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Mapping the UK domestic and global value chains from a Brexit perspective

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H. Escaith [‡]

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Abstract: *This paper aims at offering background information for a sectoral analysis of the Brexit implications on the UK value chains. It analyses trade data through the specific angle of inter-industrial relationships and international supply chains, including employment implications. The paper benchmarks UK against other key G-20 countries for three specific industries that have a particular relevance from an inter-industrial perspective: Transport equipment, Chemicals and Electronics. In the process, a number of stylised facts are identified and several synthetic indicators are produced. Because a hard Brexit is expected to increase trade costs and affect prices, the paper estimates the impact of additional tariff and non-tariff trade costs on the competitiveness of these three sectors. Hopes that a devaluation of the Pound may compensate for higher trade costs must take into consideration that devaluation affects only the domestic share of the value-added, requiring larger exchange rate adjustment. In the case of Transport equipment, the required devaluation is around 30% if all tariff and non-tariff trade costs are passed to the producers.*

JEL codes: C43, C67, F14, F15, O50

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Mapping the UK domestic and global value chains from a Brexit perspective

H. Escaith, June 2018

1. Introduction

The trade dimension of Brexit has been extensively analysed by scholars and international experts. Probably because trade integration is an important aspect of modern economies, but also because, at the difference of the other political, social or economic dimensions which may have been the real drivers of the Brexit referendum, it is a sector where the quantitative analysts can easily find data and models. The present essay aims at contributing to this burgeoning literature from the descriptive side, in the hope to add to our understanding of UK's insertion in international trade.

More precisely, the objective is to produce a "background paper", exploring trade data through the specific angle of inter-industrial relationships and global value chains. To this aim, the analysis uses some recent analytical and statistical developments related to the measure of "trade in value-added". In the process, a number of stylised facts are identified and several synthetic indicators are produced that are expected to help in deepening the opinion and decision makers' understanding of the economic and social implications of trade in the modern UK context.

The paper presents a brief review of the literature related to the analysis of Brexit from a trade perspective. The review will be particularly brief for Global Value Chains (GVC) trade due to the reduced volume of literature published up to now on this specific subject. One of the reasons is that the relevant information is limited and/or difficult to comprehend using traditional analytics. As mentioned by De Backer and Flaig (2017) "The empirical evidence evaluating the potential impact of [the structural shifts affecting the world economy] largely lags behind [the theoretical debate], which makes these discussions somewhat speculative".

With this caveat in mind, the core of the analysis starts with a general review of UK's insertion in the global economy and her comparative advantages. The investigation, which uses traditional trade statistics as well as network and input-output analysis, covers both trade in goods and services as well as trade in tasks (or trade in value-added). Identifying the tasks embodied in UK's exports allows also to estimate the number of jobs created by exports of final and intermediate goods and services. After this general survey, the second substantive part is devoted to focus on a few sectors, selected for their relevance in global value chains (Transport equipment, Electronics and Chemicals). The sectoral analysis follows the same approach than before, applying trade and network analysis to traditional and value-added statistics. The database used to estimate the trade in value-indicators is the OECD-WTO *TiVA*, more specifically its recent 2012-2014 extension produced by OECD statisticians. When necessary, WIOD data are used to supplement *TiVA* information. The section includes a estimation of the impacts of Brexit's related trade costs on UK's export competitiveness. Conclusions synthesize the main results.

2. A review of the literature

The Brexit referendum has generated an enormous literature, in particular on its impacts on trade and welfare. Two kinds of empirical models have been used to estimate them. Bilateral flows are usually simulated through gravity equations, factoring-in the trade-creation effect of joining the EU (and therefore, the negative outcome of leaving it). The economic effects are usually estimated using Computable General Equilibrium models (CGE), either static or dynamic ones.

Most analysis that were published before or immediately after the referendum forecasted a very negative outcome unless the UK remained in the EU or was able to obtain some soft Brexit conditions from the EU negotiators. Under all exit scenarios, UK-EU trade declines and the drop is sharp in the case of a hard Brexit (the so-called “WTO option”). For some representative examples, see Dhingra et al. (2016), HM Treasury (2016), NIESR (2016; OECD (2016) or PWC (2016). Uncertainty deters investments in the short term and long-term effects are felt through reduced productivity and competitiveness. According to Dhingra et al. (2016), in the long run, the lower trade levels induced by Brexit will reduce productivity gains, increasing the welfare costs to 9.5% of GDP. Similar results are found by HM Treasury (2016).

There were only few exceptions to the economists’ consensus, one of them from Minford (2016) which led to welfare gains of 4%. Minford’s assumed that leaving the EU would reduce the negative effects of trade diversion induced by this trade agreement, allowing the UK to remove trade barriers and import from more efficient sources than the EU suppliers. Many observers expressed doubts about the potential gains related to correcting trade diversion. Indeed, a few years before, Freund and Ornelas’ (2010) review of the literature found that trade diversion is usually not a major concern.¹ On the other hand, while recognizing that RTAs did not lead to trade diversion as advocates of multilateralism may have feared, Baldwin (2011) had declared that “unilateralism is a key driver of trade opening” (p. 25) and that the “focus on tariff preferences is not appropriate for 21st century regionalism”. Yet, most Brexit analysts rejected the optimistic approach to unilateralism and the profession’s consensus was that Brexit would lead to a sharp reduction in trade and economic growth.

Intrigued by the apparent resilience of the UK economy after the referendum (the so-called “Brexit boom”), recent papers have reviewed the initial estimates produced by national and international organizations, spotting and correcting some issues in the models’ parametrization. The revisions corrected two sets of parameters. On purely econometric grounds, gravity equations seemed to overestimate the impact of entering a deep regional trade agreement (RTA) like the EU for a country like UK. Moreover, besides the value of the RTA parameters, there were doubts about the symmetry of the effects: while joining a RTA creates and/or deviates trade, leaving a RTA is expected to have less trade destruction effects due to the resilience of business linkages. Another set of revisions dealt with the dynamic effect of RTA membership on investment and productivity, one of the main channels of long term shock transmission.

These revisions lead in general to negative but smaller impacts. Gudgin et al. (2017), for example, estimate that the UK might lose 20% of its exports to the EU after 2019 in the case of a hard

¹ “The direst predictions about RTAs—that they will generate significant trade diversion and erode the world trade system—have not come to pass.”, p.4

Brexit, half the impact estimated by the Treasury and lower than estimated by the OECD or IMF. The impact on trade and FDI is likely to be offset through a lower exchange rate, resulting in UK's GDP to be only slightly lower by 2025 than on the base scenario of no Brexit. Coutts et al. (2018) estimate a smaller 12% loss of EU trade, while Kee and Nicita (2017) suggest an even smaller negative impact of 2%, once price elasticity of demand for UK products is taken into consideration.²

On the specific issue of value chains, few studies have dealt with the impact of Brexit on GVCs, even when the EU is, together with "Factory Asia" and NAFTA, one of the three main regional value chains in the world and the largest one for its economic size. Vickers and Khorana (2018) compile a series of contributions, with a specific emphasis on the implications for Commonwealth and developing countries. Curran (2017, 2018) focuses on the trade policy options and presents a review of the relevant literature. After a brief review of recent trends in the UK's destination and origin of value-added, Keane (2018) looks at Brexit implications on trade costs and GVC governance. From a more empirical side, Mulabdic et al. (2017) highlight the importance of deep RTAs when determining the unbundling of stages of production across borders. The existence of GVCs generates a demand for deeper forms of integration to align relevant national policies. They estimate that domestic value added in gross exports increased on average by as much as 35% in the UK case (p. 17) thanks to joining a deep RTA such as the EU. All or part of these gains are supposed to be put in jeopardy in the case of a hard Brexit. Leaving the EU would therefore severely disrupt UK GVCs.

Using a gravity model with sector-level input-output GVC linkages in production, Vandenbussche et al. (2017) find that both the UK and the EU27 would suffer substantial losses in the case of a hard Brexit. If the UK suffer more (4.5% of GDP and 500 thousand jobs) than the EU-27, EU-27 losses are also substantial (1.5% of GDP and 1.2 million jobs). Closer to the methodology used in our analysis, Chen et al. (2017) base their simulations on the inter-industry linkages measured through multi-regional input-output matrices and adopt a national and regional accounting approach. Their approach is somewhat extreme and better suited to modelling natural disasters; they set sectoral UK-EU trade linkages to zero, to reflect the complete disruption of regional GVCs.³ They show that UK's exposure to Brexit is some 4.6 times greater than that of the rest of other EU. The authors suggest that this extreme scenario may not represent an upper bound, and that the actual Brexit-related exposure risks facing the UK and its regions are even greater than those reported.

In summary, there is a large divergence among experts on the outcome of Brexit and, to quote Coutts et al. (2018), there is a high probability that some/most in the economic profession will get it wrong on this subject. In the next sections, we will try not to add to the confusion, reducing our ambition to highlighting a series of stylized facts relevant to GVC trade that may be useful for further research on the topic.

2 The authors show that the covariance between tariff and trade elasticity is negative for the EU. Higher tariffs are usually placed on less elastic products (such as transport equipment), meaning that a price increase of UK products due to the application of tariffs will not affect much EU's imports.

3 Extraction techniques are used in input-output analysis to estimate the importance of a sector "i". The procedure consists in deleting the i-th row and column of the input-output matrix A, then, using the Leontief model, to compute the reduced outputs obtained when i = 0 and compare with total output before extraction.

3. Mapping inter-industrial connections: UK insertion in the global economy and her revealed comparative advantages

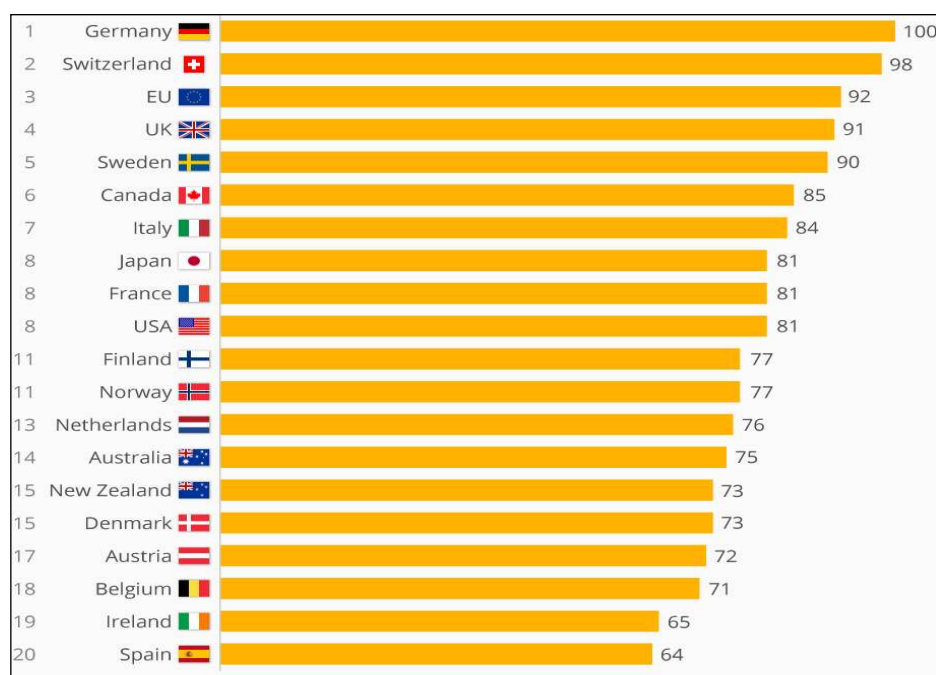
After revising UK's main trade indicators as provided by trade and balance of payments statistics, this chapter looks into UK's GVCs insertion into the inter-industrial World Trade Network. A third section will identify UK's Revealed Comparative Advantages from a trade in tasks perspective. The value-added decomposition is also used to spot employment implications and infer some trade costs and competitiveness effects.

A. UK Trade Profile

With exports estimated at \$409.4 billion in 2016 by the World Trade Organization (2.6% of world total) and imports value at \$635.8 billion (3.9% of world total), UK ranks 10th as exporter of goods and 4th as importer. While UK exhibits a large deficit in trade in goods, her situation in services is much better: UK ranks second as World exporter of commercial services with sales at \$323.7 bn (6.7% of World trade, according to WTO) and fifth as an importer (\$194.6 bn and 4.1%, respectively).

Despite her relatively low ranking as exporter of goods, products "Made in UK" enjoy a very good image with consumers, ranking third after German and Swiss ones (Figure 1). This qualitative dimension is important for our purpose: Inter-industrial trade along GVCs are Business to Business (B2B) relationships that are based on trust as much as on cost considerations.

Figure 1 World Most Respected « Made in », 2017



Note: Made-in-Country-Index 2017, based on a survey of 43,000 consumers in 52 countries

Source: Statista/Dalia Research

Table 1 provides a view of the main products traded by UK. In terms of geographical distribution, the EU trade partners absorbed 47% of UK's exports in 2016, followed by the USA (15%), Switzerland (5%) and China (4%). UK sources 52% of her imports from the EU, compared to 9% from China, another 9% from the USA and 4% from Switzerland (source: WTO).

Table 1 UK: Main exported and imported goods, 2016 (Millions of USD)

Agricultural Products,				Non-Agricultural Products,			
Top 5 exported products		Top 5 imported products		Top 5 exported products		Top 5 imported products	
HS2208 Alcohol of less than 80% volume	7 117	HS2204 Wine of fresh grapes	4 084	HS8703 Motor cars for transport of persons	41 288	HS7108 Gold	57 973
HS2106 Other food preparations	1 535	HS1602 Other prepared or preserved meat	2 422	HS3004 Medicaments in measured doses	21 997	HS8703 Motor cars for transport of persons	46 067
HS2309 Preparations of a kind used in animal feeding	1 282	HS1905 Bread, pastry, other bakers' wares	2 382	HS8411 Turbo-jets, turbo-propellers and ot.	18 852	HS3004 Medicaments in measured doses	18 852
HS1905 Bread, pastry, other bakers' wares	1 147	HS2106 Other food preparations	2 087	HS7108 Gold	15 743	HS8411 Turbo-jets, turbo-propellers and ot.	17 439
HS1806 Chocolate and other cocoa food	879	HS1806 Chocolate and other cocoa food	1 934	HS8803 Parts of goods 8801-8802	15 003	HS8708 Parts for motor vehicles 8701-8075	15 745

Source: WTO World Trade Profiles, 2017

Trade in services is UK's strength. This specialization is a positive point from a long-term perspective, as the World trade-in-services / GDP elasticity is expected to be higher for services than for merchandises (Escaith and Miroudot, 2015).⁴ As already observed for trade in goods, EU is more important for the UK as a source of imports than as an export market. Exports of commercial services in 2016 are concentrated in "Other services" with 76% of total: 44% are business services (other than finance and ICT), financial services arrive second with 29%, far ahead of ICT services (10%). Travel services (a close proxy of tourism) represent 12% of services exports and transport 11%. EU absorbs 37% of UK exports of services and the USA 25%. Imports of "Other services" weight 51%, travel 33% and transport 16%. UK sources 50% of her services imports from EU and 19% from the USA.

B. UK role in the World Trade Network

In this section, we use the inter-industrial trade flows reported in *TiVA* for 2014; these flows correspond to trade in processed and unprocessed goods as well as services used as inputs in the production process. For the time being, we focus only on the trade gross value (domestic plus foreign value-added contents) because we want to identify UK's role as a world trade platform. Two sets of indicators are relevant here: some based on economic weight, others on connections. Weight is probably more relevant when it comes to bilateral negotiations; in a more complex negotiation framework, strong connections allow for building alliances.

In order to simplify the analysis, we use 12 aggregated sectors (goods and services) based on the 34 industries included in *TiVA*:

⁴ The expected outcome is due to a long-term evolution of demand composition across sectors favouring services, due to non-homothetic demand effects (Engel's Law).

C01T05	Agriculture	C27T28	Metals
C10T14	Mining	C30T33	Electronics
C15T16	Agroindustry	C34T35	Vehicles
C17T19	Textiles	C50T64	Transport, communication and commerce
C20T22	Wood and Paper	C65T74	Business services
C23T26	Chemicals	C75T95	Health, education and administration

Even with such an aggregation, the resulting World Trade Network based on the 62 *TiVA* countries is dense and not easily decipherable (not shown in the paper). The following Table 2 and its associated graph (Figure 2) provide more analytical information on UK's role in the World Trade Network, considering all inter-industrial trade flows.

Table 2 UK and the Inter-Industrial World Trade Network: selected indicators, 2014

Sector	Eigen centrality	Weight indegree	Weight outdegree	Weight degree	PageRank	Betweenness centrality
Agriculture	0.653	13044	4571	17615	0.003238	0.00004
Mining	0.343	37315	36045	73361	0.001582	0.000075
Agroindustry	0.878	55634	19250	74885	0.004243	0.000004
Textiles	0.859	34314	11366	45681	0.004446	0.000008
Wood and Paper	0.653	20147	15159	35306	0.003991	0.000024
Chemicals	0.896	114647	96489	211136	0.003107	0.000007
Metals	0.728	40918	25928	66847	0.002792	0.000019
Electronics	0.832	72831	38808	111639	0.003608	0.000013
Vehicles	0.605	96128	69766	165895	0.005308	0.000034
Transport, communication and commerce	1.000	150009	132177	282186	0.003074	0.000001
Business services	0.770	101150	197708	298859	0.004673	0.000013
Health, education and administration	0.687	26733	28322	55056	0.006401	0.000015

Note: see Annex for a brief description of the network indicators.

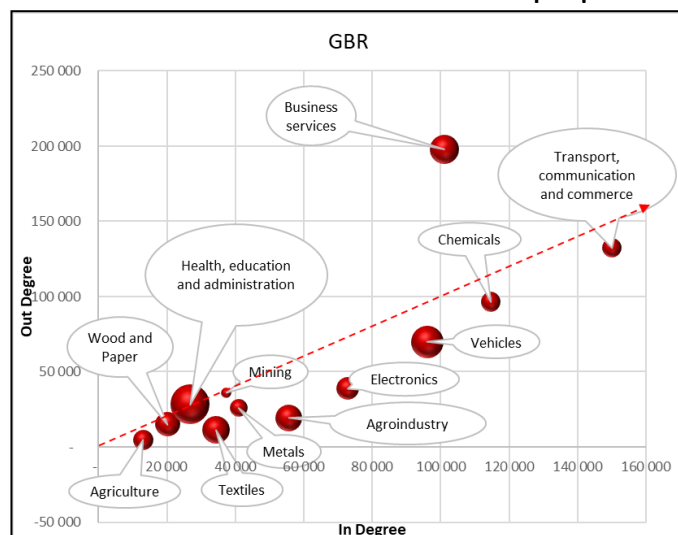
Source: Author's calculation based on *TiVA* data and Gephi software.

