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# Key sectors in Input-Output Production Networks: an application to Brexit

Mauro Gallegati, Raffaele Giammetti, Alberto Russo<sup>1</sup>

## Abstract

This paper presents the first detailed and holistic description of the European production network (EPN) and provides different rankings of the most 'systemically important' industries involved in Brexit. Employing techniques of complex networks analysis and Input-Output traditional tools, the study identifies those industries that are key in the complex structure of the UK-EU trade relationships. The method developed would help policy-makers to better understand which tariff would have a more distortive impact, which export sector should be pushed, which imports should be safeguarded. Such information may have foremost importance in the negotiations between the UK and EU. Our findings suggest that Brexit would be not just a problem for the UK, as it is often portrayed, but any form of Brexit could propagate affecting the global production system. Further, by inspecting industries centrality within the EPN, we find that the UK could be less exposed to trade barriers than EU countries.

**Keywords:** Brexit, trade barriers, tariffs, key sector, centrality measures, input-output analysis, production networks, value chains.

**JEL Classification:** C67, F13, F14, R11

## 1. Introduction

The structure of the global production system is nowadays characterised by a complex network of industries linked within and across different sectors and countries by means of input-output production ties (Amador and Cabral, 2017). The texture of the interdependencies between industries has relevant implications in the propagation throughout the economy of sectoral shocks and stimulus (Acemoglu et al., 2012). The primary role played by such interconnections in generating macro fluctuations was highlighted by the last economic crisis. Since the economic recession hit the USA and the world, there has been a large and growing body of research regarding the government bailout plans, in both the academic arena as well as in the popular press. Several criteria have emerged from the debate on the priority and choice of industries that the government should bailout in economic recessions (Luo, 2013). For example, focussing on the scale of the industry and its internal performance, some literature states that governments and institutions should come to the rescue of the 'too big to fail' firms and banks (White, 2014). Other studies highlighted the relevance of network effects, and suggest that should be prioritised 'too interconnected' (Battiston et al., 2012b; Markose et al., 2012) and 'too central to fail' (Battiston et al., 2012a) industries. The present paper aims to study the properties of the

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European production network (EPN) and to identify the 'systemically important' sectors from a Brexit perspective. After the vote on January 15th, the spectrum of a no-deal scenario is approaching, therefore the identification of key sectors would be of a foremost relevance to suggest which industries are to be safeguarded before the potential negative impact of Brexit unfolds.

Using the recently constructed World Input-Output Database (WIOD), we build and summarise the main features of the EPN in which the nodes are individual sectors in different EU countries, and edges are dollar goods and services flows within and across sectors. The topological properties of the EPN reveal that in Europe sectors are both highly, and asymmetrically, connected, as a few industries placed in core countries, especially Germany, the UK, and France, dominate the EPN. These key players are the most central nodes in the EPN and they could act as global propagators in the network. This implies that a shock affecting one of these hubs will spread quickly to most sectors, either domestically or abroad, thus affecting the performance of the aggregate economy (Carvalho, 2014). From a Brexit point of view, it is worth noting that the UK is the most represented country in both the top 30 sectors ranked by size and in the top 30 sectors ranked by network 'influence measures' of centrality. This means that both macro-regions, the UK and the EU27, should safeguard UK key sectors from the potential negative impact of Brexit.

In the second part of the paper, building on W. Chen et al. (2018), we develop a measure of country and sectors exposure to sectoral tariff and non-tariff barriers. We apply the 'hypothetical extraction' method, a well-known input-output technique, to identify those sectors for which a reduction in trade flows implies a higher loss for the economies involved. Furthermore, our indicator provides answers to questions like to what extent the UK (EU) GDP depends on the export of sector  $i$  to EU (UK), or conversely, to what extent the UK (EU) GDP depends on the import from the  $i^{th}$  EU (UK) sector? In this sense, the measure we develop allows for the identification of key import and export sectors.

Our results demonstrate, on the one hand, that the UK is the country most exposed to the economic risk deriving from Brexit. On the other hand, that the UK would be less exposed than EU countries to trade barriers. Indeed, we find that the most vulnerable UK sectors are services industries whose products can only be subject to non-tariff barriers, whereas the most exposed EU industries are goods sectors, mainly manufacturing, which can be subject to both tariff and non-tariff barriers. However, this conclusion could be no longer valid if EU imposes extreme non-tariff barriers, for example by banning the UK from the sale of financial products.

The structure of the paper is as follows: the second section explores and discuss the relevant literature. The third section examines the topological structure of the EPN, whilst the fourth section describes the model and the methodology used for analysis. The fifth section presents and discusses the results. Lastly, the paper offers some concluding remarks.

## **2. Propagation of Shocks and Key Sectors in Input-Output Networks: a short Literature Review**

The modern global economic system is a highly interlinked network composed of several heterogeneous industries connected within and across different countries by means of input-output trade linkages. Several studies pointed out that the structure of this production web is crucial in establishing whether and how microeconomic local shocks can propagate throughout the economy and lead to significant aggregate fluctuations (Carvalho, 2014). Therefore, understanding the structure of this production network is of a foremost importance to design predictive tools and better inform regulators on how to dampen aggregate variability and reduce the likelihood of systemic risk.

Since the contributions of Leontief (1936) and Hirschmann (1958), the idea of input-output linkages as a key channel through which shocks propagate throughout the economy has been explored mainly in the real business cycle literature (e.g. Long and Plosser, 1983; Horvath, 1998, 2000; Shea, 2002). Recently, several papers have revisited the argument, proposing new approaches and perspectives (see Roson and Sartori, 2016 for a wide review). For example, Gabaix (2011) finds that the distribution of firm size in an economy is typically fat-tailed. A degree distribution is fat-tailed when there are only a few industries which have several connections to many other industries. Hence, any shock affecting these central sectors would be able to propagate and generate macro disturbances. Under these circumstances, the central limit theorem breaks down, and idiosyncratic shocks to large sectors or firms affect aggregate outcomes. Building on Gabaix (2011) ‘granular’ hypothesis, Carvalho and Gabaix (2013), interpret the recent rise of macroeconomic volatility as a direct consequence of the increase in the size of the financial sector. Further important theoretical contributions in this direction were made by Acemoglu et al. (2012), Acemoglu et al. (2016), Acemoglu et al. (2017), Carvalho (2014) and Carvalho et al. (2016), who focused on the impact the topology of the economic network has on shock propagation. In particular, in their seminal work, Acemoglu et al. (2012) find that the existence of relatively few, ‘dominant’, suppliers of intermediate factors fosters the amplification of sectoral shocks. The authors propose to interpret the input-output structure as a (weighted) network, where the nodes correspond to the sectors and the links to the input-output trade flows. In such a framework, the relative importance of an industry as a supplier for other industries is captured by the sum of weights of all outgoing links, i.e. what is known in network theory as the weighted degree or strength of a node. Studying the distribution of degrees in the economy and the ‘fat-tailedness’ of that distribution, Acemoglu et al. (2012) conclude that the asymmetric and fat-tailed distribution of the input-output network connections serves as the micro origin of the macro economic fluctuations.

Most of the empirical works in this field focussed on a single national economy, whilst much less attention has been given to the cross-country transmission of shocks, which is crucial from a Brexit perspective. However, there are exceptions. For example, Alatriste-Contreras and Fagiolo (2014), investigate how economic shocks propagate through the input-output network connecting industrial sectors in Europe. They show that the more a sector is globally central in the country network, the largest its impact. Similar results are stressed by the recent and growing literature on trade in value added and its implication on the transmission of shocks via international trade (e.g. see Johnson and Noguera, 2012; Garbellini and Wirkierman, 2014; Nagengast and Stehrer, 2016 and Tukker and Dietzenbacher, 2013, among others). Building on this literature and on Gabaix (2011), Di Giovanni and Levchenko (2012) and Eaton et al. (2012), show that international trade amplifies the ‘granularity’ of an economy, and hence its sensitivity to sectoral shocks.

The common theme across the literature reviewed is that whenever few hubs dominate the linkage structure in the economy, an idiosyncratic shock which hit these hubs will result in sizable aggregate fluctuations. Therefore, from a Brexit perspective, it is of primary importance to study the structure of the European production network (EPN), finding out if key sectors exist and identify them in order to understand which sectors should be safeguarded. Further, a key sector analysis would allow policy-maker to better understand which sectoral tariffs would have a more distortive impact.

To date many studies have been conducted on the economic impact of Brexit (see the special issue edited by Philip McCann, 2018 and the recent mini-symposium edited by David Greenaway and Chris Milner, 2019, among others). Just a few have emphasised the relevance of input-output linkages (e.g. Vandebussche et al., 2017; Cappariello et al., 2018; W. Chen et al., 2018). Nobody focused specifically on the analysis of the key sectors in the EPN. The present study aims to fill this gap in the literature.

The identification of key sectors in an economy has been one of the most important research topics in input-output analysis, for a long time (see Miller and Blair, 2009; Temurshoev and Oosterhaven, 2014 for a wide review). Since the seminal works of Rasmussen (1956), Chenery and Watanabe (1958) and Hirschman (1958), this strand of input-output literature has often focused on the number, strength, and structure of inter-sector linkages (Yotopoulos and Nugent, 1973; Los, 2004). After the first introduction of the linkage measures, several changes have been proposed (Jones, 1976). For example, the eigenvector method of backward linkages proposed by Dietzenbacher (1992), which is based on the reasoning that industries with more linkages should be weighted more (Luo, 2014). This method is similar to the eigenvector centrality long used in network theory and social network analysis, according to which nodes are considered to be central in the network if their connections in the network are themselves well-connected nodes (see García Muñiz et al., 2008; García Muñiz et al., 2011; Alatraste-Contreras, 2015 and Gurgul and Lach, 2018 for a discussion on the similitudes between input-output linkage measures and network centrality measures). One drawback of the eigenvector method is that it does not penalise the distant connections (Newman, 2010). Therefore, its variations such as Katz-Bonachic centrality (Katz, 1953; Bonachic, 1987) and PageRank centrality (Brin and Page, 1998) have been preferred in recent studies on input-output networks (Acemoglu et al., 2012; Carvalho 2014; Cerina et al. 2015).

All these measures generally identify the key or strategic sectors in the network. However, focussing on Brexit as a trade shock, we are mainly interested in the input-output trade connections between the UK and European countries. In this case the so-called ‘hypothetically extraction method’ is the best possible choice. The extraction technique is widely 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  $\mathbf{A}$ , then using the Leontief model, to compute the reduced outputs obtained when  $i = 0$  and compare with total output before extraction (see Miller and Blair, 2009; Dietzenbacher and van der Linden, 1997; Miller and Lahr, 2001; Dietzenbacher and Lahr, 2013 and Los et al., 2016 for insight and extensions). W. Chen et al. (2018) use this method to rank European regions in terms of economic exposure to Brexit. Building on this contribution, we use the hypothetical extraction method to rank the key country-sectors in the UK EU input-output network. Hence, we develop an index of exposure to sectoral tariffs that would be useful for the design of trade policies.

