11606.913	0.2252
7	700721	Safety glass (laminated) for vehicles, aircraft, etc	Automotive	20472.654	0.2248
8	730490	Iron or steel tubes, pipes or hollow pro les, nes	Shipbuilding	18007.953	0.2211
9	940120	Seats, motor vehicles	Automotive	18219.996	0.2205
10	850422	Liquid dielectric transformers 650-10,000KVA	Electronics	18679.977	0.2202
11	721230	Flat rolled iron or non-alloy steel, <600mm, coated with zinc, nes	Shipbuilding	23211.32	0.2200
12	870892	Mufflers and exhaust pipes for motor vehicles	Automotive	21672.855	0.2198
13	902890	Parts, accessories for gas, liquid, electricity meter	Electronics	16982.256	0.2196
14	850300	Parts for electric motors and generators	Electronics	17189.941	0.2190
15	850432	Transformers electric, power capacity 1-16 KVA, nes	Electronics	17316.465	0.2188
16	721690	Angles/shapes/sections, iron or non-alloy steel, nes	Shipbuilding	15839.757	0.2188
17	870850	Drive axles with differential for motor vehicles	Automotive	24754.543	0.2183
18	870899	Motor vehicle parts nes	Automotive	13080.942	0.2171
19	721070	Flat rolled iron or non-alloy steel, painted/plastic coated,width >600mm	Shipbuilding	13109.096	0.2168
20	850164	AC generators, of an output > 750 kVA	Electronics	19148.873	0.2166
21	850423	Liquid dielectric transformers > 10,000 KVA	Electronics	17309.98	0.2163
22	853630	Electrical circuit protectors nes for < 1,000 volts	Electronics	15054.06	0.2154
23	870839	Brake system parts except linings for motor vehicles	Automotive	19293.17	0.2151
24	721540	Bar/rod, iron or non-alloy steel, cold formed/ finished, >0.6%C	Shipbuilding	12287.56	0.2147
25	720845	Hot rolled iron or non-alloy steel, at,width >600mm, t <3mm, nes	Shipbuilding	8726.391	0.2134
26	854790	Electrical insulating fittings except plastic/ceramic	Electronics	20751.69	0.2129
27	730660	Hollow pro les/tubes,iron/steel,non-circular, welded	Shipbuilding	12431.92	0.2123
28	851290	Parts of cycle & vehicle light, signal, etc equipment	Automotive	16392.58	0.2112
29	853620	Automatic circuit breakers for < 1,000 volts	Electronics	11012.77	0.2104
30	850590	Electro-magnets nes and parts of magnetic devices	Electronics	25407.06	0.2094

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