We can look, for example, at UK role as an exporter using the Outdegree score, obtained by weighting the arcs joining two nodes (countries) by the value of the export flows. According to this indicator, UK is strong in services exports (Business services or Transport, communication and commerce). As far as trade in goods is concerned, her main strength is in Chemicals. Typical of modern advanced economies, the sectors where UK is strong as an exporter are also where UK's role as an importer is the highest.⁵ This is in particular the case for Transport, communication and commerce, for Chemicals or for Business services. Figure 2 shows the positive correlation between In-Degree (role as importer) and the Out-Degree (role as exporter). Business services stands out, breaking with this pattern: While all other industries are more or less aligned along a straight line, Business services indicates a much higher ratio Out-Degree/In-Degree than other sectors, indicating a strong export-orientation. Actually, it is the only UK sector showing such a clear export orientation. Lastly, the figure shows also that the gross amount of trade is not a predictor of the role of an

⁵ This may not remain true if we use a more detailed disaggregation; remember that the analysis is performed at aggregated sectoral level, with only 12 categories of sectoral trade.

industry in the World network. PageRank (indicated by the size of the bubble in Figure 2) is high for Health, education and administration, where UK plays a specific role (especially for trade in education services) while her strategic role for Chemicals is reduced, despite her strong pharma and petrochemical industry.

Figure 2 UK industries from the World Trade Network perspective: selected indicators, 2014



Note: The size of the bubble represents the PageRank score of the industry. Dotted line: equal import export weights.

Source: Table 2.

In order to put each UK industry into a global perspective, the network indicators built in Table 2 were also constructed for all other *TiVA* trade partners. Selected comparators are presented in Annex Table 14: All EU28 members together, then Germany, France and Italy separated, all developed economies and all G20 members. In the following review, as in the previous graph, the focus is on UK's weight as exporter and importer, but also on her network centrality and influence (measured here also through PageRank⁶). A special chapter will be dedicated at analysing more in details a selection of industries that present a particular interest from a global value chain perspective.

When looking at **Agriculture** (C01T05), we see that the UK is relatively unconnected to the rest of the *TiVA* countries, as evidenced by the low weighted out-degree (through exports). If it is less connected than for the other three EU-G20 members, it remains that UK is still above the median score observed in the EU28 and the larger group of developed economies. Compared with the 19 G20 member countries, the picture is mixed: UK scores lower on her out-degree and weighted degree, but shows better centrality (e.g., PageRank). The latter is perhaps due to the over-representation of EU countries in the *TiVA* sample, as close trade ties with many other countries will influence centrality scores.⁷

⁶ The PageRank score for a trader is based on the probability that a trade flow, randomly chosen, will go through this country. The rank value indicates the importance and "centrality" of a particular country as a trade hub. This importance can be related to its economic size, but also to its close association with other influential trade partners.

⁷ Incidentally, this may show a trade diversion effect of EU membership for agricultural goods.

For **Mining** (C10T14), UK is a key player in the EU28 but not in the *TiVA* world, where she ranks only at the 9th position. On weights, UK dominates her G20 EU partners and is much above the median of EU and developed economies, thanks to strong exports connections (weighted out-degree). UK is even above the median of G20, a group with a large representation of commodity exporters (especially in the connections based on import weights). This said, UK's PageRank is low compared to EU-G20 and slightly below the G20 median. UK ranks only 18th in the list of *TiVA* reporters. A possible explanation (but a more thorough sectoral analysis would be required) is that UK's high score is mainly based on volumes rather than on the diversity and importance of its connections.

For **Agroindustries** (C15T16), UK is an important EU player in terms of imports (higher in-degree than EU-G20) but not as an exporter. She remains relatively well connected despite a low volume of exports: UK's PageRank score is higher than France or Italy and is the 5th one among the 61 *TiVA* reporters. UK remains also a key player when compared to the median score in the EU, the group of developed countries or the G20.

Textile (C17T19) shows similar features than Agroindustry: here too, UK is more important as an importer than as an exporter. Here too, the situation is opposite to what we found for Mining: While UK is less connected in terms of volumes than other EU-G20, her PageRank score compares positively with France, despite the higher French score on weighted connections (UK ranks 5th in the list of *TiVA* reporters on this indicator).

In **Wood and paper products** (C20T22), UK has no particular position in the trade network, arriving after Germany and France on most indicators (except weight out, where she is second). UK is 5th on both weighted connections and PageRank among all *TiVA* reporters.

Chemicals (C23T26) is the biggest sectoral GVC as far as its weight is concerned. UK ranks third amongst the EU-G20 members, lower than Germany but close to France. Among all *TiVA* reporters, UK ranks 5th on PageRank with a score of 0.0031, after the USA (0.0109), China (0.0059), Germany (0.0055) and France (0.0037).

Metal and metal products (C27T28) is another large GVC for its weight. UK isn't a large player here, ranking fourth in the EU-G20 group after Germany (which is dominating the sector in EU), Italy and France. UK is particularly weak as an exporter (weight-out), being below the G20 median score. Yet, on a PageRank basis, she remains well connected (better than France and Italy and above the G20 average). This shows that UK is relatively well connected with big players (in particular the USA) and will be inheriting some of their networking influence.⁸

Electronics (C30T33) is a sector where UK ranks third after Germany and France in the EU-G20 group, due to the weakness in her export links (weighting only the imports, UK is second and close to Germany while its export weight is less than a third of Germany's one). Yet, UK stands relatively well on the PageRank score, close to Germany. With a PageRank score of 0.00361, UK classifies fourth among the *TiVA* reporters, between Germany (0.0042) and Japan (0.00315) and much behind the USA (0.01263) and China (0.01251).

⁸ The USA is by far the main player in Metal and metal products with a score of 0.00975, while China, the second one, has a PageRank score of only 0.00705.

Vehicles and transport equipment (C34T35) presents a situation similar to Electronics: UK ranks third after Germany and France in the EU-G20 group, due to the weakness in her export links. Weighting only the imports, UK would be second after Germany, but her export weight is less than a third of Germany's. Here also, UK ranks better on its PageRank score and is second to Germany: With a score of 0.00531, she ranks fourth among *TiVA* reporters, after USA (0.01363), Germany (0.00667), Canada (0.00532), and before China (0.00464) and France (0.00458). One hypothesis, which remains to be checked, is that, like Canada, UK benefits here from its closer trade relationship with the USA.

Quite surprisingly, the UK, while being a large exporter of services, is not a dominant player for services of **transportation, communication and trade** (C50T64). It is in particular the case when looking at exports connections, which are lower than its import-connection at the difference of France and Italy.

At the contrary, **Business services** (C65T74) is a sector where UK shows its strength, especially on export-weighted connections where she dominates all other EU-G20 partners. On the import side, UK ranks second to Germany, which may explain why she is also second on the PageRank score. Indeed, while UK ranks second only to the USA on the basis of weighted connections, she classifies third after Germany when network centrality (i.e., PageRank) is concerned.

Health, education and other social services (C75T95) is the other strength of UK services exports. The high score is due, among other things, to the exports of Education services. Nevertheless, the import weights are also the highest in the EU-G20 subgroup, indicating an intense exchange in both directions. UK is second after the USA in terms of weight (and almost second at par with Germany on PageRank).⁹

C. *Synthetizing UK GVC trade through Exploratory Data Analysis*

The section applies Exploratory Data Analysis (EDA) on network indicators to isolate and identify most relevant patterns emerging from the World Trade Network, with a special emphasis on the role of the UK in this Network. We look at “the big picture” using gross trade flow to analyse three categories of goods closely related to industrial production and global value chains: Investment and intermediate goods, that are closely related to the supply side, and final consumers’ goods, which are the end-result of the value chain. We analyse separately a fourth category of goods, transport equipment (final goods and parts). This category includes goods that are both final consumers’ goods (e.g., cars and motorcycle) or investment goods (lorries, trains, aeroplanes...). An important caveat is that the UN COMTRADE database used here covers only goods and excludes trade in services, where UK has shown comparative advantages.

1. *Exploratory Data Analysis on Network Indicators*

Network analysis produces a number of indicators that are often closely correlated. Analysing the World Trade Network defined by the UN COMTRADE database produces a 217 x 44 table (217 trade partners and 36 indicators per country): Understanding the “big picture” out of almost ten thousand indicators is almost impossible. Multidimensional Exploratory Data Analysis is particularly

⁹ Interestingly, India ranks third on the criteria of exports.

well suited to identify patterns in the data, reducing the size of the problem to a few significative “illustrative” factors.

After reviewing the data and their correlations, we applied Principal Component Analysis (PCA) to a series of quantitative network indicators computed on four categories of goods selected using the BEC classification: Final goods for consumption, Transport equipment and parts, final goods for investment (capital goods excluding transport equipment) and Processed Intermediate Goods (goods used as inputs by industry, excluding unprocessed commodities). As mentioned, these four categories of goods are particularly relevant for analysing global value chains.

The 11 network indicators retained were the following: two Indegree and two Outdegree indicator (weighted or not by trade flows); Eccentricity; Closeness; Harmonic Closeness Centrality; Betweenness Centrality; Pagerank; Clustering and Eigen Centrality.¹⁰ It should be kept in mind that the role of a country in the World Trade Network is based on its activity as exporter but also as importer. If the economic weight of a country is definitely important, the geographical distribution of its trade partners (clustered into a few ones or, at the contrary, diversified) is also determining its role in the network.

2. *Network score and ranking according to the whole World Trade Network*

When applying PCA to the whole network database (including results for the four groups of goods), the first two principal components presented in Figure 3 capture 80% of the total variance (F1: 69% and F2: 11%). This is encouraging as 80% of the “information” (variance) can be reproduced using only two dimensions. Nevertheless, some other interesting features can be identified when looking beyond these two principal components.

The first component (horizontal axis) captures by itself 69% of the “information” contained in the data. *Prima facie*, F1 appears to rank countries according to the value of their total trade, the largest economies being on the right side of the graph. A closer look show that it is not exactly the case: F1 privileges more the number of connections than the sum of their value in monetary term. In particular, weighted degrees (connections weighted by the value of the trade flows) are less correlated than unweighted degrees. Similarly, we find a negative correlation of F1 with the clustering indicator: on the left side of the graph, we can expect to find local or regional players, while on the right side will appear the global players.

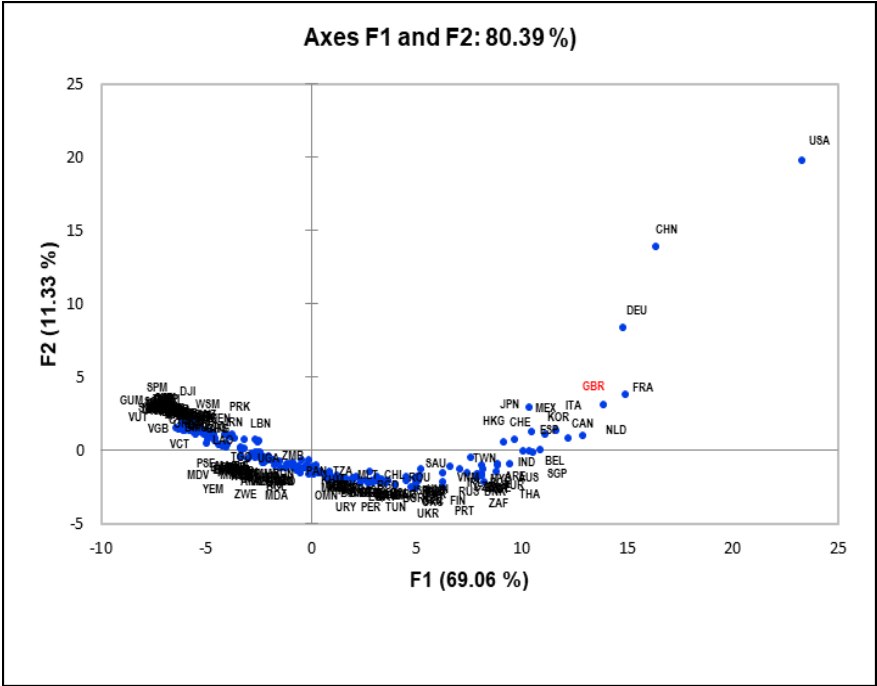
F2 weights 11% of the total variance and is positively correlated with weights and betweenness. Large players are therefore expected to be on the positive side of the vertical axis. But this is not the only criteria. Actually, the axis is also positively correlated with trade in capital goods. So, large player but specialising in consumer or intermediate goods will remain closer to the lower positive part of the axis.

Most countries are arranged in a U, with three countries standing out: Germany, China and the USA as frontrunner. According to this combination of variables, UK is part of the pack of followers,

¹⁰ See Annex for a brief description of these network indicators.

but is positioned on its front position, just after France.¹¹ A first conclusion would be that while not a “special case” (there is no an English exception as far as trade in goods is concerned), the UK is in the Top5 of most relevant players in the trade in goods network.

Figure 3 Principal Component Analysis on four groups of goods, 2015



Source: Author’s elaboration on the basis of Comtrade data.

PCA can be used to construct a synthetic index using the “scores” of each country on the most relevant principal components. Here, we use the first three components, representing 87% of the total information contained in the sample. Each score on a component is weighted by the percentage of total variance explained by the component. An index, ranging from 0 to 100, is derived from those scores (see summary Table 3 at the end of this section).

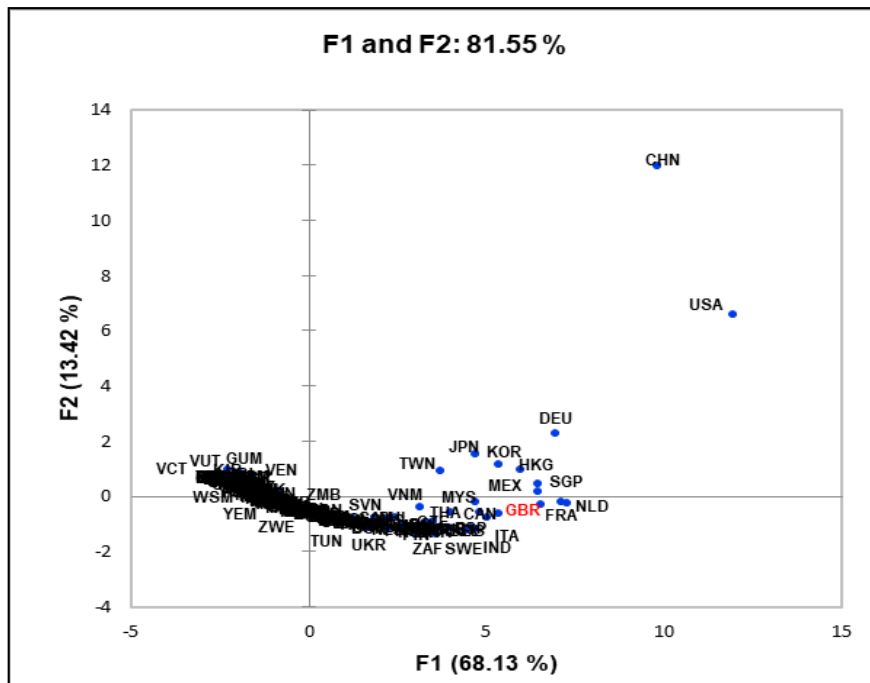
Rankings should be taken with due care when scores are adjacent: a small change in the analysis (dropping or adding variables or countries) may change the results. For example, a ranking based on total trade aggregating all categories of goods except fuels (Figure 3) puts the UK in a 5th position. But the distance between the USA, China and Germany is large from the other group of front runners (France, UK, Japan, etc) which are neck and neck and should be considered as part of the same cluster. In the following sections, we will look more in details at UK’s situation according to each individual group of goods.

11 Further transformation (Varimax rotation) would show that Japan is not part of the “pack” and stands-out —albeit less than the three leaders—due to her role in the capital goods sub-network. When taking into consideration the third principal component (6% of total variance), the leading role of China is reduced due to her relatively lower profile as exporter of transport equipment and the lower geographical distribution of her exports of capital goods.

a) Score and ranking for capital goods

The PCA on network indicators for trade in capital goods results in two principal factors explaining more than 80% of total variance (Figure 4). The main (horizontal) axis (68% of variance) is driven by connectedness and the geographical distribution of trade, while the second factor (13% of variance) is more correlated with the economic weight of the traders. China and the USA stand-out in this context, Germany being only distant third player. The UK is not part of the front-runners, even if she remains close to them. On the basis of her score, she ranks only 8th (see summary Table 3). Actually, the largest European economies are confronted with the competition of Asian traders.

Figure 4 Principal Component Analysis on capital goods, 2015

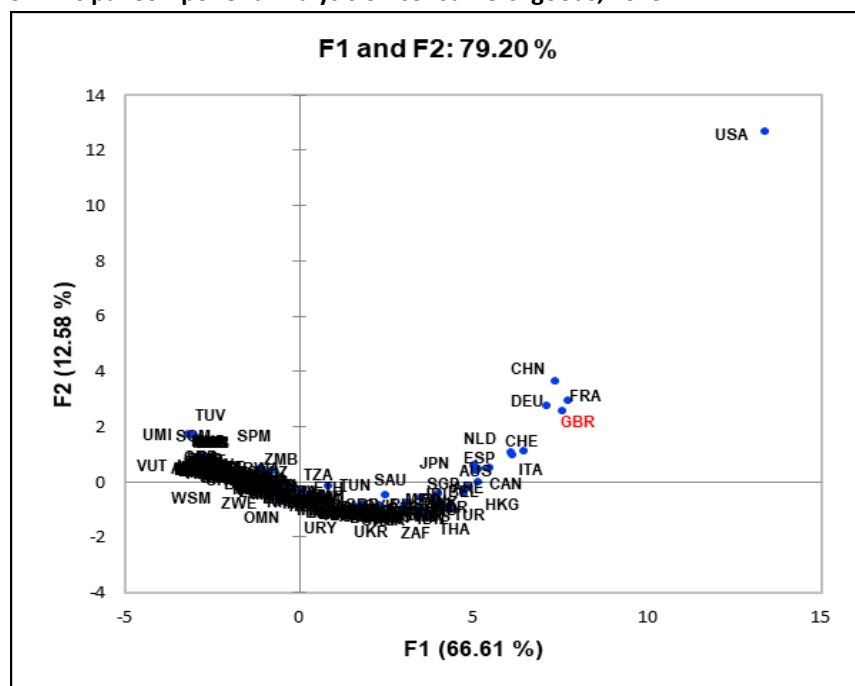


Source: see Figure 3.

b) Score and ranking for consumers' goods

Again, we find that the first two principal components explain about 80% of the total variance of the indicators related to the World Trade Network in consumer goods. The first factor on the horizontal axis of Figure 5 captures 67% of the information and is closely associated with the geographical connectiveness of the country and its economic weight as an importer. At the contrary, F2 (13% of the variance) is almost entirely driven by the weight of the countries as importer and exporter. On these criteria, the USA stand-out as an outlier, with China, Germany France and the UK clustered in a small group of front-runners, followed by the rest of the countries. When computing a score based on the first three principal components, UK ranks 3rd (see Table 3).