### **3. The European Production Network**

During the last decades, the degree of trade integration between the UK and EU countries has strengthened significantly due to the increased trade in intermediate goods and the development of supply chains (Mulabdic et al. 2017; J. Chen, 2018). The emergence of such production networks implies that one can no longer consider bilateral trade in isolation when evaluating the impact and transmission of idiosyncratic shocks or trade policy as Brexit (Johnson, 2014; Acemoglu et al., 2012). Therefore, in this section we show how to build the EPN, the main features of the EPN, and the most central sectors.

#### **3.1. Mapping inter-industrial connections to data**

The construction of the EPN requires the availability of a global input-output table. Such data have become available only very recently. Here, we employ the World Input-Output Table (WIOT) available from the World Input-Output Database (WIOD), which has the main advantage that it

provides time-series of global input-output tables, covering, at the time of writing, 56 industries classified by the International Standard Industrial Classification revision 4 (ISIC Rev.4), in 43 countries in the world plus a region called ‘Rest of the World’, for the period 2000-2014, although we make use only of the 2014 data (see Timmer et al., 2014 and Dietzenbacher et al., 2013 for sources and details). Figure 1 shows the schematic outline for a WIOT. Essentially, it includes a combination of national input-output tables in which the use of products is broken down according to country-industry of origin.

	Intermediate use (S columns per country)			Final use (C columns per country)			Total
	1	...	N	1	...	N	
S Industries, country 1	$\mathbf{Z}^{11}$	$\mathbf{Z}^{1\cdot}$	$\mathbf{Z}^{1N}$	$\mathbf{F}^{11}$	$\mathbf{F}^{1\cdot}$	$\mathbf{F}^{1N}$	$\mathbf{x}^1$
...	$\mathbf{Z}^{\cdot 1}$	$\mathbf{Z}^{\cdot\cdot}$	$\mathbf{Z}^{\cdot N}$	$\mathbf{F}^{\cdot 1}$	$\mathbf{F}^{\cdot\cdot}$	$\mathbf{F}^{\cdot N}$	$\mathbf{x}^{\cdot}$
S Industries, country N	$\mathbf{Z}^{N1}$	$\mathbf{Z}^{N\cdot}$	$\mathbf{Z}^{NN}$	$\mathbf{F}^{N1}$	$\mathbf{F}^{N\cdot}$	$\mathbf{F}^{NN}$	$\mathbf{x}^N$
Value added	$(\mathbf{v}^1)'$	$(\mathbf{v}^2)'$	$(\mathbf{v}^N)'$				
Output	$(\mathbf{x}^1)'$	$(\mathbf{x}^2)'$	$(\mathbf{x}^N)'$				

**Figure 1.** A world input-output table with  $N$  countries and  $S$  sectors (source: Los et al. 2013).

The stylised WIOT depicted in Figure 1 illustrates a simplified WIOT with  $N$  countries and  $S$  sectors, which together constitute the world economy. The rows in the WIOT give the total dollar value of deliveries of output from a particular industry in a given country to another industry for intermediate use (block matrices labelled  $\mathbf{Z}$ ), or to final user (block matrices labelled  $\mathbf{F}$ ), either within the same country or abroad. The fundamental accounting identity of any input-output table is that total use of output in a row equals total output of the same industry as indicated by the sum of inputs in the respective column in the left-hand part of the table. The columns indicate the amounts of intermediate inputs needed for production; hence, they are informative about the technology of production. What remains between total output and total intermediate inputs is value added ( $\mathbf{v}$ ), i.e. the direct contribution of domestic factors to output.

Input-output tables, as one can guess, provide a natural source of information for representing the economy as a network. In particular, in order to build the EPN we consider the  $\mathbf{Z}$  block matrices of the WIOT, for the 28 EU economies, as a weighted adjacency matrix of a network where the nodes are individual sectors in different countries, and edges are dollar goods flows within and across sectors. The direction of the flows goes from the supplier sector to the buyer sector. This data contain 1568 nodes (56 sectors in each of the 28 countries) and 2241747 directed weighted edges.

### 3.2. The Structure of the EPN

The aim of this section is to summarise the main topological properties of the EPN, from a Brexit perspective. Our primary interest is in illustrating the degree of industries connection, the density of sectoral interactions, the distance between country-sectors, and the presence of hub sectors or potential shock propagators in the network. These basic network statistics allow us to provide a descriptive analysis of the EPN and advance hypotheses on the propagation of a trade shock, as Brexit would be.

To study the extent to which industries are connected in the EPN we start analysing the degree and strength distributions. The degree of a node in a network is defined as the number of links incident upon a node, here, the number of input-output connections each sector has. When these connections

are weighted, the strength of a node is measured, i.e. the sum of weights attached to the edges belonging to a node. Here, the dollar amount of input-output connections each sector has. Recall that the EPN is based on the weighted adjacency matrix  $\mathbf{Z}$  that is suitable to study the strength distribution. On the other hand, to analyse the degree distribution of the EPN, as in Cerina et al. (2015), we need to define a regular binary adjacency matrix  $\mathbf{D}$ , where  $D_{ij} = D_{ji} = 1$  if either  $Z_{ij} > 0$  or  $Z_{ji} > 0$ , and  $D_{ij} = D_{ji} = 0$  otherwise. Further, according to the direction of the connections, a sector has an in-degree ( $d_i^{in}$ ) and an in-strength ( $s_i^{in}$ )<sup>2</sup> respectively defined as the sum of all elements in the column  $i^{th}$  of the adjacency ( $\mathbf{D}$ ) and weighted ( $\mathbf{Z}$ ) matrices:

$$d_i^{in} = \sum_{j \neq i} d_{ji} \quad (1)$$

$$s_i^{in} = \sum_{j \neq i} s_{ji} \quad (2)$$

Conversely, a sector has an out-degree ( $d_i^{out}$ ) and an out-strength ( $s_i^{out}$ ) defined as the sum of all elements in the row  $i^{th}$  of the adjacency ( $\mathbf{D}$ ) and weighted ( $\mathbf{Z}$ ) matrices, respectively:

$$d_i^{out} = \sum_{j \neq i} d_{ij} \quad (3)$$

$$s_i^{out} = \sum_{j \neq i} s_{ij} \quad (4)$$

Summarising, the in(out)-degree of a node  $i$  represents the number of supplier (buyer) sectors linked to sector  $i$ . Similarly, the in(out)-strength of a node  $i$  represents the dollar value of goods employed as inputs (delivered as outputs) by sector  $i$ . The sum of in and out degree or in and out strength are respectively the total-degree and total-strength.

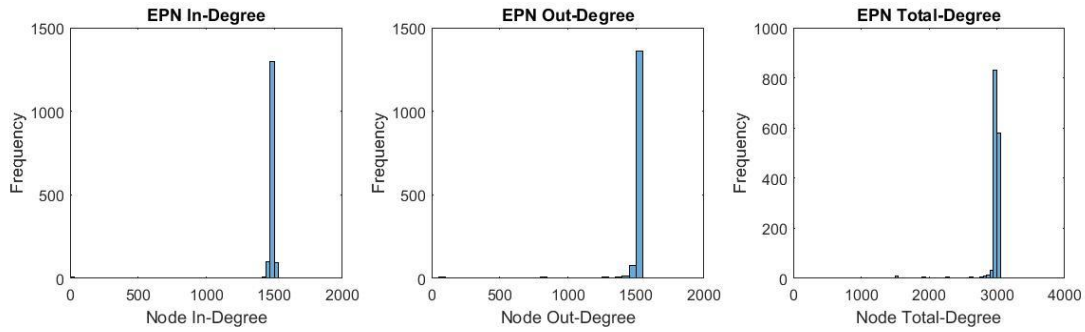
As shown in Figure 2, the EPN is featured by highly left skewed degree distributions, showing that most of the sectors in the economy have many connections with other sectors. The average in-degree and out-degree is about 1478, i.e. every node is linked with almost every node. In particular, most of the values of the out-degrees are concentrated on the highest values. Therefore, there are sectors that act as general suppliers delivering inputs to many or all other sectors (Alatriscite-Contreras, 2015 shows similar results). The high connectivity of the EPN is also highlighted by the density of the EPN that is 0.976, a high value which suggests that in the network under consideration sectors are highly dependent on almost all other sectors. Furthermore, the diameter, defined as the shortest distance between the two most distant nodes in the network, which is the largest number of steps that separate sector  $i$  from sector  $j$  for all possible pairs of sectors ( $i, j$ ), is 3; and the average path length, i.e. the average of the number of steps it takes to get from sector  $i$  to sector  $j$  for all possible pairs of sectors ( $i, j$ ), is 1.

Moving from the unweighted EPN to the weighted one, Figure 3 illustrates the empirical distributions of in-strength, out-strength and total-strength in the EPN. The  $x$ -axis is, respectively, the in, out and total strength for each country-sector presented on a log scale. The  $y$ -axis, also in log scale, represents the probability that the sector  $i^{th}$  has a strength larger than or equal to  $x$ . Hence, the upper left-hand portion of all the three subgraph, shows that nearly 100 percent of country-sectors have an in, out and total strength greater than 0.01; moving down on the  $y$ -axis we see that only about one tenth

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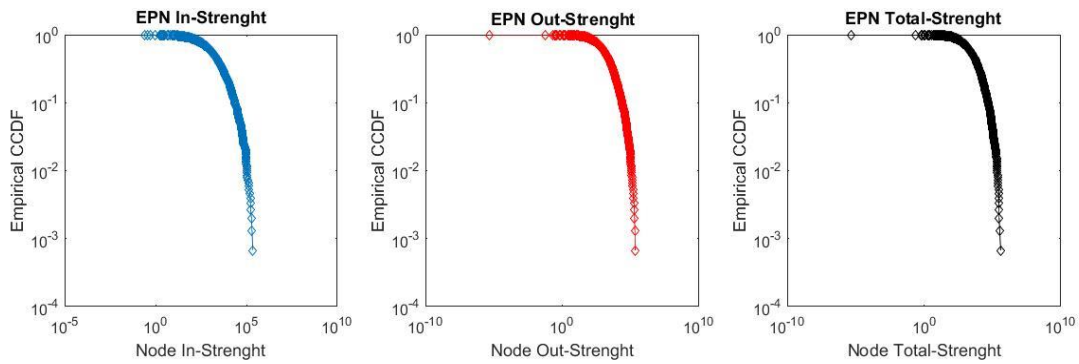
<sup>2</sup> Note that the in-strength is similar to the Chenery and Watanabe (1958) direct backward linkages measure, obtained by the column sums of the input matrix  $\mathbf{A}$ .

of all country-sectors have an in, out and total strength greater than 10000; and finally, the right-hand portion of all the distributions shows that only less than 1 percent of all country-sectors have an in, out and total strength greater than 100000. Therefore, on the contrary to the degree distributions observed, the in, out and total strength distributions for country-sectors in the EPN are all positively skewed.