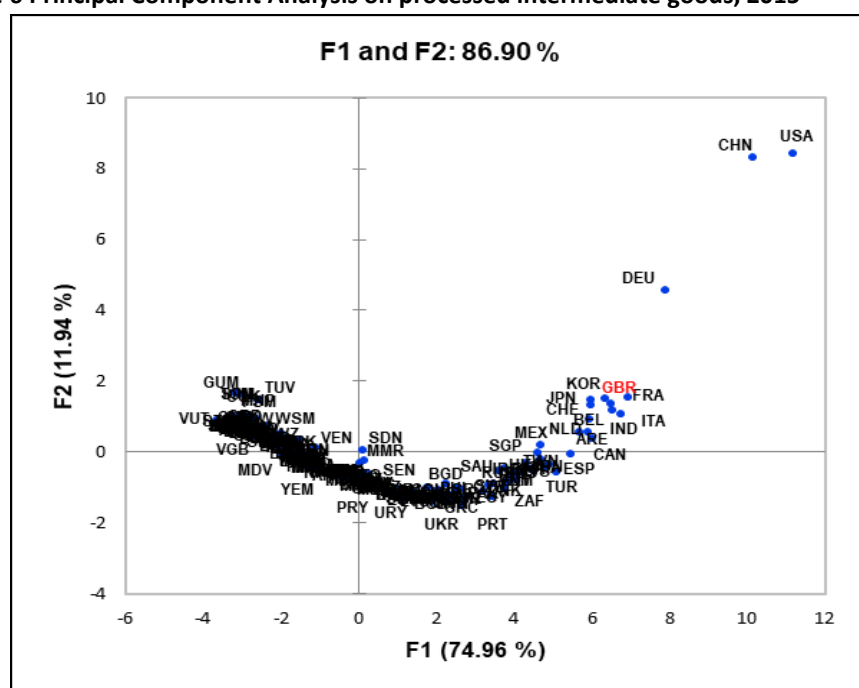
Figure 5 Principal Component Analysis on consumers' goods, 2015



Source: see Figure 3.

c) Score and ranking on processed intermediate goods

Figure 6 Principal Component Analysis on processed intermediate goods, 2015



Source: see Figure 3.

The patterns observed with processed intermediate goods for industry (Figure 6) is similar to what was obtained when considering all groups of goods. The two first principal components explain

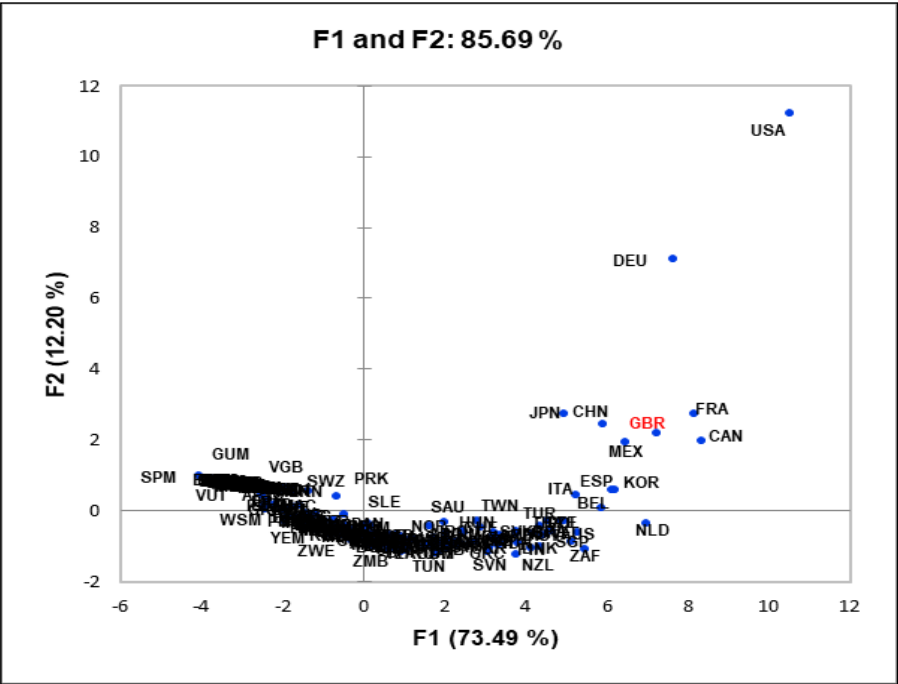
a large proportion of the total (87%). F1 (75% of variance) organises the countries according to their central role in the network and the geographical diversification of their trade partners. F2 gives more weight on the economic size of the nodes (the value of their imports and exports). On these criteria, China and the USA are two outstanding traders, followed by Germany. The UK ranks 6th when computing her score on the basis of the first three principal component and is among the front runners of the group of other countries (see Table 3).

d) Score and ranking according to transport equipment

The last graph (transport equipment, Figure 7) is organised according to the same logic: two first principal components explain a large proportion of the total (86%), with F1 (73% of variance) ranking countries according to their central role in the network and the geographical diversification of their trade partners while F2 privileges the economic size of the countries as measured by the value of their trade flows. But, at the difference of intermediate goods, China is not singled out as a leader: The USA remains alone in pole position, followed by Germany. Based on her score on the composite index, the UK is well placed in the Top-5 of the rest of countries (Table 3) and belongs to the sub-group of 11 countries that emerge from the rest of the pack (Figure 7).

Indeed, this sector, together with capital goods is probably the most demanding in terms of technology, thus only a few countries can belong to the group of leaders. This explains the existence of a sub-group of second-rank leaders between the front-runners and the rest of the pack.

Figure 7 Principal Component Analysis on transport equipment and parts, 2015



Source: see Figure 3.

Table 3 summarizes the results obtained when computing the score of each country for each one of the four categories of goods. When considering transport equipment, UK ranked 5th. UK does better (3rd) for consumers’ goods and worse for processed intermediate goods (6th) and capital goods, other than transport equipment (8th). Overall, UK ranked 5th when considering all categories.

Note that these rankings are contingent to the variables included in the analysis and the size of the sample. Therefore, small differences in scores are not statistically significant. For example, it is safe to consider that Mexico, Singapore, UK and Hong Kong share the same rank for capital goods and India, UK, Italy and Korea for intermediate goods.

Table 3 Summary Top 10 network scores on each groups of goods, 2015

Capital goods			Intermediate goods ^a			Consumers' goods ^a			Transport goods			All goods ^a		
ISO3	Score	Index	ISO3	Score	Index	ISO3	Score	Index	ISO3	Score	Index	ISO3	Score	Index
USA	10.4	100.0	USA	10.2	100.0	USA	12.4	100.0	USA	9.3	100.0	USA	21.6	100.0
CHN	9.3	91.6	CHN	9.4	93.8	FRA	6.4	58.9	DEU	6.8	79.2	CHN	14.8	74.4
DEU	5.7	61.9	DEU	7.0	75.5	GBR	6.2	57.8	CAN	6.6	77.9	DEU	13.0	67.5
NLD	5.6	61.5	FRA	5.8	66.2	DEU	5.8	55.1	FRA	6.6	77.7	FRA	12.5	65.8
FRA	5.5	60.4	IND	5.6	64.5	CHN	5.6	54.2	GBR	5.8	71.7	GBR	11.6	62.1
MEX	5.1	57.1	GBR	5.4	63.3	CHE	5.0	50.0	NLD	5.3	67.6	NLD	10.5	58.0
SGP	5.0	56.5	ITA	5.4	63.3	NLD	4.8	48.2	MEX	5.2	66.6	CAN	9.9	55.7
GBR	5.0	56.4	KOR	5.3	62.6	ITA	4.7	47.8	CHN	4.9	64.5	ITA	9.4	54.0
HKG	4.8	54.6	JPN	5.0	60.2	ESP	4.2	44.2	KOR	4.9	64.2	KOR	8.9	52.3
KOR	4.2	50.2	CHE	5.0	60.1	HKG	4.0	42.8	ESP	4.8	63.6	ESP	8.6	51.0

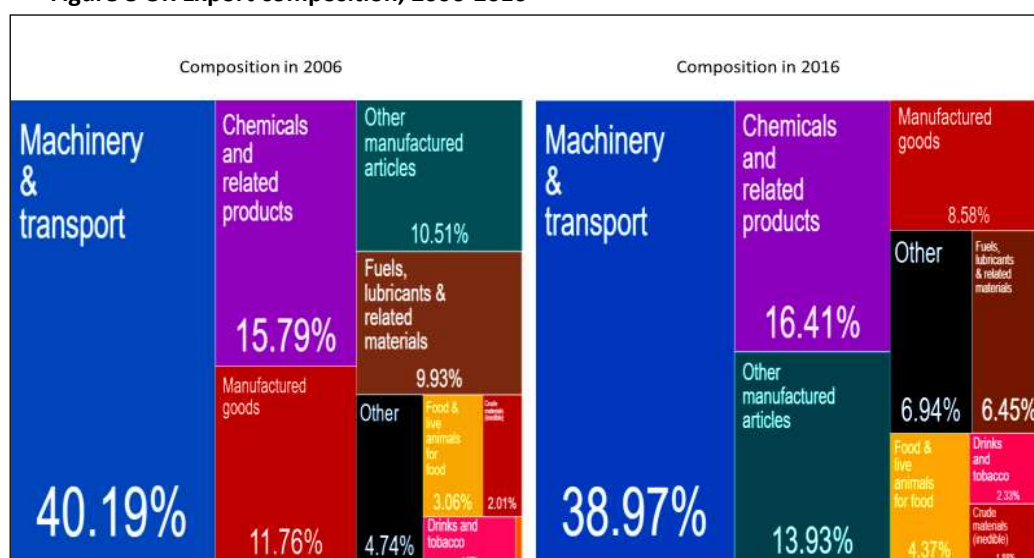
Note: Score based on the countries position according to the first three principal components calculated for each group of goods and the related index ranging from 0 to 100. a/ Except oil and fuels.

Source: Author's elaboration on the basis of Comtrade data.

D. UK's revealed comparative advantages from a GVC perspective

After characterising UK trade from the aggregated perspective of the basic economic classification, this section looks at more detailed product group. Over the past 10 years, the composition of UK's exports of merchandises didn't change much, except for a lower share of fuels, largely due to the decline in oil prices after 2011 (Figure 8).

Figure 8 UK Export composition, 2006-2016

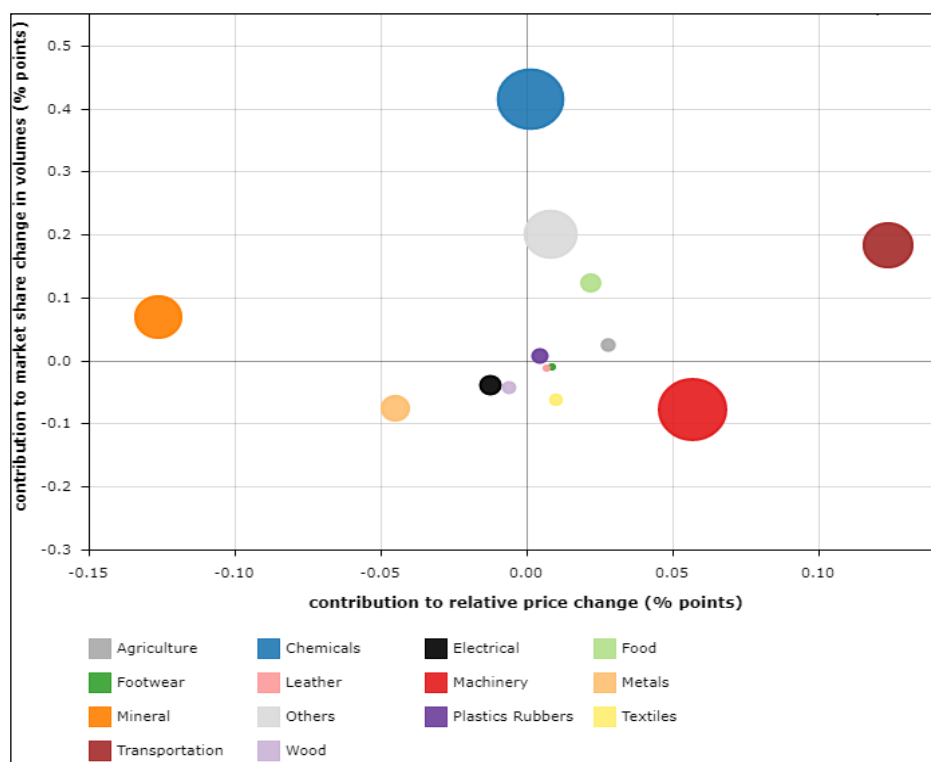


Notes: Based on SITC4 trade data

Source: Atlas of Economic Complexity, Harvard Centre for International Development.

A closer look (Figure 9) indicates that the aggregate Machinery and Transport is composed of two sub-sectors that followed different paths. Transport equipment did well, thanks to a mix of increased volume in terms of market share and relative price. The good orientation of Transport equipment is largely due to road vehicles: it represented 8.6% of exports in 2006 and 12.1% in 2016. Machinery, which excludes electrical and electronics and was not included as such in our *TiVA* review, is also a heavily traded group of products. It gained in prices but lost in terms of market share (we saw in the previous section that UK ranks only 8th on capital goods). The most dynamic group of products from 2006 to mid-2016 was Chemicals, one of the strongest UK good-producing sectors.

Figure 9 Product Mix and Sector Specialization, 2006-2016



Notes: The products are classified according to the Harmonized System 1996 and do not correspond to the industrial sectors used in *TiVA*. The size of the bubbles (weight) is equal to a country's sector specialization. Source: World Bank "Measuring Export Competitiveness".

- ***Revealed Comparative Advantages and Product-Space from a Trade Perspective***

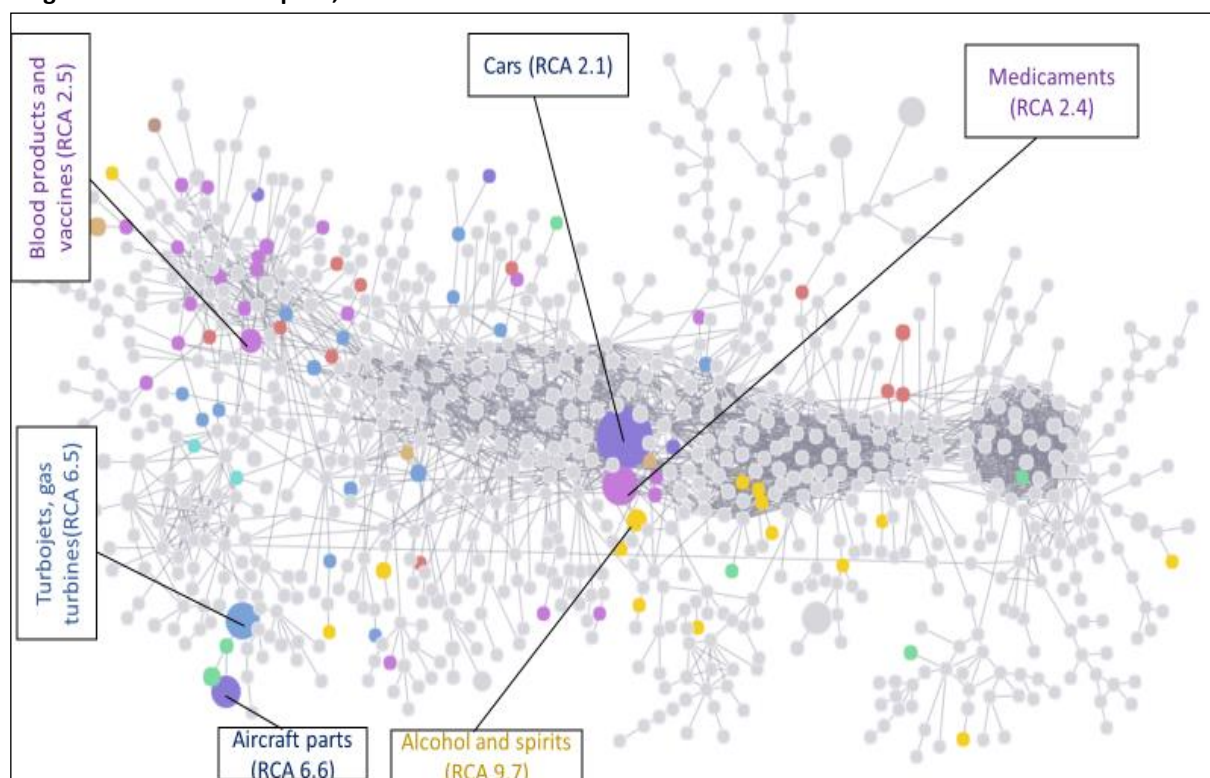
Figure 10 plots UK's exports from a product-space perspective. It shows the connectedness between products, based on the similarities of revealed comparative advantages (RCA) required to produce them, itself calculated as a correlation between these exports across all countries.¹² For example, car production (which has a RCA of 2, meaning that UK has a strong comparative advantage in this product) is closely associated with the following products: Springs and leaves for springs; Other lifting, handling, loading or unloading machinery; Other articles of vulcanized rubber other than hard

¹² RCA is called 'revealed' because the calculation of comparative advantages is based on trade statistics: if a country has a comparative advantage in a given product, it will specialize in exporting it. RCA=1 indicates a neutral position (the country's export specialization corresponds to the weight of this product in world trade); scores higher/lower than 1 indicate an advantage/disadvantage in exporting the product.

rubber; Parts and accessories of the motor vehicles: Safety glass, consisting of toughened (tempered) or laminated glass. When an exporter has a comparative advantage in one of these products, this competitiveness can (relatively) easily be transferred to the other related products.¹³

Besides the particular strength of UK in exporting alcohol and spirits (with an RCA close to 10), the graph identifies two strong clusters: one articulated on car, aircrafts and turbines (transport and related machinery), the other on medicaments and chemical products.

Figure 10 UK Product space, 2016



Notes: The product space (here at HS4 classification) depicts the connectedness between products, based on the similarities of endowments required to produce them. Revealed Comparative Advantage (RCA) compares the share of a product in the country's exports with the weight of this product in world trade. Coloured nodes are products for which UK's RCA is higher than 2.

Source: Atlas of Economic Complexity, Harvard Centre for International Development.