**Figure 2.** Histogram of in-degree, out-degree and total-degree distribution for the European Production Network 2014.

Our findings are coherent with Alatraste-Contreras and Fagiolo (2014), Alatraste-Contreras (2015) and Luu et al. (2017), which show that each European economy at sectoral level of aggregation is characterised by negatively skewed degree distributions and positively skewed strength distributions. The heavy tailed behaviour of the strength distributions means that there is a statistically significant probability that a node has a very large strength compared to the average, i.e. in the EPN many country-sectors have a low strength, whilst only a few have high strength values.



**Figure 3.** Empirical Counter-Cumulative Distribution Function of in-strength, out-strength and total-strength for the European Production Network 2014.

The unequal distribution of in, out and total strength suggests the presence of hub-like country-sectors. In fact, as shown in Table 1, the EPN is dominated in terms of strength, i.e. dollar goods that flow through a sector, by a few industries placed in core countries, especially, Germany, the UK, and France. These key players could act as global propagators in the network. This implies that a shock affecting one of these hubs will spread quickly to most sectors, either domestically or abroad, thus affecting the performance of the aggregate economy (Carvalho, 2014). From a Brexit point of view, it is worth noting that the UK economy plays a primary role hosting more than 20 percent of top industries. Notably, according to the strength rankings, the UK and EU should take care of the trade



relationships that involving the following UK's industries: construction (F), which is the largest sector in terms of total strength, health (Q), real estate (L68), electricity and gas (D35), food products (C10-12), administrative services (N), financial services (K64), retail trade (G47), legal and accounting (M69-70).

country-sector	in-strength	country-sector	out-strength	country-sector	tot-strength
DEU_C29	272498,8	DEU_N	234098,36	GBR_F	424515,55
GBR_F	225088,8	FRA_N	213793,85	DEU_C29	402500,36
FRA_F	203144,5	GBR_F	199426,72	DEU_N	336599,33
DEU_F	188456,9	GBR_N	191547,49	DEU_F	309562,27
DEU_C10-12	170753,8	DEU_L68	185875,73	FRA_N	306366,88
ITA_F	167043,6	FRA_M69_70	174760,05	FRA_G46	300768,77
DEU_C28	164105,8	FRA_G46	158369,81	DEU_L68	296700,69
GBR_Q	151958,3	DEU_H52	152657,35	FRA_F	288916,08
FRA_G46	142399	DEU_G46	146143,95	GBR_N	288616,79
FRA_C10-12	139922,9	GBR_K64	133260,23	DEU_C28	265780,30
ESP_C10-12	133140,2	GBR_M69_70	131851,37	ITA_F	263051,82
ITA_C10-12	126986,3	DEU_C29	130001,58	DEU_G46	251530,40
DEU_L68	110825	FRA_K64	126867,99	DEU_C10-12	249352,16
ITA_G46	107965,7	DEU_F	121105,40	ESP_C10-12	236122,80
GBR_L68	107884,4	GBR_D35	117598,56	GBR_K64	229237,41
FRA_M69_70	107149,9	DEU_K64	115622,15	GBR_D35	224378,79
GBR_D35	106780,2	ITA_G46	112145,64	FRA_C10-12	223866,58
DEU_C20	105407,3	DEU_C25	112080,42	ITA_G46	220111,31
DEU_N	102501	DEU_C24	105357,57	DEU_M69_70	218904,98
DEU_Q	98574,22	DEU_C20	103988,15	DEU_C20	209395,42
GBR_C10-12	97505,82	ITA_N	103771,05	GBR_Q	209232,51
GBR_N	97069,3	DEU_D35	103011,98	DEU_K64	207556,63
GBR_K64	95977,18	ESP_C10-12	102982,65	ITA_C10-12	203823,38
DEU_G47	95218,18	DEU_C28	101674,50	DEU_C25	199102,33
GBR_G47	93847,27	FRA_D35	99000,40	FRA_K64	196062,07
DEU_D35	92778,75	ITA_K64	98489,34	DEU_D35	195790,73
ITA_C28	92725,99	ESP_D35	96462,71	DEU_C24	194794,47
FRA_N	92573,03	GBR_C10-12	96027,96	GBR_C10-12	193533,79
DEU_K64	91934,47	ITA_F	96008,18	GBR_M69_70	182039,83

**Table 1.** Top 30 country-sectors ranked by in, out and total strength (millions of dollar). For sector abbreviations see di annex.

To sum up, the structure of the EPN in which sectors are both highly connected as shown by the degree distributions, and asymmetrically connected as reported by the strength distributions, combined with the remarks about the EPN density, diameter, average path length, and the presence of a small number of hubs, suggest the small-world nature of the EPN (on the definition of small-world networks see Caldarelli, 2007). In production networks characterised by these topological properties a local idiosyncratic shock, as it could be a trade shock due to Brexit, is able to propagate through the whole European economy and generate a sizeable global disturbance (Acemoglu et al., 2012; Carvalho, 2014; Cerina et al., 2015).

### 3.3. Central Nodes in the EPN

In the previous section, we have explored the EPN and identified the main sectors in terms of strength. However, this preliminary rough measure does not offer a complete view of the importance of a sector. For example, the strength of a node does not take into account the degree to which a specific sector is involved in global value chains (Bohn et al., 2018). Therefore, in this section we conduct a local analysis of the nodes and individualise the key sectors in the EPN employing the traditional methods

of input-output literature and the PageRank centrality, a network-based measure also known as Google's algorithm (Brin and Page, 1998).

Consider an economy with  $n$  industries and denote the interindustry flows by the  $n \times n$  transaction matrix  $\mathbf{Z}$ . Let  $\mathbf{f}$  be the vector of industry final demands and  $\mathbf{x}$  the vector of industry gross output. The accounting equations are given as  $\mathbf{x} = \mathbf{Z}\mathbf{i} + \mathbf{f}$ , where  $\mathbf{i}$  is the summation vector, i.e. a vector of all ones. Define the direct input coefficients as the ratio of input supplied by  $i$  and bought by  $j$  over the gross output of sector  $j$  as  $a_{ij} = z_{ij}/x_j$ , which is the typical element of the economy's direct requirements matrix  $\mathbf{A}$ , also known as the technical coefficients matrix. Considering that,  $\mathbf{A} = \mathbf{Z}\hat{\mathbf{x}}^{-1}$  we can substitute  $\mathbf{Ax} = \mathbf{Zi}$  in the accounting equations to get  $\mathbf{x} = \mathbf{Ax} + \mathbf{f}$ . Solving for  $\mathbf{x}$  yields:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} = \mathbf{L}\mathbf{f} \quad (5)$$

where  $\mathbf{I}$  is the identity matrix and  $\mathbf{L} \equiv (\mathbf{I} - \mathbf{A})^{-1}$  is the Leontief inverse or multiplier matrix, which makes clear the direct and indirect dependence of each of gross outputs on the values of each of the final demand. The  $j^{\text{th}}$  column sum of the Leontief inverse describes the total output increase due to an increase of one unit in the final demand of sector  $j$ . Thus, Rasmussen (1956) proposed to use the column sums of the  $\mathbf{L}$  matrix,  $\mathbf{i}'\mathbf{L}$ , to rank the industries and identify the key ones in the economy. One drawback of the Rasmussen method of backward linkages is that it assumes homogeneous sectors, assigning the same weight to all the industries, which is far from the reality. In particular, the industries composing the EPN are very heterogeneous as are the 28 economies that host them. Therefore, as in Cerina et al. (2015) we use the final-demand-weighted version of the Rasmussen method, i.e. the Laumas (1976) key sector measure:

$$\mathbf{w} = \mathbf{i}'\mathbf{L} \circ \frac{\mathbf{f}'}{\mathbf{i}'\mathbf{f}} \quad (6)$$

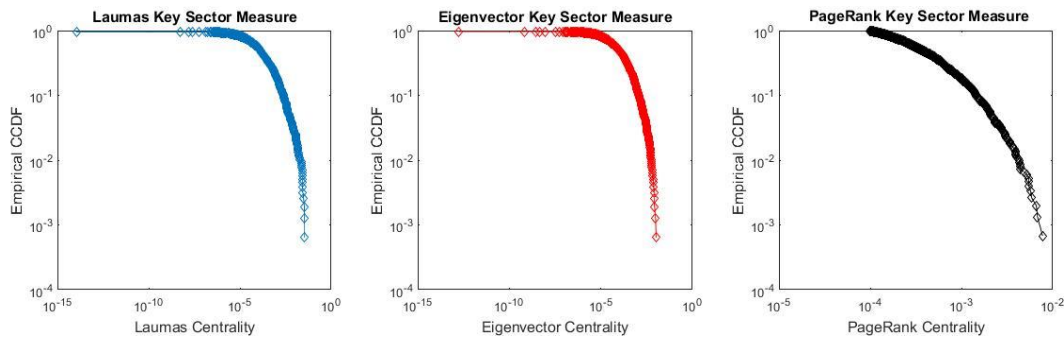
where  $\circ$  is the element-wise multiplication operator. However, in the Laumas method the weighting scheme is arbitrary. Furthermore, this measure, although weights the industries according to their final demand, does not take into account the heterogeneity of intersectoral relationships, i.e. it assumes that all the neighbouring industries have the same importance. To solve this issue, Dietzenbacher (1992) proposed the eigenvector method of backward linkages, which is based on the reasoning that the inputs from a sector with stronger pulling power should be weighted more than the inputs from a sector with weaker power (Luo, 2014). In other words, not all the connected industries are equal but the one with more strength should be weighted more. Dietzenbacher (1992) proved that sectors can be ranked by importance computing a sector power indicator, which we denote as  $\mathbf{e}$ , that coincides to the left-hand eigenvector corresponding to the dominant eigenvalue of the technical coefficients matrix  $\mathbf{A}$ . In the input-output literature, Dietzenbacher method is de facto in line with the eigenvector centrality one of the best known 'influence measures' employed in network theory and social network analysis, according to which nodes are considered to be central in the network if their connections in the network are themselves well-connected nodes. One drawback of this indicator is that it does not penalise the distant connections, this means that it can overestimates the importance of some peripheral industries if they have even only an insignificant indirect connection with a hub industry (Cerina et al., 2015). Therefore, other 'influence measures' of network centrality such as Katz-Bonachic centrality (Katz,

1953; Bonachic, 1987) and PageRank centrality (Brin and Page, 1998) have been preferred in recent studies on input-output networks (Acemoglu et al., 2012; Carvalho 2014; Cerina et al. 2015). Here, we refer mainly to the weighted version of PageRank centrality used in Cerina et al., 2015. The PageRank ( $PR$ ) also relates the importance of a sector with the quality of its connection but it contains a damping factor that penalises distant connections. It is computed iteratively for each node  $i$  as follows:

$$PR(i; t + 1) = \frac{1 - d}{N} + d \sum_{j \in M(i)} \frac{PR(j; t)w_{ij}}{S(j)} \quad (7)$$

where  $N$  is the total number of nodes (sectors),  $d$  is the damping factor set to its default value, 0.85,  $M(i)$  are the in-neighbours of  $i$  (input supplier for the  $i$  sector),  $w_{ij}$  is the weight of the link connecting the nodes  $i$  and  $j$ ,  $S(j)$  is the sum of the weights of the outgoing edges from  $j$  (the sum of the output delivered by sector  $j$ ). Note that the algorithm starts at time step  $t = 0$ , assuming a probability distribution such that  $PR(i; 0) = 1/N$ .

As in the strength distributions, Figure 4 shows that the network centrality of different nodes is distributed as a power-law. Far out in the right tails, we find the central production nodes in the network, which we rank for each centrality measures in Table 2. Again, as in Table 1 we find that key sectors in the EPN are placed in core countries. In particular, the Laumas indicator ( $w$ ), which emphasises the role of final demand, indicates the construction (F) sector in France as the key EPN sector, followed by two UK sectors, respectively real estate (L68) and health (Q).



**Figure 4.** The distribution of different country-sector centrality measures.

Differently, the Dietzenbacher eigenvector indicator ( $e$ ) shows the relevance of German sectors. Especially according to this measure, almost fifty percent of the top 30 sectors in the EPN are from Germany that hosts even the first four key sectors. However, the presence of many German sectors in the  $e$  ranking reveals another drawback of this measure already noted in Cerina et al. (2015). Indeed, in the presence of clusters in the network, such as in the EPN where sectors usually cluster domestically, the eigenvector centrality measure tends to overestimate the importance of some nodes. For example, if some industries in Germany have strong linkages, the eigenvector method imputes a high strength to almost all other industries in Germany due to the national connections and this process will reinforce itself. In addition, to penalising ties with distant nodes, the other ‘influence measure’,

namely PageRank centrality (*PR*), addresses also this problem. According to *PR*, Germany still plays a central role in the EPN, hosting the first two sectors, which are motor vehicles (C29), and machinery and equipment (C28), respectively. However, what is noteworthy from a Brexit point of view is that with eleven industries, the UK is the most represented country in the top 30 sectors ranking. In other words, more than 35 percent of key sectors in the EPN are hosted by the UK. Recalling the definition of the *PR*, this means that UK sectors are among the most influential sectors, i.e. they are very important sectors and are well connected with other EPN key sectors.

<i>w</i>	<i>e</i>	<i>PR</i>
FRA_F	DEU_C20	DEU_C29
GBR_L68	DEU_N	DEU_C28
GBR_Q	DEU_H52	GBR_Q
DEU_Q	DEU_C24	DEU_F
DEU_F	FRA_N	GBR_F
GBR_F	DEU_M69_70	FRA_F
DEU_L68	GBR_N	GBR_O84
FRA_L68	FRA_M69_70	GBR_L68
ITA_F	DEU_C28	DEU_C10-12
DEU_O84	DEU_G46	GBR_G47
GBR_G47	FRA_G46	ITA_F
FRA_Q	ESP_D35	FRA_C10-12
FRA_O84	DEU_C29	FRA_G46
GBR_O84	DEU_L68	DEU_C20
DEU_C10-12	GBR_D35	DEU_O84
DEU_C29	FRA_D35	ITA_G46
ITA_Q	DEU_C25	GBR_G46
FRA_G47	ITA_G46	DEU_Q
ITA_L68	DEU_H49	ITA_C28
DEU_G47	GBR_K64	ITA_C10-12
FRA_C10-12	GBR_M69_70	GBR_K65
DEU_P85	GBR_B	ESP_C10-12
ESP_F	ITA_D35	GBR_K64
GBR_P85	DEU_K64	ESP_C29
ESP_I	DEU_D35	DEU_L68
ITA_O84	ITA_C24	GBR_N
GBR_I	NLD_M69_70	FRA_O84
ITA_I	FRA_C20	GBR_I
ITA_G47	DEU_J62-63	GBR_C10-12
DEU_R-S	FRA_K64	ITA_I

**Table 2.** Top 30 country-sectors ranked by Laumas (*w*), eigenvector (*e*) and PageRank (*PR*) centrality measures. For sector abbreviations see di annex.

Our findings on the structure of the EPN help the understanding of the UK relevance within the EPN and suggest that a shock hitting key sectors placed in the UK could propagate through other key sectors and generate macro disturbances in other European economies. However, they merely give us a descriptive and qualitative view, whereas it does not provide any effective quantitative measure of the possible economic implications of Brexit. This will be the object of the next section.

#### 4. The Hypothetically Extraction method to unveil Key Industries from a Brexit perspective

The Brexit debate has been enriched by numerous studies of academics and governing bodies that attempt to quantify the economic impacts of Brexit on the UK, the EU and the rest of the world (see Gasiorek et al., 2019; Hantzsche et al., 2019; Minford, 2019 and the special issue edited by Philip McCann, 2018, among others). In general, this literature focussed on the trade effects of Brexit, noting that the UK decision to leave the EU will have a significant negative impact on international trade.

However, as the outcome of the negotiations between the UK and Europe is not known yet, most of these studies are based on assumptions about possible future scenarios. Furthermore, these analyses require also assumptions on the strength of international substitution patterns. One exception is W. Chen et al. (2018), which opt for a different approach to study the degree to which EU regions and countries are exposed to negative trade-related consequences of Brexit. In particular, using an extended version of the general formula proposed by Los et al. (2016), they get estimates of domestic value added (DVA) in exports of EU regions to the UK and DVA exports of UK regions to the EU. Dividing these estimates by regional GDP, they compute an index of the share of GDP exposed to Brexit, for EU regions and countries, which takes into account all the effects due to the fragmented production processes within the UK, the EU and beyond. This accounting exercise, which not allows for an actual quantification of changes in regional GDP due to Brexit, helps in answering the question: what if the UK and EU regions would stop trading? In other words, W. Chen et al. (2018) are able to rank EU regions and countries by the risk they face due to Brexit.

The method employed by Los et al. (2016) and W. Chen et al. (2018) is called “hypothetical extraction” and it is used in the input-output literature to identify key sectors (for a complete review and insights see Dietzenbacher and Lahr, 2013 and Miller and Blair, 2009). The aim of this technique is to quantify how much the output of an  $n$ -sectors economy would decrease if a particular industry were not present. Extracting industry  $k$  requires that the  $k^{th}$  row and column of the  $\mathbf{A}$  matrix are set equal to zero. We define this matrix by  $\mathbf{A}^*$ . Equally, the final demand for goods and services provided by industry  $k$  is set to zero, i.e.  $f_k = 0$ , which gives the new final demand vector  $\mathbf{f}^*$ . Thus, the estimated new vector of sector gross outputs will be:

$$\mathbf{x}^* = (\mathbf{I} - \mathbf{A}^*)^{-1}\mathbf{f}^* \quad (8)$$

The change before and after extraction is equal to the difference  $\mathbf{s}' = (\mathbf{x} - \mathbf{x}^*)$ . This method can be easily extended to an inter-country input-output framework with  $N$  countries and  $n$  production sectors in each country to quantify the effect on the output of the rest of the economy, as induced by hypothetically extracting a country (see Ditezenbacher et al., 1993; Dietzenbacher and van der Linden, 1997). As shown by W. Chen et al. (2018), this approach is suitable in the case of Brexit to quantify how much the GDP of UK and EU would change if these two macro regions stop trading.

		Intermediate use			Final Demand			Gross Output
		UK	EU	ROW	UK	EU	ROW	
		Industry	Industry	Industry	Industry	Industry	Industry	
UK	Industry	Intermediate use of domestic output	Intermediate use by EU of exports from the UK	Intermediate use by ROW of exports from the UK	Final use of domestic output	Final use by EU of exports from UK	Final use by ROW of exports from the UK	$\mathbf{X}_{UK}$
EU	Industry	Intermediate use by the UK of exports from EU	Intermediate use of domestic output	Intermediate use by ROW of exports from EU	Final use by the UK of exports from EU	Final use of domestic output	Final use by the ROW of exports from EU	$\mathbf{X}_{EU}$
ROW	Industry	Intermediate use by the UK of exports from ROW	Intermediate use by EU of exports from ROW	Intermediate use of domestic output	Final use by the UK of exports from ROW	Final use by EU of exports from ROW	Final use of domestic output	$\mathbf{X}_{ROW}$
<b>Value Added</b>		$\mathbf{V}_{UK}$	$\mathbf{V}_{EU}$	$\mathbf{V}_{ROW}$				
<b>Gross Input</b>		$\mathbf{X}_{UK}$	$\mathbf{X}_{EU}$	$\mathbf{X}_{ROW}$				

Figure 5. A three-country one-sector representation of the WIOT.

Figure 5 shows a simplified version of the global WIOT presented in Figure 1, with one sector and three countries, namely the UK, an EU country (EU), and the rest of the world (ROW).

The darker panels indicate the sub-matrices directly involved into Brexit, i.e. the sub-matrices of intermediate and final trade between the UK and EU. An extended version of Figure 5, with three countries and  $n$  sectors, can be formally represented using partitioned matrices. The coefficients matrix  $\mathbf{A}$  and the final demand matrix  $\mathbf{F}$  are constructed as:

$$\mathbf{A} = \begin{bmatrix} \mathbf{A}^{UU} & \mathbf{A}^{UE} & \mathbf{A}^{UR} \\ \mathbf{A}^{EU} & \mathbf{A}^{EE} & \mathbf{A}^{ER} \\ \mathbf{A}^{RU} & \mathbf{A}^{RE} & \mathbf{A}^{RR} \end{bmatrix} \quad \mathbf{F} = \begin{bmatrix} \mathbf{F}^{UU} & \mathbf{F}^{UE} & \mathbf{F}^{UR} \\ \mathbf{F}^{EU} & \mathbf{F}^{EE} & \mathbf{F}^{ER} \\ \mathbf{F}^{RU} & \mathbf{F}^{RE} & \mathbf{F}^{RR} \end{bmatrix} \quad (9)$$

Extracting trade flows between the UK and EU requires that the matrices  $\mathbf{A}^{UE}$ ,  $\mathbf{A}^{EU}$ ,  $\mathbf{F}^{UE}$  and  $\mathbf{F}^{EU}$  are replaced by matrices of appropriate dimension filled with zeros, such that the new  $\mathbf{A}^*$  and  $\mathbf{F}^*$  matrices are:

$$\mathbf{A}^* = \begin{bmatrix} \mathbf{A}^{UU} & 0 & \mathbf{A}^{UR} \\ 0 & \mathbf{A}^{EE} & \mathbf{A}^{ER} \\ \mathbf{A}^{RU} & \mathbf{A}^{RE} & \mathbf{A}^{RR} \end{bmatrix} \quad \mathbf{F}^* = \begin{bmatrix} \mathbf{F}^{UU} & 0 & \mathbf{F}^{UR} \\ 0 & \mathbf{F}^{EE} & \mathbf{F}^{ER} \\ \mathbf{F}^{RU} & \mathbf{F}^{RE} & \mathbf{F}^{RR} \end{bmatrix} \quad (10)$$

Again, the estimated new vector of sector gross outputs is given by equation (8), and the change before and after extraction will be equal to the difference  $\mathbf{s}' = (\mathbf{x} - \mathbf{x}^*)$ . To express this change in GDP terms we pre-multiply equation (8) by the value added coefficients matrix  $\widehat{\mathbf{V}}$ , i.e. a diagonal matrix, of which the typical element on the main diagonal,  $v_j^s/x_j^s$ , is the value added coefficient of industry  $j$  in country  $s$ . This leads to:

$$\mathbf{v}^* = \widehat{\mathbf{V}}(\mathbf{I} - \mathbf{A}^*)^{-1}\mathbf{f}^* \quad (11)$$

Finally, the change in value added is derived by the difference  $\mathbf{s}' = (\mathbf{v} - \mathbf{v}^*)$ .