- **Revealed Comparative Advantages from a Trade in Value-Added Perspective**

In a world where industrial production is geographically fragmented, the product-space based on gross trade statistics may be strongly biased. An exporter specialising in the final stages of production (e.g., assembly) will appear as exporting a set of very sophisticated products, even if most of the value-added comes from upstream industries located outside the country. When analysing trade from a GVC perspective, it is therefore necessary to look at trade in "tasks" rather than trade in

¹³ Product-space is based on a statistical association (correlation) often based on similar know-how and resources endowments (in the UK case, cars and aircraft exports). It should not be confounded with the notion of value chains, where intermediate products are linked through a production function (for example, the barley required to produce whisky and the glass bottles used to package it).

goods. The OECD-WTO *TiVA* database is particularly suited for this purpose as it allows to trace the origin (sectoral and geographic) of the value added embodied into the trade goods and services.¹⁴

The picture provided by trade in value-added as estimated in Table 4 differs in several ways from the patterns observed in Figure 10. We look now at the sectoral (good but also services) domestic value-added directly or indirectly embodied in trade, instead of looking at the gross value of merchandises as recorded by customs administrations and official trade statistics. Moreover, the RCA is not calculated in reference to all World trade partners, but only against the other developed G20 members (Australia, Canada, France, Germany, Italy, Japan, United Kingdom and United States). It is principally within this group that UK has to compete, even if some “emerging economies” have indeed attained a high level of industrial development.¹⁵

Table 4 Revealed Comparative Advantages in Tasks, Developed G20 Countries (2012-2014 average)

	United Kingdom	Australia	Canada	France	Germany	Italy	Japan	United States
C01T05: Agriculture, hunting, forestry and fishing	0.31	2.43	2.21	1.49	0.44	1.03	0.24	1.22
C10T41: Industry (Mining, Manufactures and Utilities)	0.77	1.13	1.22	0.72	1.20	0.98	1.14	0.92
C15T37: Total Manufactures	0.73	0.36	0.76	0.81	1.33	1.10	1.32	0.95
C20T22: Wood, paper, paper products, printing and publishing	0.84	0.52	1.73	0.67	0.99	0.77	0.79	1.21
C23T26: Chemicals and non-metallic mineral products	0.86	0.36	0.66	0.88	1.16	0.86	1.19	1.13
C27T28: Basic metals and fabricated metal products	0.53	0.62	0.98	0.96	1.29	1.57	1.57	0.67
C30T33: Electrical and optical equipment	0.67	0.14	0.29	0.53	1.31	0.79	1.93	1.06
C34T35: Transport equipment	0.73	0.15	0.81	0.82	1.79	0.48	1.54	0.76
C45T95: Total Services including Construction activities	1.19	0.86	0.80	1.19	0.88	1.02	0.93	1.05
C50T95: Total Services	1.18	0.84	0.80	1.18	0.87	1.02	0.93	1.06
C50T74: Total Business Sector Services	1.15	0.83	0.80	1.16	0.87	1.04	0.98	1.05
C50T64: Wholesale, retail, hotels, restaurants, transport	0.89	0.97	0.95	1.18	0.75	1.09	1.39	0.97
C50T55: Wholesale and retail trade, Hotels and restaurants	0.86	0.90	0.94	1.16	0.74	1.09	1.52	0.95
C60T64: Transport and storage, post and telecommunication	0.94	1.10	0.97	1.23	0.78	1.10	1.14	0.99
C65T74: Finance, Real Estate and business services	1.43	0.68	0.64	1.14	0.99	0.98	0.54	1.14
C70T74: Real estate, renting and business activities	1.26	0.68	0.55	1.23	1.12	0.99	0.57	1.09
C75T95: Community, social and personal services	1.52	1.00	0.83	1.37	0.91	0.71	0.29	1.17

Notes: The RCA is calculated “relative” to all G20 developed economies, over the 2012-2014 period. For any particular sector, the RCA is greater than 1 if the share of domestic value added in World Final Demand is larger than the DVD-G20 weighted average.

Source: Author’s elaboration based on OECD *TiVA* Nowcasts.

On this basis, UK’s comparative advantages are mainly to be found in services, particularly in Finance and Business services (sector C65T74). Figure 11 synthesises the information by comparing the UK with the DVD-G20 (unweighted) average. The highest UK’s RCAs (on the left part of the graph) are all in services, headed by Finance intermediation. The first good-producing sector is Chemicals,

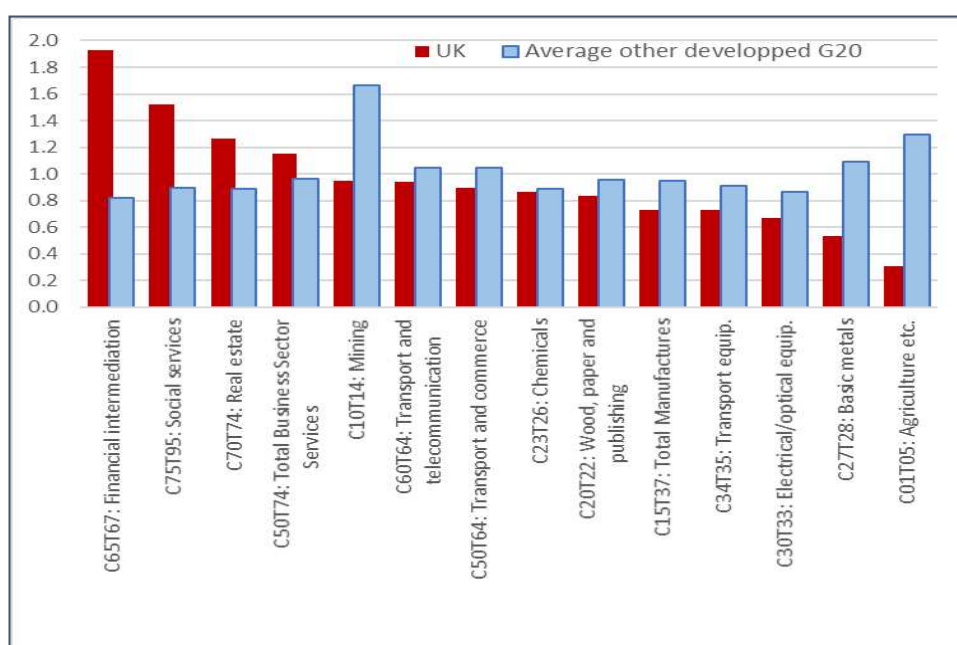
¹⁴ There are other databases that provide similar information; in particular WIOD, an EU-funded project, or Eora, initially funded by the Australian Research Council. *TiVA* has the advantage of being produced according to internationally recognised official statistical standards with a special attention given to filling the gaps in bilateral trade in services data. Being based on official data, it suffers from more delays in its updating and from uncomplete country coverage. In particular, *TiVA* does not cover yet many African and Central Asian countries. Since the launch of *TiVA* in 2012, several regional projects have started compiling their own trade in value-added data (e.g., APEC, Latin America). The Beijing-based UIBE GVC Index project compiles most of these data and derives a series of ready-made indicators.

¹⁵ Korea, for example, informed during the WTO Doha Round discussion her intention of being treated as a “developed economy” and the Russian Federation joined the WTO under this status.

where the UK is almost at par with other developed G20 countries. Transport equipment, which appeared in Figure 10 as a strong sector when looking at the exports of final products (including parts and components), is now below par, at 0.73 compared with 0.91 in DVD-G20 average where Germany and Japan lead the group.

However, a word of caution is in order. It would be a mistake to conclude that UK has no comparative advantages in the production of cars or aircrafts. What trade in tasks tells us is that a large share of the value embodied in these products comes has been imported. The result may have been influenced by differences in business models: UK car industry may be less incorporated than in Germany and Japan or more dependent of a foreign lead-firm. A UK firm may, in this case, outsource more of its tasks compared to older-style incorporated firms that amalgamated all core and non-core activities under the same corporate roof. Additionally, UKs automotive firm may be very good at assembling the various pieces of value-added embodied into a car, producing a final product that proves competitive on international markets (remember the very good ranking of the “Made in UK” brand, Figure 1). Therefore, the *TiVA* approach does not substitute the traditional product-space approach but complements it by identifying more closely the sources of competitiveness.

Figure 11 UK Revealed Comparative Advantages in Tasks Relative to Developed G20 Countries, 2012-2014



Note: The G20 statistics is based on a simple average of the 8 developed G20 members over 2012-2014.

Source: Table 4

E. Exports, value-added and employment

Another advantage of analysing trade in value-added is to provide a basis for estimating the employment content of exports. The estimate requires data on the amount of sectoral value-added absorbed by wages (compensation of employees) and additional labour statistics. Using OECD estimates for 2011, Annex 1 presents the results by sector and aggregates, distinguishing the destination of exports supporting the jobs. Again, a word of caution is in order: *TiVA* data are based on national industry averages, mixing small and large firms. Exporters are known to be mainly large firms that are

more efficient than the industrial average. As a result, the number of jobs that are reported here as embodied in exports is probably an upper estimate.

In 2011, export activities supported, directly or indirectly 6.6 million UK jobs according to OECD (see Annex). The business services sector represents 4.4 million (67%) of these posts. By comparison, UK exports of manufacture support 1.3 million of jobs (20% of total export-related employment) and the primary sectors (agriculture plus mining) only 2%. ¹⁶ Looking at individual sectors, Financial intermediation alone weights 6% of total jobs, twice as much than Chemicals or Transport equipment (3% each).

Table 5 Sectoral distribution of UK employment supported by foreign final demand in 2011, by main region

World	EU	NAFTA	East & South Asia	Central & South America	Other
CTOTAL: TOTAL	43%	19%	11%	2%	25%
Of which	100%	100%	100%	100%	100%
C01T05: Agriculture, hunting, forestry and fishing	58%	11%	7%	1%	23%
C10T14: Mining and quarrying	52%	18%	7%	3%	21%
C17T19: Textiles, textile products, leather and footwear	60%	11%	9%	1%	19%
C23: Coke, refined petroleum products and nuclear fuel	53%	25%	5%	2%	15%
C24: Chemicals and chemical products	42%	21%	11%	3%	23%
C27T28: Basic metals and fabricated metal products	35%	17%	12%	2%	34%
C27: Basic metals	30%	16%	14%	2%	38%
C29: Machinery and equipment, nec	28%	22%	14%	3%	34%
C30T33: Electrical and optical equipment	37%	21%	15%	2%	26%
C30T33X: Computer, Electronic and optical equipment	37%	22%	15%	2%	24%
C31: Electrical machinery and apparatus, nec	35%	18%	14%	3%	30%
C34T35: Transport equipment	30%	16%	10%	2%	41%
C35: Other transport equipment	23%	17%	9%	1%	50%
C36T37: Manufacturing nec; recycling	53%	13%	7%	1%	26%
C60T63: Transport and storage	34%	15%	13%	2%	36%
C65T67: Financial intermediation	20%	36%	17%	2%	25%
C72: Computer and related activities	43%	24%	11%	1%	20%
C80: Education	36%	21%	12%	3%	28%
C85: Health and social work	39%	22%	10%	2%	26%
C90T95: Other social services	54%	14%	6%	1%	26%
C65T74: Finance, Real Estate and business services	45%	23%	11%	2%	20%

Note: Highlighted sectors (red shade) based on the 5 largest source of UK employment by importing region

Source: Annex 1 UK jobs embodied in exports of sectoral value-added, 2011 based on OECD data

In terms of geographic distribution, 43% of the total export-related jobs are related to EU final demand, 19% to NAFTA (Canada, Mexico and the USA) and 11% to East and South Asia (please note that the results are constrained by the geographic *TiVA* coverage). The distribution of employment supported by the demand emanating from these regions varies from sector to sector. If we compare EU and NAFTA regions, the main difference is on the relative weigh of goods vs services sectoral value-added. With the exception of fuels (C23), all Top5 UK sectors of origin for the NAFTA region are in services. Comparatively, EU demand for UK labour-related value-added is concentrated in low-wages sectors (primary sector, other manufacture and recycling, social services) or in fuels. ¹⁷ Asia absorbs principally manufacture value-added and financial services. The distribution of demand from South and Central America is relatively flat, while the Rest of the World concentrates its imports mainly on metals and transport equipment (and the transport and storage services that are associated with trade in goods).

¹⁶ The remaining jobs are distributed among other sectors, in particular administration and other services.

¹⁷ Irrespective of the important fact that EU demand is also large, relative to other region, for other products.

4. Special focus on key GVC sectors

This chapter looks into the specificities of a selection of goods producing industries that have a particular relevance from a GVC perspective: Transport equipment, Electronics and Chemicals. UK's GVCs are benchmarked against other countries, in particular the other three EU G20 members (France, Germany and Italy) plus China and the USA, the two largest World economies.

A. Transport equipment

1. Sectoral weight of UK as trade partner

In a comparison with the other three EU-G20 members, UK sector ranks third after Germany and France due to the relative weakness in its export links. Weighting only the imports, it is second after Germany while its export weight is less than a third of Germany's one. When trade negotiations are concerned, being a large importer provides more weight in the discussion.

Actually, UK as an import market ranks fourth in relative importance after the USA, Germany and China (see Table 6). Centrality indicators confirm that UK plays a key role as importer for many countries covered by *TiVA*.

Table 6 Transport equipment: network indicators for the Top 10 importers, 2014

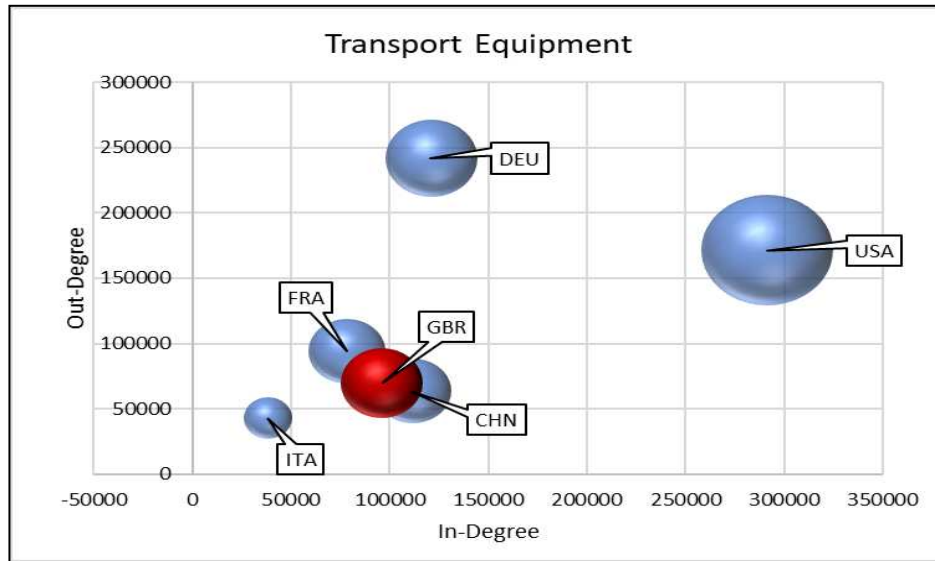
Reporter	In-Degree	Out-Degree	Betweenness Centrality	Closeness Centrality	Eigenvector Centrality ^a	PageRank
USA	291 306	171 154	0.00004	1.00	0.6142	0.0136
DEU	121 365	241 680	0.00003	1.00	0.6056	0.0067
CHN	111 846	63 508	0.00001	1.00	0.5587	0.0046
GBR	96 129	69 767	0.00003	1.00	0.6050	0.0053
CAN	87 553	68 855	0.00003	1.00	0.5987	0.0053
FRA	78 403	93 855	0.00004	1.00	0.6142	0.0046
MEX	58 511	99 505	0.00002	0.97	0.5912	0.0037
RUS	39 545	585	0.00001	0.89	0.5720	0.0017
ITA	38 163	42 935	0.00003	1.00	0.5974	0.0018
ESP	35 922	49 398	0.00003	1.00	0.6076	0.0018

Notes: The reporters are ranked according to their In-degree score. Bilateral flows are weighted by the share of the bilateral flow in total vehicle exports of the reporter; bilateral flows smaller than 1% of reporter's exports were not considered in the calculation of network indicators. a/ Provided for illustration only, see Annex 2.

Source: Author's calculations based on OECD *TiVA* Nowcasts.

Indeed, UK, with a PageRank score of 0.00531, ranks third with Canada among all *TiVA* reporters, after the USA and Germany, but before China and France. One hypothesis for this influential role is that, like Canada, UK benefits from her closer trade relationship with the USA. Another key partner for the UK is Germany (Figure 12), which is particularly export oriented (at the difference of the USA) and maintains close trade relationship with the UK in this sector.

Figure 12 Inter-Industrial World Trade Network in Transport equipment: selected indicators, 2014



Note: The size of the bubble indicates the PageRank score.

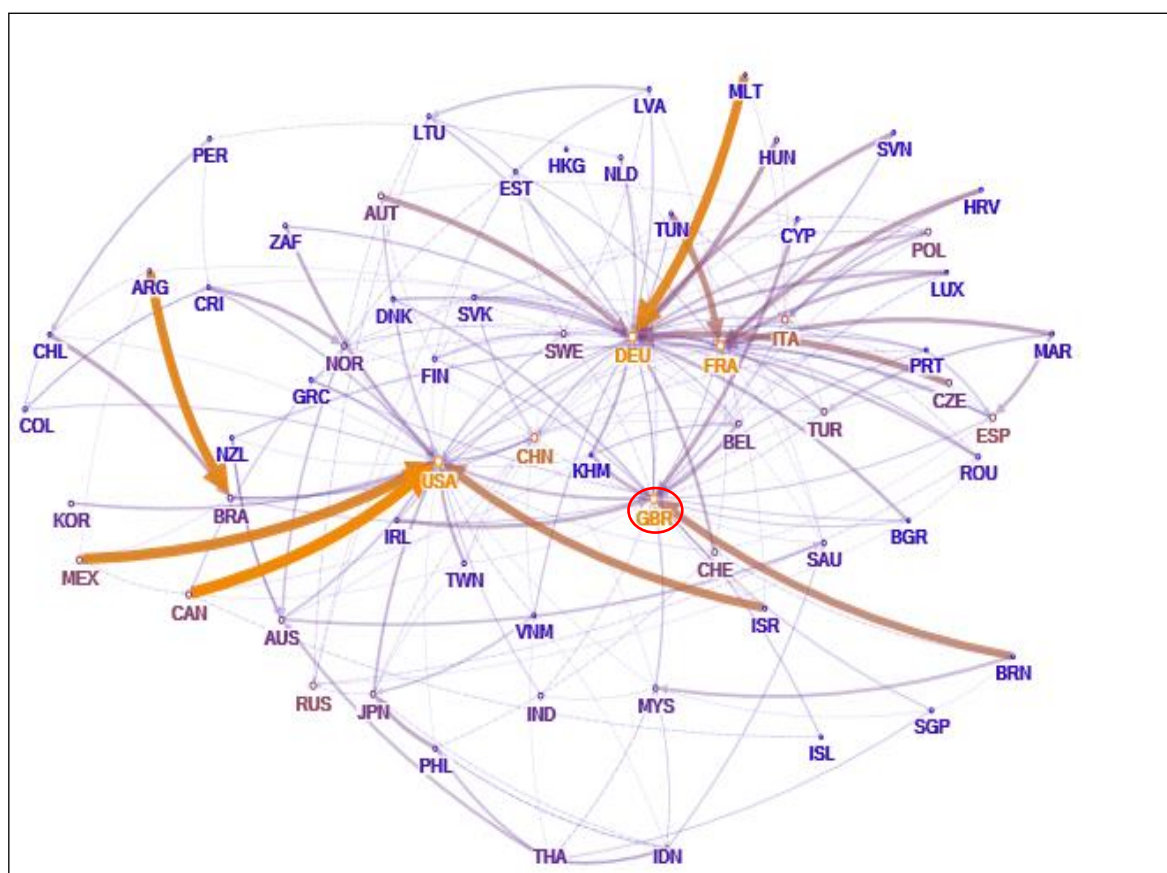
Source: Table 2.

a) Market shares and bilateral trade

In the previous paragraphs, UK's role in the World Trade Network was seen from a global inter-industry perspective, and the inter-industry trade flows were weighted by the monetary value of bilateral trade flows. In such a case, large economies will naturally dominate the results.