Briefly, this is the technique employed by W. Chen et al. (2018). Here, we build on this approach and develop a more granular monetary indicator able to quantify the impact of sectoral hypothetical extraction on the GDP of the UK and EU countries. One can consider such a measure as the exposure of the UK and EU countries to sectoral tariff and non-tariff barriers (on the determinants and relevance of trade barriers see Ennew et al, 1990; Greenaway and Milner, 1994 and Greenaway and Milner, 2003). Indeed, if trade barriers, in general, can reduce bilateral trade between two countries, applying country-sector hypothetical extractions allows us to identify those sectors for which a reduction in trade flows implies a higher loss for the economies involved (on the impact of trade barriers and border effects see Capello et al., 2017 and Capello et al., 2018).

Our exposure measure is closely related to the concept of industries vulnerability to Brexit developed by Gasiorek et al. (2019). Employing a multisector and partial equilibrium framework, Gasiorek et al. (2019) analyse effects on 122 UK manufacturing sectors, using 2016 trade data. The authors provide one of the most detailed and granular analysis on the possible impacts of Brexit on prices, output and trade on specific manufacturing industries. Gasiorek et al. (2019) model five different Brexit scenarios, and achieve results that point to considerable variation across manufacturing sectors, and across skill categories of labour. Here, adopting a different modelling strategy, we extend Gasiorek et al. (2019) by including raw material and services industries and exploring the sectoral vulnerability to Brexit in both the UK and EU27 countries. Furthermore, the indicator that we propose, in addition to being a measure of risk, provides answers to questions like: to what extent the UK (EU)

GDP depends on the export of sector  $i$  to EU (UK), or conversely, to what extent the UK (EU) GDP depends on the import from the  $i^{th}$  EU (UK) sector? In this sense, the measure we develop could be seen as a kind of sector external centrality measure. In other words, our measure identifies also key import sectors and key export sectors.

#### 4.1. Methodology

As in section 3, in our accounting exercise we use the last available WIOT released by the WIOD (2014), but we consider all the 44 economies in order to quantify the impact the extraction of sectoral trade flows between the UK and EU will have on these directly involved countries and the rest of the world.

Using partitioned matrices, the coefficients matrix  $\mathbf{A}$  and the final demand matrix  $\mathbf{F}$  of the WIOT are presented in summary form as:

$$\mathbf{A} = \begin{bmatrix} \mathbf{A}^{UU} & \mathbf{A}^{UE_1} & \dots & \mathbf{A}^{UE_{27}} & \mathbf{A}^{UR} \\ \mathbf{A}^{E_1U} & \mathbf{A}^{E_1E_1} & \dots & \mathbf{A}^{E_1E_{27}} & \mathbf{A}^{E_1R} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \mathbf{A}^{E_{27}U} & \mathbf{A}^{E_{27}E_1} & \dots & \mathbf{A}^{E_{27}E_{27}} & \mathbf{A}^{E_{27}R} \\ \mathbf{A}^{RU} & \mathbf{A}^{RE_1} & \dots & \mathbf{A}^{RE_{27}} & \mathbf{A}^{RR} \end{bmatrix} \quad (12)$$

$$\mathbf{F} = \begin{bmatrix} \mathbf{F}^{UU} & \mathbf{F}^{UE_1} & \dots & \mathbf{F}^{UE_{27}} & \mathbf{F}^{UR} \\ \mathbf{F}^{E_1U} & \mathbf{F}^{E_1E_1} & \dots & \mathbf{F}^{E_1E_{27}} & \mathbf{F}^{E_1R} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \mathbf{F}^{E_{27}U} & \mathbf{F}^{E_{27}E_1} & \dots & \mathbf{F}^{E_{27}E_{27}} & \mathbf{F}^{E_{27}R} \\ \mathbf{F}^{RU} & \mathbf{F}^{RE_1} & \dots & \mathbf{F}^{RE_{27}} & \mathbf{F}^{RR} \end{bmatrix}$$

where again U stands for the UK,  $E_1$  and  $E_{27}$  are respectively the first and the last EU country in the WIOD list and R identify a generic extra-EU country.

Suppose that the UK after Brexit will stop importing intermediate and final product delivered by the  $i^{th}$  EU sector. This means that the  $i^{th}$  row of the sub matrices  $\mathbf{A}^{E_1U}$  to  $\mathbf{A}^{E_{27}U}$  are set equal to zero. Thus, the pre and post extraction coefficients matrix of the EU country  $s$  will be:

$$\mathbf{A}^{E_sU} = \begin{bmatrix} a_{ij}^{E_sU} & \dots & a_{ij}^{E_sU} \\ \vdots & \ddots & \vdots \\ a_{nj}^{E_sU} & \dots & a_{nn}^{E_sU} \end{bmatrix} \quad \mathbf{A}^{E_sU^*} = \begin{bmatrix} 0 & \dots & 0 \\ \vdots & \ddots & \vdots \\ a_{nj}^{E_sU} & \dots & a_{nn}^{E_sU} \end{bmatrix} \quad (13)$$

The same holds for the final demand:

$$\mathbf{F}^{E_sU} = \begin{bmatrix} f_{ij}^{E_sU} & \dots & f_{ij}^{E_sU} \\ \vdots & \ddots & \vdots \\ f_{nj}^{E_sU} & \dots & f_{nn}^{E_sU} \end{bmatrix} \quad \mathbf{F}^{E_sU^*} = \begin{bmatrix} 0 & \dots & 0 \\ \vdots & \ddots & \vdots \\ f_{nj}^{E_sU} & \dots & f_{nn}^{E_sU} \end{bmatrix} \quad (14)$$

Hence, the post extraction global  $\mathbf{A}$  and  $\mathbf{F}$  matrices are constructed as:

$$\mathbf{A}^* = \begin{bmatrix} \mathbf{A}^{UU} & \mathbf{A}^{UE_1} & \dots & \mathbf{A}^{UE_{27}} & \mathbf{A}^{UR} \\ \mathbf{A}^{E_1U^*} & \mathbf{A}^{E_1E_1} & \dots & \mathbf{A}^{E_1E_{27}} & \mathbf{A}^{E_1R} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \mathbf{A}^{E_{27}U^*} & \mathbf{A}^{E_{27}E_1} & \dots & \mathbf{A}^{E_{27}E_{27}} & \mathbf{A}^{E_{27}R} \\ \mathbf{A}^{RU} & \mathbf{A}^{RE_1} & \dots & \mathbf{A}^{RE_{27}} & \mathbf{A}^{RR} \end{bmatrix} \quad (15)$$

$$\mathbf{F}^* = \begin{bmatrix} \mathbf{F}^{UU} & \mathbf{F}^{UE_1} & \dots & \mathbf{F}^{UE_{27}} & \mathbf{F}^{UR} \\ \mathbf{F}^{E_1U^*} & \mathbf{F}^{E_1E_1} & \dots & \mathbf{F}^{E_1E_{27}} & \mathbf{F}^{E_1R} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \mathbf{F}^{E_{27}U^*} & \mathbf{F}^{E_{27}E_1} & \dots & \mathbf{F}^{E_{27}E_{27}} & \mathbf{F}^{E_{27}R} \\ \mathbf{F}^{RU} & \mathbf{F}^{RE_1} & \dots & \mathbf{F}^{RE_{27}} & \mathbf{F}^{RR} \end{bmatrix}$$

Finally, as in W. Chen et al. (2018), we estimate the new vector of sector value added using equation (11), and the hypothetical loss in value added (LiVA) derived from trade flows extraction, as the difference  $\mathbf{s}' = (\mathbf{v}^* - \mathbf{v})$ .

Clearly, one can consider also the opposite case, in which the  $i^{th}$  row of the sub matrices  $\mathbf{A}^{UE_1}$  to  $\mathbf{A}^{UE_{27}}$  are set equal to zero, or both cases simultaneously, i.e. the UK and EU countries will stop importing each other product delivered by sector  $i$ .

In the next results section, we contemplate all these three scenarios extracting one at a time all the 56 UK and EU sectors included in the WIOT.

## 5. Results and Discussion

### 5.1. The exposure to sectoral hypothetical extractions due to Brexit

In this sub-section, we discuss the results about the hypothetical extractions of sectoral bilateral trade flows between the UK and EU countries. The results are presented in Tables 3, 4 and 5, more detailed information can be found in tables from A.3 to A.8 in the Appendix.

Table 3 summarises the results in tables A.3 to A.6, and shows the top 30 sectors ranked by LiVA aggregates at the country level, i.e. those sectors delivering products that if excluded in bilateral trade between the UK and Europe would generate a greater loss in terms of aggregate domestic value added. The UK would be most affected by the exclusion of wholesale trade products (G46), administrative and support activities (N) and auxiliary financial services (K66). On the other side of the channel, EU countries appear to be very sensitive to the dynamics affecting motor vehicles industries (C29), food products (C10-12) and wholesale trade (G46). Furthermore, the paths designed by motor vehicle (C29) and food (C10-12) sectors, together with other manufacturing industries, such as petroleum products (C19), chemicals (C20), electronics and computers (C26) etc., are also significant for extra-EU countries. This evidence suggests that EU manufacturing industries are highly integrated in global value chains, thus the economic impact of Brexit would propagate worldwide. The automotive industry (C29) is the sector most exposed to Brexit. Consistently with the PageRank ranking in Table 2, Table A.3 suggests that this finding depends largely on the relevance of the German motor vehicles industry, which is a driving sector in Europe and has many input-output connections with other key sectors both in Europe and in the UK.



As revealed by Tables A.3 and A.4, unsurprisingly, the UK is the most exposed country in the world. In particular, the most vulnerable goods sector is food products (C10-12) and the most exposed services sector is the wholesale trade industry (G46). The fact that Brexit is risky and costly especially for the UK is in line with W. Chen et al. (2018) and the main Brexit literature. Here this finding is obtained by applying our technique by extracting all sectoral trade inflows and outflows between the UK and the EU, thus in a context of 1 against 27 countries. On the other hand, it is noteworthy that some EU countries such as Germany, the most exposed EU country in absolute LiVA terms, Ireland, France, Italy, the Netherlands, and Belgium appear significantly vulnerable as well. Outside Europe, Tables A.5 and A.6 show that the USA is the most exposed country along with the region labelled in the WIOD as rest of the world (ROW).

The exposure to aggregate LiVA, as a result of sectoral bilateral trade flows extractions, could also be seen as a measure of economic exposure to sectoral trade barriers. Generally, trade barriers include tariff and non-tariff barriers (see Greenaway, 1983; Greenaway, and Milner, 2003 for more insight on this). The goods sector could face both, whereas only non-tariff barriers can be applied to the service sectors. Table 3 shows that the UK most exposed sectors are services, whereas the most vulnerable sectors in EU countries are goods industries. Therefore, the UK main trade flows are exposed to non-tariff barrier, whilst EU countries are exposed to both tariff and non-tariff barriers. Hence, we can conclude that the UK is less exposed to the economic impact of trade barriers than Europe. This last remark, clearly, holds if EU does not impose huge non-tariff barriers. For example, the picture could change in the extreme case in which EU forbids the UK from selling financial products to EU countries.

UK		EU 27		extra-EU		World	
Sector	Aggregate LiVA	Sector	Aggregate LiVA	Sector	Aggregate LiVA	Sector	Aggregate LiVA
G46	-30532,12	C29	-39690,38	C29	-9325,70	C29	-58536,82
N	-22664,77	C10-12	-28075,26	C10-12	-8810,95	G46	-55843,51
K66	-13522,43	G46	-21467,87	C19	-7821,97	C10-12	-47777,54
C10-12	-10891,33	N	-20411,80	C20	-6984,73	N	-45578,63
M74-75	-10306,99	C28	-19123,69	C26	-6502,18	C20	-32743,57
C29	-9520,74	C20	-16778,59	C28	-4617,09	C28	-31792,38
C20	-8980,25	C21	-16720,40	C21	-3893,17	C21	-28599,07
B	-8353,32	C26	-13068,68	G46	-3843,51	C26	-26060,56
C28	-8051,61	C30	-10432,92	C30	-3826,90	C30	-18617,07
C21	-7985,50	C27	-9066,50	C24	-3624,20	C19	-17150,52
M69-70	-7935,16	C31-32	-7773,90	N	-2502,06	K66	-15082,68
K64	-7066,88	C13-15	-7742,37	C27	-2440,12	K64	-15080,35
C26	-6489,70	C22	-7675,62	A01	-2412,97	C27	-14967,54
J61	-5462,65	C25	-6899,24	H51	-2173,72	M74-75	-14925,02
C24	-4416,66	A01	-6437,99	C22	-2021,30	C24	-14266,96
C30	-4357,25	J61	-6252,89	C13-15	-1871,57	M69-70	-13720,50
R-S	-4194,27	K64	-6233,71	K64	-1779,76	C22	-13496,98
J62-63	-4149,98	C24	-6226,10	C31-32	-1516,96	B	-13069,11
G47	-4028,49	C19	-6112,17	C25	-1337,21	J61	-12949,81
C22	-3800,05	H51	-5725,90	J62-63	-1281,25	C31-32	-12897,85
E37-39	-3772,97	C17	-5266,36	J61	-1234,27	C13-15	-12600,67
C31-32	-3606,99	M69-70	-4877,78	B	-1181,57	A01	-10820,96
C27	-3460,92	L68	-4350,26	C17	-1005,56	C25	-10169,82
M71	-3274,67	G47	-4158,23	H50	-915,10	H51	-9530,62
C19	-3216,38	R-S	-4148,80	M69-70	-907,56	R-S	-8980,25
G45	-3012,99	M74-75	-3761,71	M74-75	-856,31	G47	-8685,19
C13-15	-2986,74	B	-3534,23	C23	-773,61	J62-63	-7905,60
J59-60	-2937,85	H49	-3126,51	K66	-715,55	C17	-7446,92
K65	-2808,33	C23	-3009,74	E37-39	-678,24	E37-39	-7389,34
H52	-2342,49	H50	-2983,15	R-S	-637,17	G45	-5690,95

**Table 3.** Bilateral trade flows extraction. Top 30 sectors ranked by aggregate LiVA (expressed in millions of US dollars) in the UK, the EU27, extra-EU countries and World.

GOODS	EU 27		UK		extra-EU	
	Country-Sector	Sectoral LiVA	Country-Sector	Sectoral LiVA	Country-Sector	Sectoral LiVA
A01	IRL_A01	-1325,05	GBR_A01	-896,235	USA_N	-157,593
A02	IRL_A02	-92,7593	GBR_A02	-17,3005	ROW_B	-2,48136
A03	IRL_A03	-14,8149	GBR_A03	-243,513	ROW_B	-18,0207
B	NLD_B	-1738,05	GBR_B	-6439,17	ROW_B	-149,739
C10-12	IRL_C10-12	-3641,16	GBR_C10-12	-5060,76	ROW_A01	-726,375
C13-15	ITA_C13-15	-1400,9	GBR_C13-15	-2041,29	ROW_B	-131,743
C16	SWE_C16	-151,637	GBR_C16	-137,782	ROW_B	-33,9098
C17	DEU_C17	-625,176	GBR_C17	-623,538	ROW_B	-90,4396
C18	IRL_C18	-47,7861	GBR_C18	-276,965	ROW_B	-6,14191
C19	NLD_M69_70	-350,855	GBR_B	-1471,17	NOR_B	-1782,23
C20	DEU_C20	-2726,36	GBR_C20	-4325,91	ROW_B	-898,404
C21	DEU_C21	-3290,84	GBR_C21	-5772,87	USA_N	-408,401
C22	DEU_C22	-1310,38	GBR_C22	-2307,20	ROW_B	-199,177
C23	DEU_C23	-371,333	GBR_C23	-489,722	ROW_B	-118,835
C24	DEU_C24	-791,651	GBR_C24	-1627,99	ROW_B	-489,854
C25	DEU_C25	-1363,89	GBR_C25	-1312,16	ROW_B	-145,248
C26	DEU_C26	-2968,97	GBR_C26	-4506,59	CHN_C26	-436,327
C27	DEU_C27	-1900,57	GBR_C27	-1984,36	ROW_B	-197,529
C28	DEU_C28	-4147,68	GBR_C28	-4425,64	ROW_B	-348,581
C29	DEU_C29	-10074,4	GBR_C29	-3760,01	ROW_B	-718,971
C30	DEU_C30	-1258,85	GBR_C30	-2128,49	USA_C30	-599,578
C31-32	DEU_C31-32	-1257,29	GBR_C31-32	-2424,04	ROW_B	-117,936
C33	FRA_C33	-293,771	GBR_C33	-88,8211	ROW_B	-17,0681

**Table 4.** Most affected country-sectors in terms of LiVA as a result of goods sectors hypothetical extraction.

SERVICES	EU 27		UK		extra-EU	
	Country-Sector	Sectoral LiVA	Country-Sector	Sectoral LiVA	Country-Sector	Sectoral LiVA
D35	DNK_D35	-89,9569	GBR_D35	-192,203	NOR_B	-58,5909
E36	DEU_E36	-34,1954	GBR_E36	-7,48306	ROW_B	-1,39917
E37-39	DEU_E37-39	-586,425	GBR_E37-39	-2385,04	USA_E37-39	-76,9668
F	NLD_F	-657,491	GBR_F	-299,811	ROW_B	-36,9247
G45	POL_G45	-370,185	GBR_G45	-2135,31	ROW_B	-25,4499
G46	DEU_G46	-3099,89	GBR_G46	-16708,1	ROW_B	-317,358
G47	POL_G47	-513,301	GBR_G47	-2649,44	ROW_B	-36,4798
H49	NLD_H49	-599,105	GBR_H49	-349,554	ROW_B	-69,5954
H50	GRC_H50	-391,006	GBR_H50	-229,151	ROW_H52	-99,3978
H51	IRL_H51	-911,643	GBR_H51	-745,358	ROW_B	-305,426
H52	NLD_H52	-251,317	GBR_H52	-1482,15	ROW_B	-26,5833
H53	NLD_H53	-364,03	GBR_H53	-593,567	USA_H53	-14,8751
I	ESP_I	-610,171	GBR_I	-705,285	ROW_B	-20,8825
J58	IRL_J58	-279,483	GBR_J58	-1188,19	ROW_J58	-11,661
J59-60	DEU_J59-60	-59,7793	GBR_J59-60	-1901,01	USA_J59-60	-25,0757
J61	FRA_J61	-824,77	GBR_J61	-3830,47	ROW_B	-66,2622
J62-63	DEU_J62-63	-383,16	GBR_J62-63	-2982,57	USA_N	-287,77
K64	IRL_K64	-1317,46	GBR_K64	-4084,30	USA_K66	-274,662
K65	IRL_K65	-162,86	GBR_K65	-1589,07	ROW_K65	-110,325
K66	IRL_K66	-66,8403	GBR_K66	-9641,82	USA_K66	-55,7861
L68	ITA_L68	-1138,93	GBR_L68	-319,184	ROW_B	-12,8443
M69-70	NLD_M69_70	-1840,84	GBR_M69_70	-6175,10	ROW_N	-69,1682
M71	DEU_M71	-270,551	GBR_M71	-2146,94	ROW_B	-16,1577
M72	FRA_M72	-242,8	GBR_M72	-1121,99	ROW_B	-10,5223
M73	FRA_M73	-240,369	GBR_M73	-1242,72	ROW_B	-14,7716
M74-75	DEU_M74-75	-497,711	GBR_M74-75	-7205,46	ROW_B	-44,5312
N	FRA_N	-7257,87	GBR_N	-16548,5	ROW_B	-166,106
O84	NLD_O84	-568,931	GBR_O84	-338,35	ROW_B	-6,45964
P85	DEU_P85	-80,7331	GBR_P85	-894,747	ROW_B	-3,13549
Q	FRA_Q	-98,9323	GBR_Q	-124,593	ROW_B	-2,15139
R-S	MLT_R-S	-536,212	GBR_R-S	-2996,94	ROW_B	-35,0891

**Table 5.** Most affected country-sectors in terms of LiVA as a result of services sectors hypothetical extraction.

## 5.2. Brexit strategic sectors

In this sub-section, we discuss the results about the hypothetical extractions of sectoral trade inflows and outflows between the UK and EU countries. We first extract UK sectoral exports to EU, and then

we extract UK sectoral imports from EU. The results are presented in tables 6 and 7, more detailed information can be found in tables from A.9 to A.20 in the Appendix.

Tables 6 and 7 present the top 30 sectors ranked by the expected aggregate LiVA as a result of respectively the extraction of sectoral UK export flows to EU countries, and the extraction of sectoral UK import flows from EU countries. The results shown in these two tables can be interpreted as measures of sectors external centrality. In other words, tables 6 and 7 indicate the Brexit strategic sectors, i.e. those sectors that play a key role in the import-export relations between the UK and EU countries. In particular, Table 6 provides a ranking of key export sectors for the UK and reveals that the most important products exported to EU countries are delivered respectively by the wholesale trade industries (G46) administrative and support activities sector (N) and auxiliary financial services (K66). On the other side of the channel, EU countries in order to safeguard their domestic value-added should import from the UK automotive (C29), chemicals (C20) and wholesale trade (G46) industries. Conversely, Table 7 indicates the key import sectors for the UK and shows the relevance of food products (C10-12), motor vehicles industries (C29) and financial services (K64). Losing UK imports could have significant repercussions for EU countries, especially if the UK would stop importing from the automotive (C29), food products (C10-12) and wholesale trade (G46) industries. Again, the UK industries most involved in direct and indirect trade relationships with EU countries are mainly services sectors, whilst the most important EU industries are goods sectors. Thus, as aforementioned, the UK is, in general, less exposed to sectoral trade barriers than EU. This last remark could strengthen the position of the UK in the negotiation of a Brexit deal with EU.