But we can also look at the relevance of each import market from the individual perspective of each exporter. In this case, the weight for import markets is given by its relevance to its trade partner, irrespective of the monetary dimension. If an importer absorbs 50% of the exports of a small country, these imports will weigh more than trade from a much larger exporter, if this bilateral flow represents a smaller share of the exporter's total sales. On this basis, UK is an important global player for vehicles and parts (Transport equipment, sector C34T35 of *TiVA*) as far her relevance to exporters is concerned (see Figure 13).

Figure 13 Trade in transport equipment, weighted by share in reporters' exports, 2014



Note: Arcs (exports) are weighted (size and colour, from blue to red) by the share of the bilateral flow in total vehicle exports of the reporter; bilateral flows smaller than 1% of reporter's exports were not considered in the calculation of network indicators and exports smaller than 3% are not shown. Nodes (import markets) are coloured by their in-degree score from blue (low score) to red (high score).

Source: Author's calculation based on TiVA Nowcast data.

Among the Top 20 traders (Table 7), non-EU countries represent by far the main destination of UK exports (42.0% compared to 25.5% to EU27 members). The picture is more balanced when we look at the importance of UK as an export market: in average, UK represents 18.6% of exports for non-EU members, only slightly more than for EU27 members (15.4%). In particular, UK and Germany respective bilateral market shares are equal (10%) for automotive products, while UK is more important an export market for France and Italy than they are for the UK. Italy exports 10% of her sectoral products to UK while Italy represents less than 2% of UK exports. Trade is also unbalanced with France, which exports 9% of her automotive products to UK while her imports represent only 6.4% of UK exports.

The weight of UK as export market is particularly high for smaller EU countries such as Cyprus (29%), Ireland (27%), Belgium (26%) or Denmark (17%). Besides Germany, the relative burden of new UK tariffs on the EU imports in the case of a hard Brexit and tit-for-tat UK reciprocity would be particularly high for smaller EU states that have geographical proximity and/or historical ties with the UK (Cappariello, 2017).

Table 7 Transport equipment: Top20 origins and destinations, 2014

From	To	Percent ^a	From	To	Percent ^a
GBR	USA	21.0	BRN	GBR	53.3
GBR	DEU	10.0	CYP	GBR	29.3
GBR	CHN	7.0	IRL	GBR	26.8
GBR	FRA	6.4	BEL	GBR	26.1
GBR	CAN	2.8	KHM	GBR	25.7
GBR	RUS	2.6	DNK	GBR	16.5
GBR	ESP	1.9	MYS	GBR	14.9
GBR	CHE	1.9	ISL	GBR	12.9
GBR	ITA	1.9	PRT	GBR	12.4
GBR	AUS	1.8	SGP	GBR	12.2
GBR	TUR	1.7	FIN	GBR	12.1
GBR	SWE	1.3	ESP	GBR	11.7
GBR	IRL	1.3	BGR	GBR	11.3
GBR	JPN	1.0	BRA	GBR	10.7
GBR	ZAF	1.0	ITA	GBR	10.3
GBR	BEL	0.8	DEU	GBR	10.0
GBR	HKG	0.8	NLD	GBR	9.7
GBR	SAU	0.8	TUR	GBR	9.6
GBR	KOR	0.8	IND	GBR	9.3
GBR	SGP	0.7	FRA	GBR	8.9

Notes: a/ In percent of total exports of the reporter's sector.

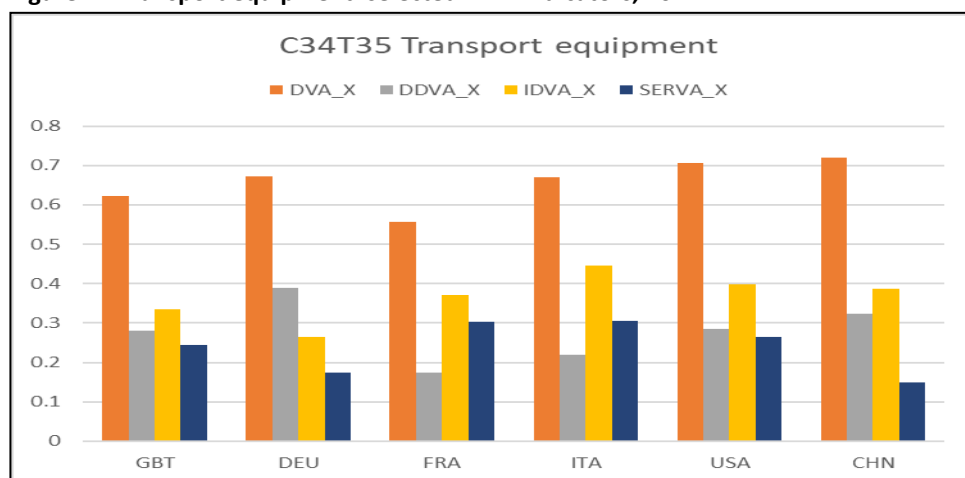
Source: Author's calculations based on OECD *TiVA* Nowcasts.

b) Sectoral TiVA indicators: comparative analysis

In this section, we shift our attention to trade in value-added and compare UK's sectoral *TiVA* indicators with the other EU G20 members (France, Germany and Italy) plus China and the USA. The following graph (Figure 14) pictures the share of domestic value added embodied in sectoral exports (distinguishing direct and indirect sources), and the share of services (domestic and foreign) in total sectoral value.

Among European countries, UK is in an intermediate situation in terms of value-added composition: the share of domestic VA is slightly above 60%, below Germany and Italy but above France. The extent of domestic outsourcing is larger (indirect value-added represent 54% of domestic value added) than in Germany (where most of the domestic value-added comes from the exporting industry itself and only 39% of the tasks are outsourced to other domestic industries) but not as large as France or Italy (67% in both cases). Similarly, the degree of "*servicification*" of UK's exports lies in-between Germany (low share of services) and France or Italy. Except for a lower contribution of indirect domestic value-added, the UK profile is very similar to US' one. Contrary to common perceptions, the imported component of Chinese exports of vehicles and parts is low compared to the other countries.

Figure 14 Transport equipment: selected *TiVA* indicators, 2014



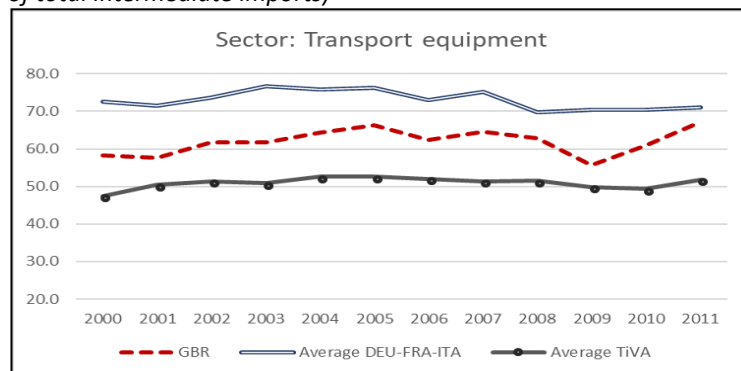
Notes: DVA_X: domestic value added embodied in sectoral exports; DDVA_X: direct domestic value added from the exporting industry; IDVA_X: indirect sources of domestic value-added (outsourced to other domestic sectors); SERVA_X: share of services value-added (domestic and foreign) in total sectoral exports.

Source: Author's calculations based on OECD *TiVA* Nowcasts.

c) Impact of Brexit on competitiveness

A hard Brexit is expected to increase EU-UK trade costs due to additional tariffs (EU applies MFN duties to UK products and UK retaliates) but also due to non-tariff trade costs (increased administrative burden and delays at the border). Cappariello (2017) provides estimates of the MFN tariffs in case of hard Brexit. In the case of automobile, the tariff would be about 9%, much higher than the average 4 to 5 percent applied to other goods. In addition, it is expected that the NTM cost will also increase due to additional administrative burden at the border. The back-of-envelope simulation sets the monetary impact of these additional costs at 5% ad-valorem for both exports and imports (see Annex 3, p. 41). The implication on production cost is based to the reliance of the UK transport industry on EU inputs, which is relatively high (67% of sectoral imported inputs were sourced from EU) and almost similar to what is observed in France, Germany or Italy.

Figure 15: Imports of intermediate products from EU by Transport Equipment sector
(share of total intermediate imports)



Notes: Simple averages on France, Germany and Italy, and on all *TiVA* countries

Source: Author's calculations based on OECD *TiVA*

In the Transport equipment case, the direct domestic value-added share is 28% and the indirect one is 33%. The Pound would have to devalue by a margin of between 15% to 28% against the Euro in order to nullify the impact of tariff and non-tariff trade costs under different scenarios (see Annex 3, Table 16). This sector is the most affected of the three industries included in our simulation, due to a combination of factors: high MFN tariffs, high reliance on EU inputs and low coefficient of domestic value-added (62% compared with a UK average of 78%). Moreover, the transport equipment global value chain is based on complex and contractually binding inter-industrial arrangements where participating firms have little freedom on the choice of their inputs. So, there is only a small margin for redirecting imports of inputs to non-EU providers. But, as mentioned in Kee and Nicita (2017), the impact of a change in import tariffs on the demand for UK product depends ultimately of the price elasticity, which is low in the case of Vehicle and Transport equipment.

B. Chemicals

Chemicals (C23T26) is the largest sectoral GVC as far as its weight in world trade is concerned. We apply the same analytical procedure than the one presented previously for Transport equipment.

2. Sectoral weight of UK as trade partner

As an importer, UK ranks third after Germany and France when looking at the other three EU-G20 members and 5th at world level (Table 8).

Table 8 Inter-Industrial World Trade Network in Chemical: network indicators for the Top 10 importers, 2014

Reporter	In-degree	Out-degree	Weighted Degree	PageRank	Betweenness Centrality	Eigen Centrality
USA	298304	328457	626760	0.0109	0.00001	0.896
CHN	224879	198974	423852	0.0059	0.00001	0.896
DEU	199384	219778	419162	0.0055	0.00001	0.896
FRA	134557	110535	245092	0.0037	0.00000	0.886
GBR	114647	96489	211137	0.0031	0.00001	0.896
JPN	95327	107933	203260	0.0028	0.00001	0.896
MEX	91003	27353	118355	0.0029	0.00000	0.886
ITA	78247	82029	160276	0.0024	0.00000	0.886
CAN	70291	45525	115816	0.0024	0.00001	0.896
ESP	63824	61781	125604	0.0020	0.00001	0.896

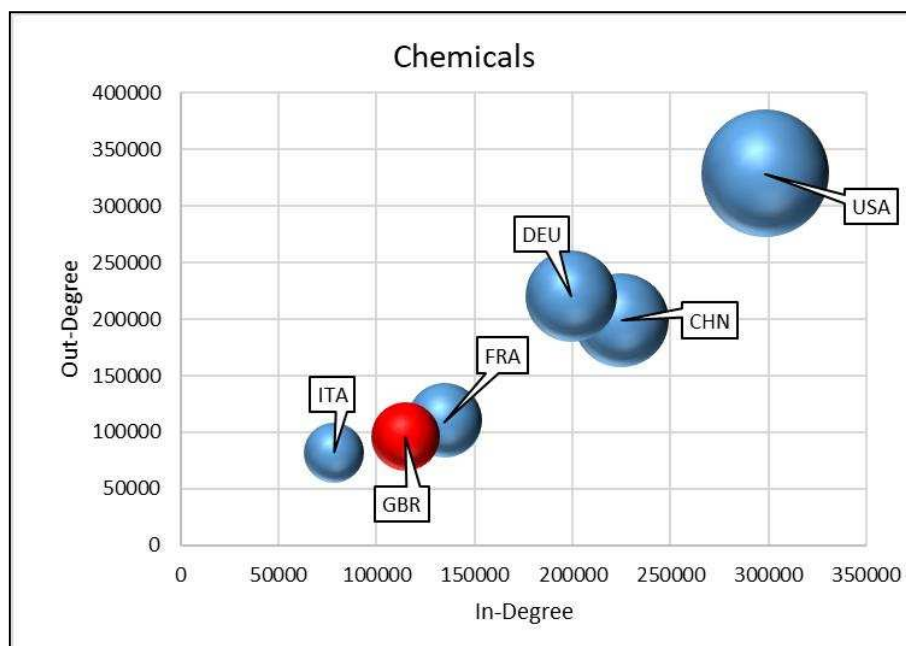
Notes and sources: see Table 6

At the difference of transport equipment, UK as a trade node has no other particular strength and her ranking in the Chemical trade reflects basically the sheer volume of trade (weighted degree). Figure 16 shows an almost linear relationship between PageRank, import and export degrees indicators: among the top players, no one benefits from a special network position independently of its economic size for the sector.¹⁸ Indeed, UK's ranking remains high when considering all *TiVA* report-

¹⁸ As seen below, UK's trade partners are mainly regional ones, with the exception of the USA. Network centrality indicators would have been higher if, for example, the UK had special trade relationship (as an importer or as an exporter) with a key partner outside the region.

ers. She ranks 5th on PageRank with a score of 0.0031, just before Mexico (0.0029) and Japan (0.0028) and after the USA (0.0109), China (0.0059), Germany (0.0055) and France (0.0037).

Figure 16 Inter-Industrial World Trade Network in Transport equipment: selected indicators, 2014



Note: The size of the bubble indicates the PageRank score.

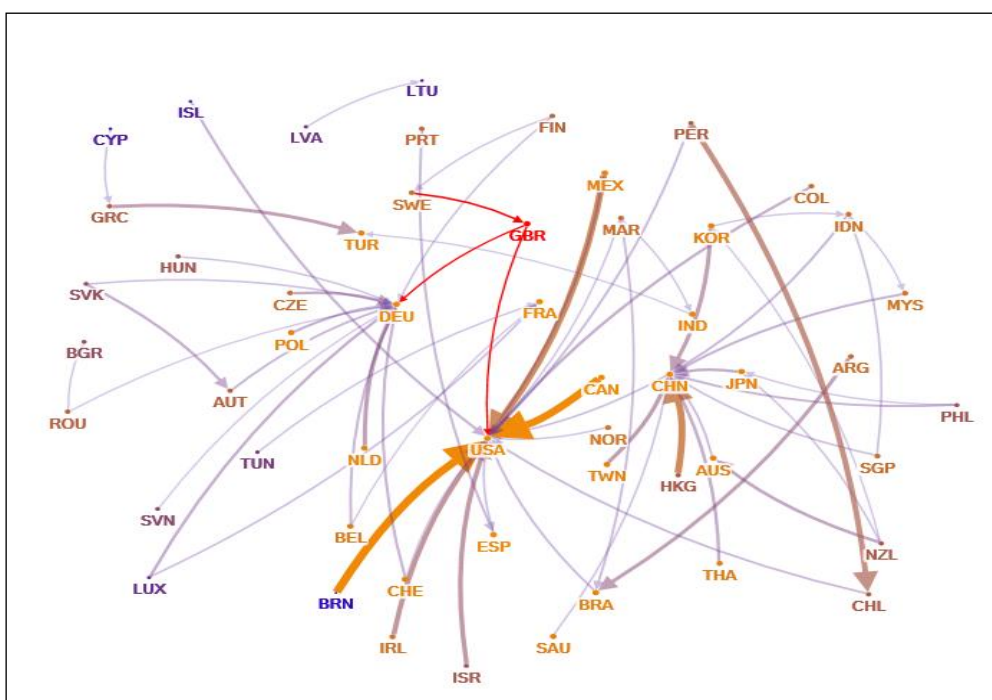
Source: Table 8.

a) Market shares and bilateral trade

Figure 17 shows the trade network graph based on the weight of nodes as export market. The difference in influence (measured as the role as key export markets for other countries) between the three dominant players (USA, China and Germany) and the three next in rank (France, UK and Japan) is obvious in the graph when looking at the number of arcs pointing to these markets (13 for Germany while only 3 for France and 1 for the UK).

Table 9 provide more details on the relative importance of trade partners for the UK's Chemical sector. Except for the USA (#1) and China (#9), the Top10 list of UK export markets is populated with European countries. Compared with Transport equipment (Table 7), Europe in general, and EU in particular are much more relevant for UK as market for exports or for imports. And the UK is an important market of export for many European countries: she absorbs about 17% of Sweden sectoral exports and 12% of Belgium's ones. Even for Germany (a key world player in this sector, as we saw), UK weights 8% of her exports, and a similar result is also found for France (in both cases, those EU members are more relevant for the UK as export markets as they are as sources of imports).