UK		EU 27		extra-EU		World	
Sector	Aggregate LiVA	Sector	Aggregate LiVA	Sector	Aggregate LiVA	Sector	Aggregate LiVA
G46	-30318,81	C29	-2897,38	C29	-2504,05	G46	-34320,49
N	-22507,18	C20	-2368,68	C20	-2356,64	N	-25271,90
K66	-13505,51	G46	-1891,19	C19	-2253,79	K66	-14684,86
M74-75	-10274,22	N	-1480,60	G46	-2110,49	C29	-14314,86
C10-12	-9833,51	C28	-1384,15	C24	-2049,25	C20	-13358,06
C29	-8913,43	C10-12	-1207,74	C26	-1561,92	C10-12	-12309,91
C20	-8632,74	C24	-1126,20	C28	-1541,50	M74-75	-11568,40
B	-8334,21	C26	-945,32	C30	-1477,26	C28	-10711,84
M69-70	-7883,89	C21	-842,50	N	-1284,13	B	-9765,32
C28	-7786,19	C19	-779,87	C10-12	-1268,66	C21	-9214,18
C21	-7717,74	C30	-673,97	B	-946,79	C26	-8743,59
K64	-6397,60	M74-75	-672,67	C27	-809,40	M69-70	-8467,04
C26	-6236,35	C27	-666,57	K66	-662,90	C24	-7459,64
J61	-5378,81	C22	-654,72	C21	-653,94	K64	-7018,96
C24	-4284,19	K66	-516,45	M74-75	-621,51	J61	-6359,01
C30	-4185,71	B	-484,33	C22	-601,91	C30	-6336,93
J62-63	-4043,99	J61	-429,88	J61	-550,31	C19	-5836,90
G47	-3961,88	C31-32	-382,65	C31-32	-472,67	C22	-4891,75
R-S	-3908,81	E37-39	-357,70	C13-15	-334,32	C27	-4796,38
E37-39	-3742,33	M69-70	-301,94	K64	-322,52	E37-39	-4418,33
C22	-3635,12	K64	-298,85	E37-39	-318,31	J62-63	-4414,41
C31-32	-3489,36	C13-15	-283,14	C25	-294,19	C31-32	-4344,68
C27	-3320,41	G45	-225,83	M69-70	-281,22	G47	-4335,10
M71	-3257,06	C25	-200,39	H51	-234,10	R-S	-4220,32
G45	-2991,91	C17	-190,16	C23	-218,03	M71	-3543,94
J59-60	-2935,11	J62-63	-182,51	G47	-205,73	C13-15	-3472,72
C13-15	-2855,26	G47	-167,48	A01	-199,27	G45	-3414,47
C19	-2803,24	A01	-166,49	G45	-196,74	J59-60	-3293,96
K65	-2758,61	C23	-165,38	J59-60	-196,37	K65	-3097,79
H52	-2320,88	J59-60	-162,49	K65	-193,47	H52	-2614,71

**Table 6.** Extraction of sectoral UK export flows to EU. Top 30 sectors ranked by aggregate LiVA (expressed in millions of US dollars) in the UK, the EU27, extra-EU countries and World.

UK		EU 27		extra-EU		World	
Sector	Aggregate LiVA	Sector	Aggregate LiVA	Sector	Aggregate LiVA	Sector	Aggregate LiVA
C10-12	-1560,32	C29	-37967,21	C10-12	-7641,43	C29	-45819,59
C29	-775,39	C10-12	-27054,19	C29	-7076,99	C10-12	-36255,94
K64	-772,01	G46	-19653,71	C19	-5674,28	G46	-21626,07
C20	-531,67	N	-19481,51	C26	-5076,75	C28	-21585,57
A01	-518,34	C28	-18111,87	C20	-5055,61	C20	-21265,04
C19	-459,37	C21	-16294,95	C21	-3320,13	N	-21013,42
C21	-339,35	C20	-15677,76	C28	-3150,00	C21	-19954,44
C26	-337,71	C26	-12459,46	C30	-2427,72	C26	-17873,93
C28	-323,69	C30	-9922,21	A01	-2230,67	C30	-12653,57
C30	-303,64	C27	-8531,99	H51	-1947,39	C19	-11546,58
R-S	-293,42	C13-15	-7545,66	G46	-1741,12	C27	-10357,69
N	-273,56	C31-32	-7410,39	C24	-1698,56	C13-15	-9261,91
H51	-270,65	C22	-7111,58	C27	-1660,90	A01	-9046,78
G46	-231,24	C25	-6735,15	C13-15	-1557,91	C22	-8746,38
C22	-193,64	A01	-6297,77	K64	-1465,84	C31-32	-8586,23
C24	-176,51	K64	-5953,93	C22	-1441,15	K64	-8191,78
C27	-164,80	J61	-5887,72	N	-1258,35	C25	-7914,05
C13-15	-158,33	H51	-5630,35	J62-63	-1095,69	H51	-7848,38
C25	-129,46	C24	-5462,80	C25	-1049,44	C24	-7337,87
C31-32	-127,66	C19	-5412,93	C31-32	-1048,18	J61	-6696,33
J61	-114,30	C17	-5151,80	H50	-878,33	C17	-6111,65
J62-63	-110,38	M69-70	-4591,61	C17	-853,64	M69-70	-5302,80
C17	-106,21	L68	-4342,16	J61	-694,31	R-S	-4770,33
M69-70	-82,42	R-S	-3999,55	M69-70	-628,77	L68	-4465,56
H50	-73,66	G47	-3992,65	C23	-560,04	G47	-4352,94
G47	-67,36	M74-75	-3176,46	R-S	-477,35	H50	-3914,19
C23	-66,35	B	-3098,32	F	-468,68	H49	-3557,66
C16	-62,56	H49	-3088,74	C16	-436,13	J62-63	-3502,33
E37-39	-57,92	H50	-2962,20	H49	-433,71	C23	-3489,08
K65	-57,19	C23	-2862,69	E37-39	-374,34	M74-75	-3463,91

**Table 7.** Extraction of sectoral EU import flows from the UK. Top 30 sectors ranked by aggregate LiVA (expressed in millions of US dollars) in the UK, the EU27, extra-EU countries and World.

The results shown in this and the previous sub-section do not provide any prediction about the economic impact of Brexit. In fact, the aim of the present study is different. Our findings would allow indicating those sectors that are key in the complex structure of the UK-EU trade relationships. In particular, our sectoral hypothetical extraction technique would help policy-maker to better understand which tariff would have a more distortive impact, which export sector should be pushed, which imports should be safeguarded. Such information may have foremost importance in the negotiations between the UK and EU.

## 6. Conclusion

This paper aimed to provide a detailed and holistic description of the EPN and to identify those sectors that are key in the complex structure of the UK-EU trade relationships.

Studying the structure of the EPN is crucial in establishing whether and how a potential shock due to Brexit can propagate throughout the economy and lead to significant aggregate fluctuations. Furthermore, the analysis of this production network and the identification of 'systemically important' sectors, is of a foremost importance to design predictive tools, rather than bailout post-recession arguments, and better inform regulators on how to dampen aggregate variability and reduce the likelihood of systemic risk.

Our results can be summarised in three major points. First, the sectors in Europe are both highly connected and asymmetrically connected, i.e. most of the sectors have many connections with other

sectors, whilst most of the goods and services flow through just a few sectors. Therefore, a few industries placed in core countries, especially, Germany, the UK, and France dominate the EPN. In particular, the UK hosts the most important sectors both in standard input-output key sectors measure and in terms of network centrality. This means that a shock affecting one of these UK hubs will spread quickly to most sectors and countries, thus affecting the performance of the aggregate economy. Therefore, both macro-regions, the UK and the EU27, should safeguard UK key sectors from the potential negative impact of Brexit.

Second, the measure of country and sectors exposure to tariff and non-tariff barriers, that we developed inspired by the 'hypothetical extraction' method used in W. Chen et al. (2018), shows that the UK would be less exposed than EU countries to trade barriers. Indeed, although in our simulation as well as in the main literature, the UK is the country most exposed to the economic risk deriving from Brexit, we find that the most vulnerable UK sectors are services industries whose products can only be subject to non-tariff barriers, whereas the most exposed EU industries are goods sectors, mainly manufacturing, which can be subject to both tariff and non-tariff barriers.

Third, our measure identifies Brexit key import and export sectors for the UK, EU27, i.e. those sectors that play a key role in the import-export relations between the UK and EU countries. Results show that the UK industries most involved in direct and indirect trade relationships with EU countries are mainly services sectors, whilst the most important EU industries are goods sectors.

Therefore, the main implication of our results is that Brexit could be risky and costly not just for the UK, as it is often portrayed, but any form of Brexit could propagate within the EPN and affect businesses and governments in the EU and globally. Further, our findings of the exposure to trade barriers could strengthen the position of the UK in the negotiation of a Brexit deal with EU.

Considering the recent rise of protectionism worldwide, our study could be a useful tool to guide governments and institutions in implementing trade and economic policies. However, our analysis could be extended by implementing a multilayer network able to consider also the countries positions within the trade agreements network (Sopranzetti, 2017). Furthermore, the measure presented in this paper shares all limits with the comparative statics exercises. Future research could be dedicated to the development of a more sophisticated model which complements the standard input-output framework with agent-based models (Gualdi and Mandel, 2018; Baqaee and Farhi, 2018 and Otto et al., 2017 provide the first experiments), allowing for endogenous sectoral interactions (Battiston et al., 2007; Delli Gatti et al., 2010; Delli Gatti et al., 2012), real and financial interactions (Sornette and Woodard, 2010; Riccetti et al., 2013; Bargigli et al., 2014), disequilibrium (Johnson, 1985), and non-linear dynamics (Dietzenbacher, 1993).

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## Appendix

Country Name	ISO Code	Country Name	ISO Code
AUSTRALIA	AUS	IRELAND	IRL
AUSTRIA	AUT	ITALY	ITA
BELGIUM	BEL	JAPAN	JPN
BULGARIA	BGR	SOUTH KOREA	KOR
BRASIL	BRA	LITHUANIA	LTU
CANADA	CAN	LUXEMBOURG	LUX
SWITZERLAND	CHE	LATVIA	LVA
CHINA	CHN	MEXICO	MEX
CYPRUS	CYP	MALTA	MLT
CZECH REPUBLIC	CZE	NETHERLANDS	NLD
GERMANY	DEU	NORWAY	NOR
DENMARK	DNK	POLAND	POL
SPAIN	ESP	PORTUGAL	PRT
ESTONIA	EST	ROMANIA	ROU
FINLAND	FIN	RUSSIA	RUS
FRANCE	FRA	SLOVAKIA	SVK
UNITED KINGDOM	GBR	SLOVENIA	SVN
GREECE	GRC	SWEDEN	SWE
CROATIA	HRV	TURKEY	TUR
HUNGARY	HUN	TAIWAN	TWN
INDIA	IDN	UNITED STATES	USA
INDONESIA	IND	REST OF THE WORLD	ROW

Table A.1. Countries in WIOD.