Figure 17 Graph of trade in Chemical products, weighted by share in reporters' exports, 2014



Notes and sources: see Figure 13

Table 9 Chemicals: Top20 origins and destinations, 2014

From	To	Percent ^a	From	To	Percent ^a
GBR	USA	13.0	SWE	GBR	16.8
GBR	DEU	12.7	NLD	GBR	11.8
GBR	FRA	9.1	CYP	GBR	11.2
GBR	NLD	8.4	BEL	GBR	11.0
GBR	IRL	5.6	LTU	GBR	10.4
GBR	CHE	4.2	IRL	GBR	10.1
GBR	ESP	3.7	MLT	GBR	9.3
GBR	ITA	3.4	PRT	GBR	9.1
GBR	CHN	3.1	EST	GBR	8.7
GBR	SWE	2.4	FRA	GBR	7.9
GBR	POL	2.4	DEU	GBR	7.8
GBR	CAN	2.0	DNK	GBR	7.3
GBR	BEL	1.9	NOR	GBR	7.2
GBR	JPN	1.8	POL	GBR	6.1
GBR	RUS	1.6	ITA	GBR	5.9
GBR	AUS	1.3	ESP	GBR	5.6
GBR	BRA	1.2	ISR	GBR	5.2
GBR	TUR	1.1	LUX	GBR	5.0
GBR	DNK	1.1	FIN	GBR	5.0
GBR	KOR	1.0	TUR	GBR	4.6

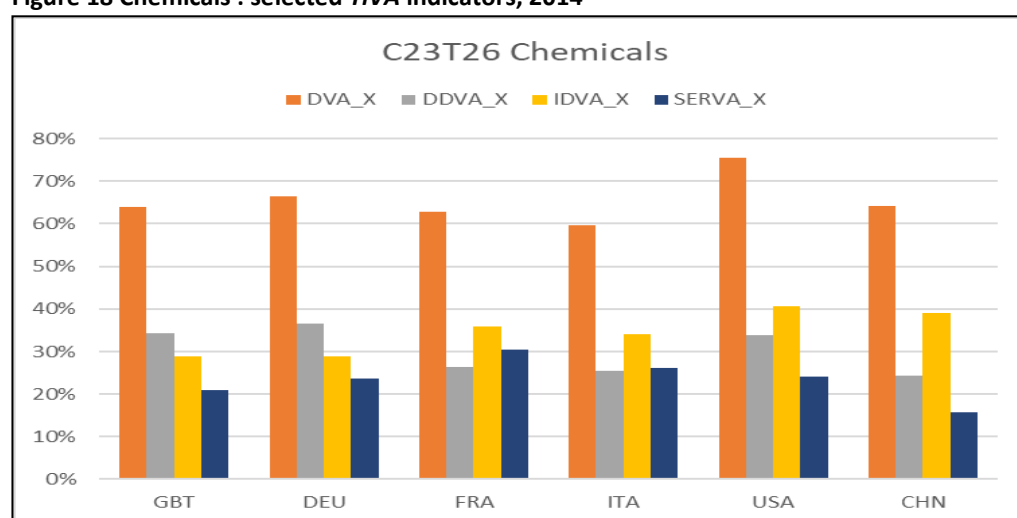
Notes: a/ In percent of total exports of the reporter's sector.

Source: Author's calculations based on OECD TIVA Nowcasts.

b) Sectoral TiVA indicators: comparative analysis

Figure 18 presents UK's sectoral *TiVA* indicators for Chemicals and compares them with the other EU G20 members (France, Germany and Italy) plus China and the USA. Among European countries, UK is in an intermediate situation in terms of domestic value-added composition: the share of domestic VA is slightly above 60%, below Germany but above France and Italy. UK's *TiVA* profile is similar to Germany's one. Like Germany, the UK chemical sector generates most of the domestic value added (37% and 34%, respectively compared to 26% and 25% for France and Italy). Similarly, UK's sector relies less on domestic outsourcing than France or even Italy. Moreover, the degree of "*servicification*" of UK's exports (including domestic and foreign sources) is low (only China has a lower value).

Figure 18 Chemicals : selected *TiVA* indicators, 2014



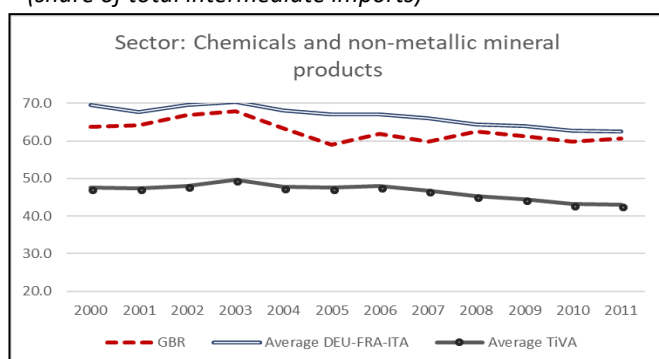
Notes and Sources: see Figure 14

c) Impact of Brexit on competitiveness

Cappariello (2017) estimates that the MFN tariffs faced by UK's exports of chemical products to EU will be low, 2.7%, in case of hard Brexit while EU inputs imported by UK would pay a 2.4% tariff duty. The increase in trade cost is therefore lower than in the case of transport equipment. On the other hand, and as was the case for Transport equipment, the share of domestic value-added is also relatively low (64%) and the reliance on EU inputs is high (Figure 19).

The impact of tariff alone on competitiveness is relatively low (5% in average of the simulations) but in order to nullify the increase in bilateral tariff and non-tariff trade costs with EU27, the Pound would have to devalue by 12% to 16% (see Annex Table 16). At the difference of transport equipment where parts and components are product specific and not easily substitutable, there is probably a greater flexibility for the UK Chemical industry to reduce its reliance on EU suppliers, at least for the basic and the generic processed inputs.

Figure 19: Imports of intermediate products from EU by UK's Chemical sector
(share of total intermediate imports)



Notes and source: see Figure 15

C. Computer, Electronic and optical equipment

After Chemicals and Transport equipment industries, Electronics and Optical equipment is the third largest good-producing sector in terms of total trade flows in 2014.

3. Sectoral weight of UK as trade partner

From a global perspective, UK ranks 5th in terms of her imports and second in Europe, after Germany. On the export side, UK is not a significant player and is the last one of Table 10 on this criterion. Yet, UK remains overall an important network player in the world of electronic industry and rank 4th on the PageRank score.

Table 10 Inter-Industrial World Trade Network in Electronics and optical equipment: selected indicators, 2014

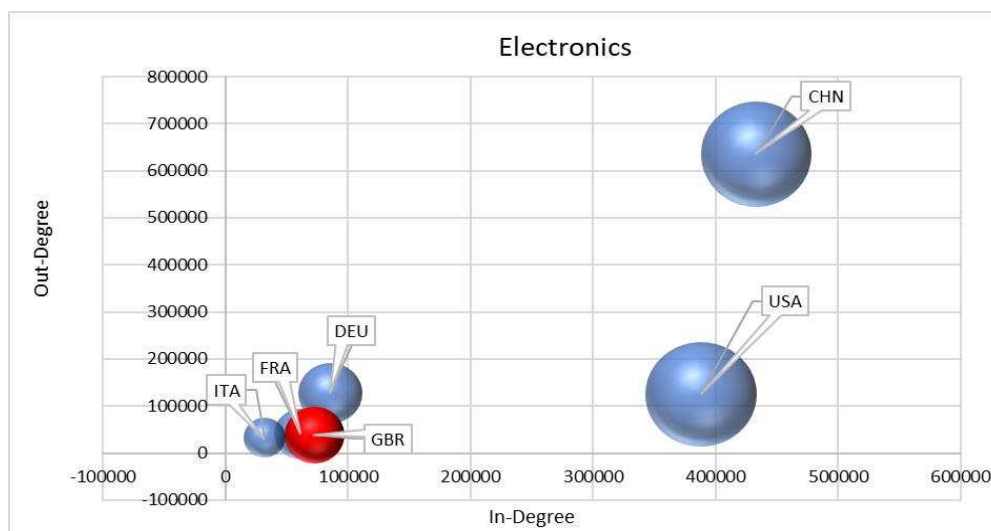
Reporter	In-degree	Out-degree	Weighted Degree	PageRank	Betweenness Centrality	Eigen Centrality
CHN	433 333	635 355	1 068 687	0.0125	0.000013	0.8322
USA	388 509	124 743	513 252	0.0126	0.000013	0.8322
JPN	103 925	133 310	237 235	0.0031	0.000007	0.8098
DEU	85 612	127 086	212 697	0.0042	0.000013	0.8322
GBR	72 832	38 808	111 640	0.0036	0.000013	0.8322
KOR	69 139	125 151	194 289	0.0022	0.000013	0.8197
MEX	63 544	79 853	143 397	0.0029	0.000007	0.8223
FRA	61 465	40 621	102 086	0.0028	0.000007	0.8223
TWN	56 892	131 112	188 004	0.0017	0.000013	0.8197
MYS	48 568	69 790	118 358	0.0018	0.000013	0.8199

Notes and sources: see Table 6

Among the EU G-20, UK's position is very similar to France's one (Figure 18) while Germany – the leading EU trader-- is the only one to have a trade surplus in this sector. China and the USA ap-

pear as much larger players in volume, China standing out for her larger exports leading to a trade surplus in this sector.

Figure 20 Inter-Industrial World Trade Network in Electronics and optical equipment: network indicators for the Top 10 importers, 2014



Note: The size of the bubble indicates the PageRank score.
Source: Table 2.

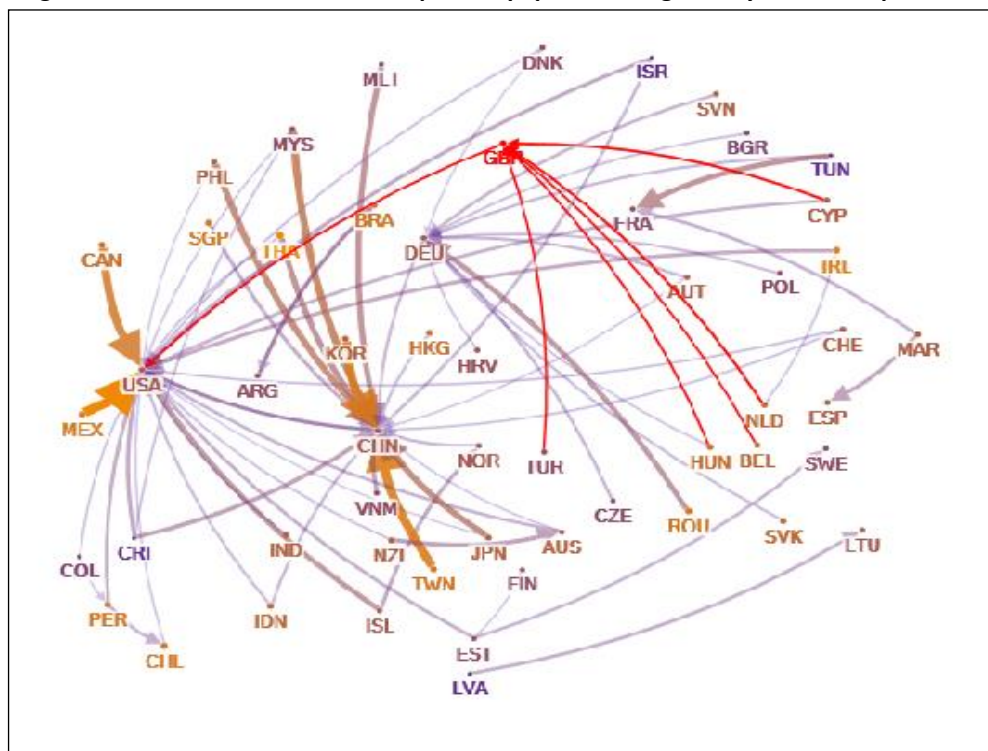
a) Market shares and bilateral trade

Compared to France, UK as an importer of electronics appears as a major market for more countries (Figure 21), especially when considering European trade partners. In the graph, France is a main export market only for two countries, both being in North Africa (Morocco and Tunisia). Among the five countries that count UK as an important market of destination, four are EU members (Belgium, Cyprus, Hungary and the Nederland). Table 11 confirms that UK is an important market for EU exporters (only 4 countries are extra-EU in the Top 20 list of exports to UK), especially for smaller countries like Luxembourg (46%) or medium ones like the Nederland (17%).¹⁹

EU is not the main market of destination for UK's exports of electronics, as it is also the case of Germany. But while Germany relies principally on China as for her exports, UK is more focused on the USA. On the basis of the Top20 bilateral flows (Table 11), UK exports to EU members weight 32% compared to 41% for non-EU destinations. The USA itself absorb almost 15% of UK's exports of electronics and optical equipment.

¹⁹ Even if statisticians tried their best to filter-out re-exports in the case of countries like the Nederland, there may still remain some over-estimation of the NLD's trade flows due to her central role as a European hub for maritime trade.

Figure 21 Trade in Electronics and optical equipment, weighted by share in reporters' exports, 2014



Notes and sources: see Figure 13

Table 11 Electronics and Optical: Top20 origins and destinations, 2014

From	To	Percent ^a	From	To	Percent ^a
GBR	USA	14.8	LUX	GBR	45.8
GBR	CHN	9.5	CYP	GBR	17.5
GBR	DEU	7.5	NLD	GBR	17.1
GBR	FRA	5.4	HUN	GBR	14.7
GBR	IRL	5.3	BEL	GBR	13.8
GBR	ESP	4.0	TUR	GBR	13.6
GBR	ITA	3.9	CZE	GBR	12.2
GBR	RUS	3.7	GRC	GBR	11.1
GBR	JPN	3.1	IRL	GBR	11.0
GBR	SWE	2.2	SVK	GBR	10.6
GBR	AUS	1.7	PRT	GBR	10.4
GBR	KOR	1.7	ESP	GBR	10.3
GBR	MYS	1.6	POL	GBR	10.2
GBR	CHE	1.4	DNK	GBR	9.9
GBR	NOR	1.4	AUS	GBR	8.8
GBR	BEL	1.4	FRA	GBR	8.6
GBR	CAN	1.3	MAR	GBR	7.9
GBR	POL	1.2	NOR	GBR	7.4
GBR	IND	1.1	BRN	GBR	7.3
GBR	BRA	1.0	DEU	GBR	6.8

Notes: a/ In percent of total exports of the reporter's sector.

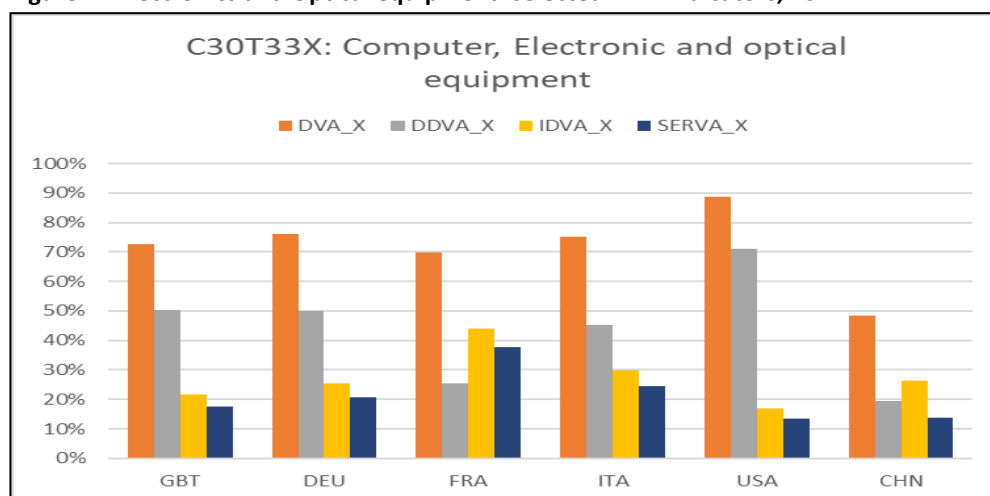
Source: Author's calculations based on OECD TiVA Nowcasts.

b) Sectoral TiVA indicators: comparative analysis

As in the case of Transport equipment and Chemicals, UK Electronic sector concentrate most of the exports of domestic value-added on the exporting sector itself, with little domestic outsourcing. Only the US industry is more concentrated. The degree of "servicification" is also low (18%, in-

cluding both domestic and foreign services) compared to other European countries, in particular France (38%).

Figure 22 Electronics and Optical equipment: selected *TiVA* indicators, 2014

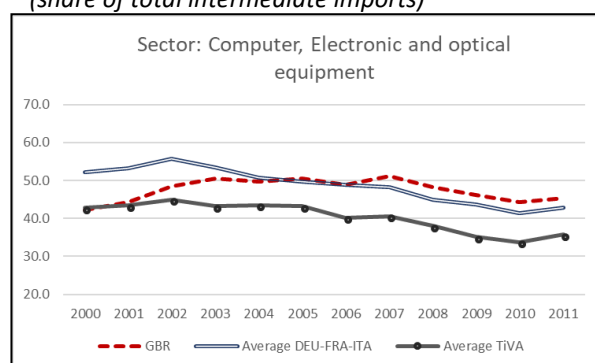


Notes and sources: see Figure 14

c) Impact of Brexit on competitiveness

The impact of Brexit on tariffs charged by EU27 on UK's exports of electronics and optical equipment is expected to be low. Cappariello (2017) estimates MFN tariffs for the wider group of machinery (except transport equipment) to average 1.9%. Indeed, under WTO's extended IT agreement, a large number of tariff lines in IT are bound to 0. In addition, reliance on EU input is low and decreasing (Figure 23) and the share of domestic value-added (72%) is higher than for Transport and for Chemicals.

Figure 23: Imports of intermediate products from EU by UK's Electronic sector
(share of total intermediate imports)



Notes and source: see Figure 15

Consequently, Electronics is the less affected of the three sectors analysed in this paper. The Pound would have to devaluate by about 3% to cancel the impact of the increase in tariffs, and between 9% to 11% to compensate for the incidence of higher tariff and non-tariff trade costs with the EU (see Annex Table 16).

D. Sectoral GVC indices

In GVC trade, firms are organised along a structured production process, with each link performing a specific role and being subject to different challenges. Analysing GVC linkages and position indices delivers some interesting information on the possible impact of export trade barriers on domestic industries (see Box 1). For example, the furthest away from the final market (the longer the length of a GVC and the most upstream an industry is placed within this chain), the less exposed is the domestic industry to a shock (e.g., an increase in tariff) affecting the final product.

Box 1: GVC production index

One of the most important GVC concepts derived from the international input-output matrices that are behind the OECD-WTO *TIVA* indicators is the ‘length’ of a production chain. This ‘length’ is not measured in geographic terms but as the number of production steps it takes for value added created at the beginning of the production chain to reach final demand, were it is “absorbed” (at the difference of intermediate products, final products are consumed and do not reintegrate the production process as such). ^{*} GVC position index is a relative measure that is based on production length. For a given sector, a country may be located at the beginning of the supply chain (upstream), at the middle or at the end of the production process, closest to final demand (downstream). This relative situation is estimated by computing its GVC position index.

Intuitively, this index is built comparing the number of steps that occur before the sector adds its value-added to the chain, with the number of steps between the industry and the final demand. Following Escaith and Inomata (2016), we use the concept of Average Propagation Length (APL) and define the GVC position index as the ratio of the length of a given country/sector’s backward linkage-based APL over its forward linkage one (the distance to final demand). This ratio provides a measure of the relative position of a country in the sectoral global production network: If the ratio is higher (or lower) than 1, the sector is relatively more upstream (or downstream). There are other ways of building GVC indices, some based on value-added (as in our case) and other based on production --see for example Escaith (2017), UIBE (2017) and Wang et al. (2017).

Three remarks are called for at this stage. First, there are many different definitions of GVC indexes. Second, because the indicator is the ratio of two indices measuring up and downstreamness, a change in one direction does not indicate a worsening of the other one, just that it grew less rapidly. Finally, one should not derive normative judgements about the relative position of a given country/sector in the supply chain. Upstreamness may indicate technological dominance in the case of electronics (e.g., production of microchips), as opposed to the downstream final assembly of consumer goods (e.g., TV sets or smartphones), while the opposite may be true for metal products, where upstream firms produce commodities.

‡/ This particularly true for consumers’ goods. Capital goods (machinery, etc.) are used, together with labour, in the production process but not as intermediary inputs. They provide investment services that are remunerated out of the value-added, together with employees’ remuneration.

Because OECD’s ICIO tables had been updated only up to 2011 at the time of collecting our data, this section will use WIOD database, which cover 2000- 2014 in their 2016 revision. Whenever necessary, we estimated 1995 using an extrapolation based on a previous release of WIOD tables. Because the construction of international input-output matrices involves a series of arbitrating between national accounts and trade statistics, the end results may differ from one source to the other one. WIOD 2016 has been compiled following the SNA2008 revision, which may artificially shorten

the length of B2B value chains.²⁰ In addition, both the country coverage and the level of sectoral aggregation differ between *TiVA* and WIOD. WIOD tables distinguish between Motor Vehicles (including trailers) and Other Transport equipment. Similarly, the Chemical sector is disaggregated into Chemical products and Pharmaceutical products. Finally, as indicated in Box.1, there are several ways of defining upstream and downstreamness, so the results presented here are partial and indicative only: understand the actual role of each UK industries in their international supply chain would require a dedicated sectoral analysis.

Table 12 GVC Position Indices, 1995-2014

	Level, 2014			Variation 1995-2014 ^a		Variation 2000-2014	
	GVC_APL ^b	APL_f ^c	APL_b ^d	APL_f	APL_b	APL_f	APL_b
<i>Manufacture of chemicals and chemical products</i>							
CHN	1.03	2.61	2.53	13%	10%	12%	12%
DEU	1.13	2.05	1.81	10%	7%	7%	5%
FRA	1.06	1.95	1.85	6%	7%	4%	7%
GBR	1.08	1.93	1.79	4%	9%	3%	9%
ITA	1.07	1.97	1.84	6%	6%	3%	2%
JPN	1.14	2.20	1.93	10%	5%	7%	4%
KOR	1.18	2.28	1.93	8%	2%	6%	2%
USA	1.09	1.88	1.73	1%	1%	3%	0%
<i>Manufacture of basic pharmaceutical products and pharmaceutical preparations</i>							
CHN	0.65	1.42	2.17	-1%	3%	0%	4%
DEU	0.85	1.47	1.73	-4%	6%	-6%	6%
FRA	0.76	1.30	1.72	-3%	10%	-3%	9%
GBR	0.88	1.43	1.62	-5%	3%	-3%	4%
ITA	0.91	1.58	1.73	7%	4%	7%	2%
JPN	0.62	1.14	1.83	-2%	0%	-1%	1%
KOR	0.77	1.48	1.93	20%	6%	17%	5%
USA	0.97	1.68	1.73	-5%	-1%	-1%	0%
<i>Manufacture of computer, electronic and optical products</i>							
CHN	0.96	2.33	2.42	18%	15%	18%	16%
DEU	1.03	1.86	1.80	6%	7%	5%	5%
FRA	0.99	1.80	1.81	4%	12%	5%	12%
GBR	0.95	1.66	1.74	2%	14%	-4%	7%
ITA	1.02	1.86	1.82	6%	11%	3%	6%
JPN	1.05	2.00	1.90	9%	4%	9%	2%
KOR	1.06	2.12	2.00	17%	13%	14%	10%
USA	1.01	1.75	1.73	-3%	7%	-2%	0%
<i>Manufacture of motor vehicles, trailers and semi-trailers</i>							
CHN	0.86	2.11	2.45	3%	9%	3%	8%
DEU	0.93	1.70	1.82	5%	5%	5%	0%
FRA	0.90	1.60	1.77	5%	7%	6%	6%
GBR	0.97	1.69	1.75	3%	6%	5%	5%
ITA	0.95	1.76	1.85	7%	4%	5%	0%
JPN	0.89	1.82	2.05	-6%	-2%	-6%	-5%
KOR	0.88	1.75	2.00	10%	11%	12%	7%
USA	0.87	1.57	1.80	-13%	13%	-3%	0%
<i>Manufacture of other transport equipment</i>							
CHN	0.75	1.79	2.38	5%	8%	4%	7%
DEU	0.92	1.58	1.72	3%	9%	7%	5%
FRA	0.85	1.46	1.72	-1%	10%	0%	9%
GBR	1.02	1.67	1.64	6%	0%	8%	-1%
ITA	0.89	1.66	1.87	7%	8%	5%	3%
JPN	0.80	1.50	1.88	0%	-1%	1%	-2%
KOR	0.92	1.82	1.97	37%	14%	39%	7%
USA	0.88	1.54	1.76	-14%	10%	-1%	2%

Notes: a/ 1995 data based on an extrapolation, the results are presented for completeness only; b/ APL based GVC index equal to the ratio (APL_f/APL_b); c/ APL, forward linkages; d/ APL, backward linkages

Source: Based on WIOD data and the UIBE GVC Index developed by the Research Institute for Global Value Chains at University of International Business and Economics (UIBE), China

²⁰ This bias occurs when intermediate goods travel down the GVC without changing ownership.

The GVC_APL index itself, calculated as the ratio (APL_f/APL_b), is of little interest in the present case for inter-country comparison (the same result may come from very different individual values of APL_f and APL_b). From the perspective of GVC index and GVC length, UK industries have followed more or less the same trend than the other three large European countries. Actually, the value of APL_f and its evolution are of more relevance in our case for inferring the vulnerability of UK GVCs to trade restrictions on their EU export market. Intuitively, the shorter is APL_f, the closer is the industry to final demand and the more directly it is to a change in the importer's trade policy.²¹

Compared with other countries in Table 12, the UK's sector of Computers and electronics industries is closer to final demand and it is getting closer with time. The length of the forward linkages is the smallest of the sample of countries, and it decreased by 4% since 2000. Tariffs are not expected to increase much on this line of products after Brexit, due to the WTO's ITA agreement that binds to zero many related tariff lines. The length of UK's forward linkages is also comparatively short for Manufacture of chemicals and chemical products (the smallest after the USA). The sector moved also forward between 2000 and 2014 on a relative basis: UK's APL_f increased by only 3% compared to the 5% median value, while the length of backward linkages increased 9%, the second highest score after China.²² The sector of "Other transport equipment" has consolidated its upstream situation between 2000 and 2014. UK is in an average situation for Pharmaceutical products and for Motor vehicles.

5. Conclusions

This paper aimed at offering background information to researchers interested in performing a sectoral analysis of the implications of Brexit on the UK value chains. Adopting a "general to detailed" comparative approach, the analysis identified the main characteristics of UK's inter-industrial trade compared to her main trade partners. From a trade perspective, UK's main comparative advantage is in services when looking at traditional or at trade in value-added statistics. Finance intermediation presents the highest revealed comparative advantage, followed by other business services. UK dominance in this sector of trade (UK ranks second after the USA, with about 7% of World exports) reflects a comparative advantage and is without common measure to her economic size as measured by total trade or GDP.

Conversely, the UK is not a "special case" when looking at trade in goods. UK's position in the Top5 group of most relevant players in the worldwide network of trade in merchandises is owed more to her economic size than to a particular comparative advantage. Indeed, at the difference of trade in services, UK's trade balance in merchandises is negative. Differentiating by categories of goods, UK ranks better on consumers' good than on capital good (excluding transport equipment). Consumers' good being easier to target in trade wars, UK's strength in consumer goods can also be seen as a vulnerability. UK's role in transport equipment is more prominent than for capital good. This sector is one of the strengths of the UK economy, representing little less than 40% of her merchandises exports. Yet, when looking at comparative advantages from a trade in value-added perspective (*id est*, including direct and indirect exports), the sector of Chemicals is the one that stands

21 Obviously, this is an oversimplification. A proper analysis would need to look at the bilateral GVC length to identify each export market and isolate those that could see a rise in trade barriers as a result of a hard Brexit. Such approach would require a dedicated analysis.

22 China being an outlier in many cases, the median is a better comparator than the mean.

out as one of the most competitive. Network analysis provided additional information on a few sectors (Agroindustry, Metal products) where UK has an influential role that surpasses the economic weight of her sectoral trade.

Estimates of the jobs embodied in the domestic value-added exported to third countries show that up to 6 to 7 million UK jobs have been generated directly or indirectly by exports. 67% of them are generated by the business services sector, much more than manufacture (20%) or primary activities (2%). North America generates the highest demand for UK business services skills, EU is the main driver for low-skill industrial jobs while exports to Asia embody medium to highly skilled jobs.

The paper benchmarks UK within “*Factory EU*” and against other key G-20 countries for three industries that have a particular relevance from a GVC perspective: Transport equipment, Chemicals and Electronics. In all cases, the UK value-added decomposition is not very different than other large European countries. Even the degree of “*servicification*” of the UK industry remains within the regional average, despite her comparative advantage in business services. On a geographical basis, UK exports are usually more diversified than other large EU countries, showing a lower degree of regional integration. UK’s imports highlights her role as market of destination for smaller EU countries. They would suffer a higher burden in the case of new tariffs imposed on EU exports by the UK.

A hard Brexit is expected to increase UK trade costs to and from the EU and affect competitiveness. The *TiVA* results were used to estimate the impact of additional tariff and non-tariff trade costs on the competitiveness of these three sectors. The Vehicle and Transport equipment UK industry is the sector that is the most affected according to the simulations, due to high MFN tariffs to be applied on bilateral trade with EU and the reliance of the UK transport industry on EU inputs. Hopes that a devaluation of the Pound may compensate for the higher costs must take into consideration that such a devaluation will affect only the domestic share of the value-added. The lower is this share, the deeper becomes the required exchange rate adjustment (the so -called “GVC magnification” effect of trade costs). In this case, the Pound would have to devalue by a margin of 15% to 28% against the Euro in order to nullify the impact of tariff and non-tariff trade costs under different scenarios. The extent of exchange rate adjustment is lower for Chemicals (12% to 16%) and for Electronics (9% to 11%). The simulations show also the role of mitigation policies to preserve the competitiveness of UK industries in the face of higher trade costs with the EU27. Such policies include comprehensive draw-back schemes to absorb the increase in tariffs and trade facilitation to reduce the monetary incidence of non-tariff trade costs. Prioritizing trade facilitation is particularly important for the industries that are inserted in international supply chains and need to work on a “just-in-time” basis.

These simulations are very rough back-of-envelope calculations and it is necessary to end on another note of caution. A brief review of the literature showed large divergences in outcome when researchers tried to estimate the trade impact of Brexit. We concur with Coutts et al. (2018) when they conclude that many in the economic profession will get it wrong on Brexit.

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7. Annexes

1. UK jobs embodied in exports of sectoral value-added, 2011

Table 13 Annex table: UK jobs embodied in exports, 2011 ^a

	World		EU	NAFTA	East & South Asia	Central & South America	Other regions
	Thousands	%					
CTOTAL: TOTAL	6 588.2	100.0%	43.0%	19.2%	11.1%	1.9%	24.8%
C01T05: Agriculture, hunting, forestry and fishing	87.3	1.3%	0.8%	0.1%	0.1%	0.0%	0.3%
C10T14: Mining and quarrying	39.0	0.6%	0.3%	0.1%	0.0%	0.0%	0.1%
C15T37: Total Manufactures	1 296.0	19.7%	7.9%	3.4%	2.3%	0.4%	5.7%
C15T16: Food products, beverages and tobacco	88.8	1.3%	0.7%	0.2%	0.1%	0.0%	0.3%
C17T19: Textiles, textile products, leather and footwear	65.4	1.0%	0.6%	0.1%	0.1%	0.0%	0.2%
C20T22: Wood, paper, paper products, printing and publishing	136.4	2.1%	1.0%	0.3%	0.2%	0.0%	0.5%
C20: Wood and products of wood and cork	17.4	0.3%	0.1%	0.0%	0.0%	0.0%	0.1%
C21T22: Pulp, paper, paper products, printing and publishing	119.0	1.8%	0.8%	0.3%	0.2%	0.0%	0.4%
C23T26: Chemicals and non-metallic mineral products	202.5	3.1%	1.4%	0.6%	0.3%	0.1%	0.7%
C23: Coke, refined petroleum products and nuclear fuel	13.3	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%
C24: Chemicals and chemical products	101.9	1.5%	0.6%	0.3%	0.2%	0.0%	0.4%
C25: Rubber and plastics products	64.3	1.0%	0.4%	0.2%	0.1%	0.0%	0.2%
C26: Other non-metallic mineral products	22.9	0.3%	0.2%	0.1%	0.0%	0.0%	0.1%
C27T28: Basic metals and fabricated metal products	167.8	2.5%	0.9%	0.4%	0.3%	0.1%	0.9%
C27: Basic metals	46.5	0.7%	0.2%	0.1%	0.1%	0.0%	0.3%
C28: Fabricated metal products	121.3	1.8%	0.7%	0.3%	0.2%	0.0%	0.6%
C29: Machinery and equipment, nec	170.6	2.6%	0.7%	0.6%	0.4%	0.1%	0.9%
C30T33: Electrical and optical equipment	198.5	3.0%	1.1%	0.6%	0.4%	0.1%	0.8%
C30T33X: Computer, Electronic and optical equipment	136.0	2.1%	0.8%	0.5%	0.3%	0.0%	0.5%
C31: Electrical machinery and apparatus, nec	62.5	0.9%	0.3%	0.2%	0.1%	0.0%	0.3%
C34T35: Transport equipment	181.9	2.8%	0.8%	0.4%	0.3%	0.0%	1.1%
C34: Motor vehicles, trailers and semi-trailers	67.6	1.0%	0.4%	0.2%	0.1%	0.0%	0.3%
C35: Other transport equipment	114.2	1.7%	0.4%	0.3%	0.1%	0.0%	0.9%
C36T37: Manufacturing nec; recycling	84.2	1.3%	0.7%	0.2%	0.1%	0.0%	0.3%
C40T41: Electricity, gas and water supply	29.1	0.4%	0.2%	0.1%	0.0%	0.0%	0.1%
C45: Construction	134.7	2.0%	0.9%	0.4%	0.2%	0.0%	0.5%
C50T74: Total Business Sector Services	4 434.0	67.3%	28.9%	13.7%	7.8%	1.3%	15.7%
C50T55: Wholesale and retail trade; Hotels and restaurants	1 492.5	22.7%	9.6%	4.1%	2.7%	0.5%	5.8%
C50T52: Wholesale and retail trade; repairs	1 300.5	19.7%	8.3%	3.6%	2.4%	0.4%	5.0%
C55: Hotels and restaurants	191.9	2.9%	1.3%	0.5%	0.3%	0.1%	0.7%
C60T64: Transport and storage, post and telecommunication	514.6	7.8%	2.9%	1.3%	1.0%	0.1%	2.5%
C60T63: Transport and storage	380.3	5.8%	2.0%	0.9%	0.7%	0.1%	2.1%
C64: Post and telecommunications	134.2	2.0%	0.9%	0.4%	0.2%	0.0%	0.5%
C65T67: Financial intermediation	379.2	5.8%	1.2%	2.1%	1.0%	0.1%	1.4%
C70T74: Real estate, renting and business activities	2 047.8	31.1%	15.2%	6.2%	3.2%	0.5%	5.9%
C70: Real estate activities	17.7	0.3%	0.1%	0.1%	0.0%	0.0%	0.1%
C71: Renting of machinery and equipment	27.0	0.4%	0.2%	0.1%	0.0%	0.0%	0.1%
C72: Computer and related activities	189.5	2.9%	1.2%	0.7%	0.3%	0.0%	0.6%
C73T74: R&D and other business activities	1 813.6	27.5%	13.7%	5.4%	2.8%	0.5%	5.2%
C75T95: Community, social and personal services	568.1	8.6%	4.2%	1.4%	0.7%	0.1%	2.3%
C75: Public admin. and defence; compulsory social security	42.5	0.6%	0.3%	0.1%	0.1%	0.0%	0.2%
C80: Education	134.1	2.0%	0.7%	0.4%	0.2%	0.1%	0.6%
C85: Health and social work	19.0	0.3%	0.1%	0.1%	0.0%	0.0%	0.1%
C90T95: Other social services	372.5	5.7%	3.0%	0.8%	0.3%	0.1%	1.5%
C10T41: Industry (Mining, Manufactures and Utilities)	1 364.2	20.7%	8.4%	3.6%	2.3%	0.4%	6.0%
C45T95: Total Services including Construction activities	5 136.8	78.0%	33.9%	15.5%	8.7%	1.4%	18.5%
C50T95: Total Services	5 002.1	75.9%	33.0%	15.1%	8.4%	1.4%	17.9%
C50T64: Wholesale, retail, hotels, restaurants, transport	2 007.0	30.5%	12.5%	5.4%	3.6%	0.6%	8.3%
C65T74: Finance, Real Estate and business services	2 427.0	36.8%	16.4%	8.3%	4.1%	0.6%	7.4%

Note: a/ The estimates, based on national industrial averages, are probably over-estimating the actual number of jobs: Export-oriented firms and their suppliers are usually larger and more efficient in the use of labour than purely domestic firms.

Source: OECD Trade in employment Data Set: Core Indicators

2. Sectoral Network Indicators for Selected TiVA countries and groups

Social network analysis is “social” in the sense that it looks at the strength of ties or relations between individuals (called “nodes” or “vertices”). It is particularly well adapted for analysing trade along supply chains, where GVCs may be of the “spider type”, hubs and spokes where traders are connected at short lengths, or “snakes” where distances may be larger from beginning to end, but the connections are strong and stable. The network indicators retained in this study are:

Indegree and Outdegree, which can be unweighted (in this case, it is the number of trade flows pointing to or from a given node or weighted by trade flows (value of imports and exports). The weighted degree is the sum of imports plus exports.

Other indicators belong to the family of centrality scores. This area is one of the most studied concepts in social network analysis (Borgatti, 2005). Numerous measures have been developed, including degree centrality, closeness, betweenness, eigenvector centrality etc. Closeness: nodes with low score have relatively short distance to travel to link with other nodes. Betweenness centrality and eigen centrality includes some idea of dominance: going through these nodes is the best way of getting to all others because of their influence (centrality). A trader with higher betweenness centrality would have more control over the trade network, because more trade flows pass through it. To quote Borgatti (2005, p. 61), “the idea is that even if a node influences just one other node, who subsequently influences many other nodes (who themselves influence still more others), then the first node in that chain is highly influential.” Closely associated with eigen centrality, PageRank is a probabilistic score based on a hierarchy of node by “link popularity”: A node is ranked higher as there are more links pointing to it. It is our best choice in this case of acyclic directed graph as it avoids issues found in other indicators such as eigenvector centrality (Newman, 2010, p. 171).

Clustering measures the tendency of a country to trade into a tightly knit group of trade partners. Eccentricity measure captures the distance between a country and the trade partner that is furthest from it; a low eccentricity means that the furthest away node is actually quite close. Here, a word of caution is called for. When working with the World Trade Network at aggregated level, only few bilateral trade flows are nil, so an indicator like eccentricity would have little sense. In order to focus only on significant bilateral trade relationship, in most of the analysis, bilateral flows smaller than 1% of reporter’s exports were not considered in the calculation of network indicators

Table 14 Annex table on World Trade Network indicators, selected countries (2014)

Sector	Label	Reporter	Eigen centrality	Weigh indegree	Weight out-degree	Weight in-degree	Page Rank	Between. centrality
C01T05	Agriculture	GBR	0.653	13044	4571	17616	0.0032	4.0E-05
C01T05	Agriculture	DEU	0.654	26109	11488	37597	0.0068	2.1E-05
C01T05	Agriculture	FRA	0.660	16621	15738	32359	0.0046	4.2E-05
C01T05	Agriculture	ITA	0.644	16333	5952	22285	0.0046	1.8E-05
C01T05	Agriculture	G20	0.637	11524	8431	19950	0.0023	1.5E-05
C01T05	Agriculture	EU	0.623	1848	2355	4377	0.0008	1.2E-05
C01T05	Agriculture	DVD	0.635	1848	2533	4720	0.0008	1.3E-05
C10T14	Mining	GBR	0.343	37316	36045	73361	0.0016	7.5E-05
C10T14	Mining	DEU	0.353	40716	5339	46055	0.0030	9.8E-05
C10T14	Mining	FRA	0.340	21849	3164	25013	0.0031	7.7E-05
C10T14	Mining	ITA	0.328	30371	1515	31886	0.0022	5.2E-05
C10T14	Mining	G20	0.328	26110	31789	64507	0.0019	5.1E-05
C10T14	Mining	EU	0.274	5023	713	5718	0.0006	2.2E-05
C10T14	Mining	DVD	0.277	5023	876	5920	0.0007	2.5E-05
C15T16	Agroindustry	GBR	0.878	55635	19250	74885	0.0042	4.0E-06
C15T16	Agroindustry	DEU	0.889	49377	50380	99757	0.0045	8.0E-06
C15T16	Agroindustry	FRA	0.878	41858	40595	82452	0.0038	4.0E-06
C15T16	Agroindustry	ITA	0.878	29678	31364	61041	0.0028	4.0E-06
C15T16	Agroindustry	G20	0.878	18709	16888	30433	0.0022	7.0E-06

C15T16	Agroindustry	EU	0.867	5501	4709	9856	0.0007	3.0E-06
C15T16	Agroindustry	DVD	0.873	6475	5471	13991	0.0008	3.5E-06
C17T19	Textiles	GBR	0.859	34315	11367	45681	0.0044	8.0E-06
C17T19	Textiles	DEU	0.859	32791	17020	49811	0.0052	8.0E-06
C17T19	Textiles	FRA	0.859	33226	16095	49322	0.0037	8.0E-06
C17T19	Textiles	ITA	0.850	26510	46456	72966	0.0047	6.0E-06
C17T19	Textiles	G20	0.854	13250	8288	23544	0.0023	6.5E-06
C17T19	Textiles	EU	0.842	2528	1561	3641	0.0007	5.0E-06
C17T19	Textiles	DVD	0.850	2942	1561	4742	0.0008	6.0E-06
C20T22	Wood and Paper	GBR	0.653	20147	15160	35307	0.0040	2.4E-05
C20T22	Wood and Paper	DEU	0.653	29947	37039	66986	0.0060	2.4E-05
C20T22	Wood and Paper	FRA	0.659	23499	13128	36627	0.0050	3.9E-05
C20T22	Wood and Paper	ITA	0.653	17244	10042	27286	0.0034	2.4E-05
C20T22	Wood and Paper	G20	0.635	9243	5924	12330	0.0018	2.1E-05
C20T22	Wood and Paper	EU	0.606	2185	2258	4946	0.0006	1.1E-05
C20T22	Wood and Paper	DVD	0.619	2768	2369	6251	0.0007	1.3E-05
C23T26	Chemicals	GBR	0.896	114647	96489	211137	0.0031	7.0E-06
C23T26	Chemicals	DEU	0.896	199384	219778	419162	0.0055	7.0E-06
C23T26	Chemicals	FRA	0.886	134557	110535	245092	0.0037	4.0E-06
C23T26	Chemicals	ITA	0.886	78247	82029	160276	0.0024	4.0E-06
C23T26	Chemicals	G20	0.896	66861	76037	128738	0.0024	7.0E-06
C23T26	Chemicals	EU	0.867	14821	15698	30653	0.0006	3.0E-06
C23T26	Chemicals	DVD	0.874	15683	15698	32518	0.0006	3.0E-06
C27T28	Metals	GBR	0.728	40919	25928	66847	0.0028	1.9E-05
C27T28	Metals	DEU	0.730	82521	101506	184028	0.0050	1.4E-05
C27T28	Metals	FRA	0.730	43068	36280	79348	0.0026	1.4E-05
C27T28	Metals	ITA	0.739	40505	52357	92863	0.0026	2.0E-05
C27T28	Metals	G20	0.729	40231	31104	73098	0.0027	1.4E-05
C27T28	Metals	EU	0.699	5740	4442	11889	0.0005	9.0E-06
C27T28	Metals	DVD	0.705	8082	7931	16163	0.0006	1.0E-05
C30T33	Electronics	GBR	0.832	72832	38808	111640	0.0036	1.3E-05
C30T33	Electronics	DEU	0.832	85612	127086	212697	0.0042	1.3E-05
C30T33	Electronics	FRA	0.822	61465	40621	102086	0.0028	7.0E-06
C30T33	Electronics	ITA	0.832	31984	32980	64964	0.0017	1.3E-05
C30T33	Electronics	G20	0.822	40131	22162	58724	0.0019	9.5E-06
C30T33	Electronics	EU	0.804	6926	5783	12524	0.0005	5.5E-06
C30T33	Electronics	DVD	0.811	8087	5783	15123	0.0006	6.0E-06
C34T35	Vehicles	GBR	0.605	96129	69767	165896	0.0053	3.4E-05
C34T35	Vehicles	DEU	0.606	121365	241680	363045	0.0067	3.1E-05
C34T35	Vehicles	FRA	0.614	78403	93855	172258	0.0046	3.7E-05
C34T35	Vehicles	ITA	0.597	38163	42935	81098	0.0018	2.8E-05
C34T35	Vehicles	G20	0.575	34241	53221	85739	0.0017	2.1E-05
C34T35	Vehicles	EU	0.555	5742	7351	12464	0.0004	1.2E-05
C34T35	Vehicles	DVD	0.560	7111	4795	15236	0.0005	1.5E-05
C50T64	Transport, etc.	GBR	1.000	150009	132177	282187	0.0031	1.0E-06
C50T64	Transport, etc.	DEU	1.000	240839	233691	474529	0.0048	1.0E-06
C50T64	Transport, etc.	FRA	1.000	154358	179782	334141	0.0032	1.0E-06
C50T64	Transport, etc.	ITA	1.000	102767	125590	228357	0.0023	1.0E-06
C50T64	Transport, etc.	G20	1.000	100382	90176	195155	0.0023	1.0E-06
C50T64	Transport, etc.	EU	1.000	16930	20700	40130	0.0005	1.0E-06
C50T64	Transport, etc.	DVD	1.000	24359	30113	50755	0.0007	1.0E-06
C65T74	Business services	GBR	0.770	101151	197709	298860	0.0047	1.3E-05
C65T74	Business services	DEU	0.770	148265	110426	258691	0.0066	1.3E-05
C65T74	Business services	FRA	0.758	69887	49973	119860	0.0029	1.1E-05
C65T74	Business services	ITA	0.758	56323	33794	90117	0.0025	1.1E-05
C65T74	Business services	G20	0.764	37497	27892	67744	0.0016	1.1E-05
C65T74	Business services	EU	0.734	13420	8468	21922	0.0008	9.0E-06
C65T74	Business services	DVD	0.741	15240	10660	28888	0.0009	9.0E-06
C75T95	Health, edu., etc.	GBR	0.687	26734	28323	55056	0.0064	1.5E-05
C75T95	Health, edu., etc.	DEU	0.697	24747	10876	35623	0.0065	1.9E-05
C75T95	Health, edu., etc.	FRA	0.687	15046	16528	31573	0.0040	1.5E-05
C75T95	Health, edu., etc.	ITA	0.687	9325	5489	14814	0.0024	1.5E-05
C75T95	Health, edu., etc.	G20	0.687	6565	5460	12879	0.0015	1.5E-05
C75T95	Health, edu., etc.	EU	0.636	1943	2143	3832	0.0007	1.3E-05
C75T95	Health, edu., etc.	DVD	0.661	2429	2143	4264	0.0009	1.3E-05

Notes: DVD: developed countries; DVD, EU28 and G20: simple average of countries' scores.

Source: Author's calculation based on *TiVA* data and Gephi software (Bastian et al. , 2009). ²³

3. Nominal competitiveness, trade costs and exchange rate simulation

The simulation is based on the national and industrial *TiVA* indicators for 2014 and looks at the compensatory devaluation that would be necessary to compensate the loss of UK exports competi-

²³ Gephi is an Open Source software for exploring and manipulating networks (<https://gephi.org/>)

tiveness to the EU27 due to increased trade costs on inputs imported from EU and output exported to the EU. *TiVA* allows to separate the direct domestic value-added (exported by the exporting industry) and the indirect domestic value-added. Therefore, it is possible to disentangle the cross-effects of trade costs, devaluation of the domestic currency and differentiated draw-backs.

This back-of-envelope simulation is extremely simplified and looks first at the losses incurred by UK firms due to increased tariff and non-tariffs trade costs on UK output exported to EU and on UK's imports of inputs originating from EU, under three draw-back scenarios. Then the simulation defines the devaluation relative to the Euro which will be necessary to compensate for the increase in trade costs. UK exporters are price takers and have to lower their factory-gate price in Euro in order to compensate for the higher cost of exporting to EU. In addition, they face higher production costs if UK retaliates and imposes MFN tariffs on the inputs they source from EU. A devaluation of the Pound with respect to Euro is expected to compensate both effects, but exchange rate variation will affect only the domestic part of the value-added.

Additional trade costs on output exported to and inputs imported from the EU are the MFN tariffs taken from Cappariello (2017) plus an hypothetical 5% due to the monetary incidence of non-tariff aspects (increased administrative paperwork, delays at the border, etc). The share of inputs sourced from EU is based on *TiVA* data for year 2014 and includes both goods and services. Indeed, foreign service value-added is often embodied or embedded in tangible inputs (goods) and is also affected by tariffs and other trade costs. The general trend on available 2000-2011 data is for a decrease in the role of EU input suppliers to UK industries, the weight of components sourced from this region has increased markedly for transport equipment and –but to a lesser extent– for electronics and computer (see Table 15).

Table 15 Annex table: Imports of intermediate products imported from EU by sector, UK and selected countries (2000-2011)

Sector/Importers ^a	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All sectors												
GBR	52.4	52.8	55.1	56.2	54.7	52.4	51.5	52.7	51.0	50.3	49.0	47.9
Average DEU-FRA-ITA ^b	57.7	58.8	60.7	61.3	60.9	58.6	57.3	57.8	55.4	57.0	55.5	54.5
Average <i>TiVA</i> ^b	40.3	40.9	42.0	42.6	43.3	42.0	40.8	41.8	39.7	40.0	39.2	38.9
All Manufacture sectors												
GBR	56.3	57.5	60.8	62.5	61.6	60.6	59.7	60.0	59.8	56.9	56.9	57.8
Average DEU-FRA-ITA ^b	66.6	66.4	68.2	68.5	67.6	66.9	65.6	65.0	63.4	63.3	62.1	62.3
Average <i>TiVA</i> ^b	46.6	46.9	47.1	47.8	47.9	46.9	46.1	45.6	44.3	43.7	42.5	42.9
Chemicals and non-metallic mineral products												
GBR	63.9	64.2	66.8	67.9	63.3	59.0	61.9	59.9	62.5	61.2	59.8	60.7
Average DEU-FRA-ITA ^b	69.5	67.7	69.6	70.4	68.2	67.2	67.1	66.0	64.3	63.9	62.7	62.6
Average <i>TiVA</i> ^b	47.5	47.4	48.0	49.8	47.7	47.5	48.0	46.8	45.3	44.6	43.2	43.0
Computer, Electronic and optical equipment												
GBR	42.3	44.3	48.4	50.5	49.7	50.4	48.9	51.2	48.2	46.2	44.2	45.4
Average DEU-FRA-ITA ^b	52.2	53.2	55.8	53.3	50.7	49.7	48.8	48.2	45.0	43.7	41.4	42.8
Average <i>TiVA</i> ^b	42.8	43.5	44.9	43.2	43.5	43.2	40.2	40.6	38.0	35.1	33.8	35.7
Transport equipment												
GBR	58.3	57.7	61.8	61.8	64.3	66.2	62.3	64.5	62.9	55.7	60.8	67.1
Average DEU-FRA-ITA ^b	72.6	71.6	73.6	76.6	75.9	76.2	73.0	75.2	69.9	70.5	70.3	71.1
Average <i>TiVA</i> ^b	47.5	50.4	51.4	50.9	52.6	52.6	52.0	51.4	51.5	49.9	49.3	51.9

Notes: a/ Share of EU imported intermediate imports in the imported total, percentage; b/ simple average.
Source: Source: Author's calculation based on *TiVA* data

The devaluation of the Pound affects the price of the domestic value added (wages, profits and net indirect taxes) expressed in USD (the *TiVA* accounting unit). Because the domestic share of value-

added is always lower than 1, a 1% increase in trade cost will only be compensated by a devaluation larger than 1%. This is an example of the “*magnification effect*” of trade costs in GVC production settings (Escaith, 2017). For example, in the case of transport equipment, a 9% increase in EU tariff on UK exports requires a $(9\%/62\% = 14.5\%)$ Pound-Euro devaluation to reduce one-to-one the cost of UK primary and intermediate inputs (calculation based on 2014 *TiVA* coefficients). The lower the domestic share of value-added, the higher the devaluation required to compensate higher trade costs. We assume for simplicity that the procurement price of the indirect domestic-value added is derived from a fixed mark-up on the cost of production of first and second tiers domestic suppliers: The cost of sourcing inputs from these suppliers will increase in proportion of the additional import costs they have to pay on the share of Foreign Value-Added sourced from EU.²⁴

Three options are considered for drawing-back the additional trade costs (tariffs and non-tariffs) paid on imported inputs when the product is exported. In the first one, additional trade costs on imported inputs can be drawn-back by all domestic producers; in the second one, only the direct exporters can reclaim the additional trade costs: first and second-tiers domestic suppliers cannot benefit from draw-back schemes and reflect the increased trade costs on their imported inputs in their output prices. The third option excludes all possibility of draw-backs. Another way of looking at these options is the following: the full draw-back situation refers to the case where all UK firms contributing to the domestic value chain are able to divert their purchase of inputs to cheaper non-EU suppliers, a situation somewhat similar to the Minford (2016) hypothesis; the second option applies when the UK lead-firm can do it but not its second-tier suppliers (a very improbable situation when trade takes place in a global value chain as participating firms have little choice when picking their key suppliers, see footnote 24); the third option applies when no trade substitution is possible.

The cost-implication of the first case is straightforward: when all additional trade costs on imported inputs are subsidized (reimbursed through a draw-back system) or avoided, the net effect on the market price of the UK export in EU is the additional trade cost on exported output (e.g., additional tariffs imposed by importing countries). When draw-backs are limited to the exporting industry (the general case), the calculation is more complex. If the exporting firm does not have to pay a higher price for its imported inputs, its production costs will nevertheless increase due to the higher procurement cost of EU inputs sourced from first and second tier domestic suppliers (per Table 15, 48% of foreign inputs are sourced from EU in average of UK sectors). In absence of drawbacks, the additional trade cost is equal to the cost of exporting plus the cost of sourcing all EU inputs required by the exporting industry and its UK suppliers.

For example, if no drawback schemes are made available to the exporters of transport equipment and their domestic suppliers, the additional production cost due to higher inputs imported from EU is 1.3% and the required compensatory devaluation is 16.6% $([9\%+1.3\%]/62\%)$, see Table 16. The simulation highlights the weight of non-tariff trade costs which may amplify the devaluation required to compensate additional trade costs up to a factor of 5, as well as the importance of devising administrative and fiscal measures to reduce their impact.

²⁴ In other words, there is no trade deviation on inputs after leaving the EU (correcting an EU28 trade diversion effect), a hypothesis which is consistent with most empirical studies (Freund and Ornelas, 2010) and would almost certainly apply when B2B input trade takes place within a well-structured international supply chain.

Table 16 Compensatory devaluation required to cancel-out the effect of increased EU27 trade costs

Drawback:	Full		Partial		None	
Additional trade costs :	Tariff	Tariff and NTM	Tariff	Tariff and NTM	Tariff	Tariff and NTM
Sectors:						
Transport equipment	14.5%	22.5%	15.3%	24.1%	16.6%	26.7%
Chemicals and non-metallic mineral products	4.2%	12.1%	4.9%	13.3%	6.0%	15.6%
Computer, electronic and optical equipment	2.6%	9.5%	2.9%	10.1%	3.5%	11.3%

Note: Based on 2011 *TiVA* coefficients, includes additional production and export costs (see text)

Source: Author's calculation based on *TiVA* data and Cappariello (2017)

This simulation is based on a set of simple accounting relationships and does not pretend to be an economic analysis of the impact of trade costs on production and market prices. A more detailed backward linkage analysis would allow identifying the particular sector supplying specific inputs to each exporting industries and calculate more precisely the additional net cost. Inputting the monetary impact of non-tariff trade costs would be more difficult, albeit some estimates do exist (Escaith, 2017). Moreover, the simulation implies a full passthrough on prices of duty taxes and other additional trade costs due to a hard Brexit. This may not be the case when firms “price to market” and adjust accordingly their mark-up margins. Additionally, if demand for intermediate products is price elastic (high Armington elasticity), UK producers may shift to cheaper non-EU suppliers.²⁵ For complex GVC products, it is probable that the price elasticity within a GVC is low, so little substitution may take place in the short to medium terms. On the other hand, as the market for complex products is often oligopolistic, adjusting mark-up margins to absorb variations in procurement prices is quite plausible.

²⁵ Long-run estimates of Armington elasticities are usually larger than short-run estimates, which means that our simulation applies mainly in the short-run.