<b>Goods</b>		<b>Services</b>	
ISIC Rev. 4 Code	Sector Legend	ISIC Rev. 4 Code	Sector Legend
A01	Live Animals	D35	Electricity & Gas
A02	Forestry	E36	Water Collection Activities
A03	Fishing	E37-39	Waste Collection Activities
B	Mining and quarrying	F	Construction
C10-12	Food Product	G45	Wholesale and retail trade
C13-15	Textiles	G46	Wholesale trade
C16	Wood and Cork	G47	Retail trade
C17	Paper Products	H49	Land & Pipeline transport
C18	Printing and Media	H50	Water transport
C19	Petroleum Products	H51	Air transport
C20	Chemicals	H52	Warehousing
C21	Pharmaceutical	H53	Postal
C22	Rubber and Plastic	I	Accommodation & Food serv.
C23	Other Non-metallic mineral	J58	Publishing Act.
C24	Basic Metals	J59-60	Media Production
C25	Metal products	J61	Telecom
C26	Electronics and Computers	J62-63	Computer Programming
C27	Electrical Equipment	K64	Financial Services
C28	Machinery & Equipment	K65	Insurance
C29	Motor vehicles	K66	Auxiliary Financial Serv.
C30	Transport equipment	L68	Real Estate
C31-32	Furniture & other manufac.	M69-70	Legal and Accounting
C33	Installation of machinery	M71	Architectural and engineering act.
		M72	Scientific Research
		M73	Advertising and market research
		M74-75	Other professional activities
		N	Administrative and support act.
		O84	Public admin and defence
		P85	Education
		Q	Health
		R-S	Other services
		T	Activities of Households as Employers
		U	Activities of Extraterritorial Org.

Table A.2. Sectors in WIOD.



	AUS	BRA	CAN	CHE	CHN	IDN	IND	JPN	KOR	MEX	NOR	RUS	TUR	TWN	USA	ROW	WORLD
A01	-17	-50	-54	-75	-130	-23	-24	-44	-21	-28	-94	-139	-19	-12	-919	-764	-10821
A02	0	0	-1	-1	-2	0	0	-1	0	0	-2	-2	0	0	-11	-10	-242
A03	-1	-2	-3	-2	-8	-1	-3	-2	-2	-1	-13	-10	-2	-1	-22	-52	-733
B	-11	-15	-29	-28	-75	-5	-14	-20	-11	-6	-340	-101	-11	-7	-173	-337	-13069
C10-12	-84	-342	-183	-264	-576	-129	-132	-152	-79	-65	-299	-376	-110	-48	-3002	-2969	-47778
C13-15	-25	-44	-24	-55	-349	-29	-99	-43	-56	-13	-44	-80	-173	-22	-226	-590	-12601
C16	-3	-9	-10	-15	-55	-5	-6	-10	-6	-3	-30	-64	-6	-3	-104	-142	-3327
C17	-9	-27	-19	-43	-110	-10	-19	-25	-16	-7	-83	-112	-23	-8	-207	-288	-7447
C18	-1	-2	-5	-3	-11	-1	-2	-2	-2	-1	-5	-5	-2	-1	-43	-28	-869
C19	-68	-93	-126	-82	-255	-42	-60	-65	-47	-72	-2050	-1699	-44	-21	-583	-2515	-17151
C20	-75	-130	-131	-246	-704	-91	-164	-225	-144	-85	-461	-647	-103	-55	-1450	-2274	-32744
C21	-27	-47	-59	-339	-334	-31	-48	-80	-45	-27	-91	-128	-34	-24	-1483	-1095	-28599
C22	-22	-35	-38	-86	-255	-28	-56	-74	-51	-22	-98	-161	-55	-21	-418	-603	-13497
C23	-7	-11	-16	-23	-68	-5	-11	-17	-10	-9	-87	-98	-14	-5	-127	-264	-4921
C24	-54	-71	-324	-71	-277	-24	-47	-78	-46	-54	-373	-501	-79	-31	-538	-1055	-14267
C25	-17	-28	-66	-50	-159	-11	-26	-44	-28	-15	-65	-150	-40	-19	-227	-393	-10170
C26	-58	-51	-101	-219	-1556	-42	-66	-398	-349	-35	-101	-172	-61	-232	-1181	-1879	-26061
C27	-28	-34	-78	-102	-504	-21	-46	-126	-85	-25	-88	-172	-68	-54	-367	-640	-14968
C28	-53	-77	-179	-205	-862	-35	-92	-247	-123	-48	-186	-320	-169	-85	-783	-1153	-31792
C29	-99	-137	-260	-383	-1502	-90	-218	-592	-337	-113	-312	-651	-495	-167	-1396	-2574	-58537
C30	-30	-55	-142	-112	-443	-25	-99	-162	-76	-58	-88	-139	-71	-75	-1518	-734	-18617
C31-32	-17	-25	-45	-67	-268	-17	-31	-51	-35	-15	-65	-107	-46	-23	-270	-434	-12898
C33	-2	-4	-5	-11	-41	-2	-4	-11	-7	-2	-7	-14	-6	-5	-42	-61	-1853

Table A.5. Aggregate LiVA (expressed in millions of US dollars) in all Extra-EU countries and ROW as a result of bilateral trade flows extraction. Goods.

	AUS	BRA	CAN	CHE	CHN	IDN	IND	JPN	KOR	MEX	NOR	RUS	TUR	TWN	USA	ROW	WORLD
D35	-2	-3	-5	-8	-17	-1	-2	-4	-2	-1	-68	-35	-2	-1	-27	-91	-1445
E36	0	0	0	0	-1	0	0	0	0	0	0	-1	0	0	-3	-4	-152
E37-39	-6	-11	-22	-23	-58	-5	-9	-16	-11	-5	-27	-33	-9	-6	-279	-160	-7389
F	-5	-12	-11	-21	-87	-7	-10	-21	-10	-4	-22	-36	-11	-6	-95	-151	-3653
G45	-4	-5	-9	-13	-46	-3	-8	-19	-9	-3	-16	-21	-13	-5	-76	-106	-5691
G46	-47	-74	-115	-169	-407	-30	-65	-104	-66	-25	-215	-230	-68	-36	-901	-1293	-55844
G47	-6	-8	-12	-21	-45	-4	-8	-12	-8	-3	-25	-32	-8	-4	-128	-177	-8685
H49	-4	-8	-11	-25	-39	-4	-6	-10	-7	-4	-24	-54	-8	-3	-94	-185	-4232
H50	-10	-18	-14	-25	-62	-7	-12	-17	-10	-5	-56	-77	-20	-6	-173	-404	-4396
H51	-17	-31	-48	-51	-119	-17	-25	-39	-24	-24	-101	-189	-23	-14	-592	-859	-9531
H52	-4	-6	-9	-17	-34	-2	-6	-9	-5	-2	-18	-23	-7	-3	-82	-124	-4641
H53	-2	-3	-5	-9	-21	-1	-3	-5	-3	-1	-8	-9	-3	-2	-79	-63	-2371
I	-2	-8	-5	-8	-20	-5	-4	-5	-3	-2	-10	-13	-4	-2	-47	-92	-3654
J58	-2	-4	-5	-9	-18	-1	-3	-5	-3	-2	-11	-12	-3	-2	-82	-78	-2855
J59-60	-3	-3	-10	-7	-25	-1	-3	-6	-5	-1	-9	-7	-3	-2	-71	-59	-3564
J61	-14	-13	-27	-51	-245	-8	-23	-56	-41	-7	-38	-41	-15	-32	-259	-364	-12950
J62-63	-6	-8	-20	-26	-54	-3	-11	-23	-13	-4	-18	-16	-5	-7	-661	-406	-7906
K64	-12	-11	-60	-166	-86	-4	-12	-21	-15	-4	-36	-36	-36	-7	-805	-470	-15080
K65	-5	-5	-9	-12	-24	-2	-4	-9	-6	-1	-10	-9	-3	-3	-115	-275	-4022
K66	-11	-9	-21	-23	-60	-4	-10	-18	-13	-3	-41	-28	-8	-7	-223	-234	-15083
L68	-1	-2	-2	-8	-16	-1	-2	-3	-4	-1	-3	-21	-2	-1	-18	-38	-4893
M69-70	-11	-17	-25	-60	-142	-12	-12	-19	-14	-3	-25	-20	-6	-7	-282	-260	-13720
M71	-3	-7	-9	-12	-32	-2	-10	-9	-7	-1	-14	-11	-3	-3	-88	-82	-5325
M72	-2	-3	-7	-10	-19	-1	-3	-7	-5	-1	-8	-7	-2	-2	-45	-48	-3083
M73	-3	-4	-7	-11	-27	-1	-4	-6	-4	-1	-10	-11	-3	-2	-85	-84	-4010
M74-75	-9	-12	-47	-33	-83	-5	-14	-48	-37	-5	-44	-31	-9	-10	-196	-275	-14925
N	-31	-58	-117	-134	-269	-17	-49	-80	-55	-16	-120	-106	-44	-24	-561	-822	-45579
O84	-1	-3	-3	-6	-19	-1	-2	-4	-3	-1	-3	-4	-2	-4	-36	-36	-1911
P85	-1	-1	-2	-2	-5	0	-1	-1	-1	0	-3	-2	-1	-1	-9	-16	-1586
Q	0	-1	-1	-3	-5	0	-1	-1	-1	0	-1	-2	0	0	-9	-14	-654
R-S	-5	-8	-38	-28	-62	-4	-10	-13	-12	-3	-21	-27	-18	-6	-147	-235	-8980

Table A.6. Aggregate LiVA (expressed in millions of US dollars) in all Extra-EU countries and ROW as a result of bilateral trade flows extraction. Services.

Extracted Sector		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A01	Country-Sector	IRL_A01	GBR_A01	ESP_A01	NLD_A01	FRA_A01	IRL_J58	ITA_A01	DEU_A01	USA_N	USA_G46	IRL_C31-32	ROW_B	GBR_C10-12	ROW_A01	USA_M72
	Loss	-1325,05	-896,24	-559,16	-476,98	-352,61	-331,02	-161,13	-157,87	-157,59	-140,35	-129,85	-128,11	-124,27	-121,85	-107,22
A02	Country-Sector	IRL_A02	GBR_A02	SWE_A02	GBR_G45	DEU_A02	IRL_J58	GBR_A01	GBR_H49	GBR_N	GBR_G46	POL_A02	ROW_B	SVK_A02	GBR_F	USA_N
	Loss	-92,76	-17,30	-9,96	-4,63	-4,24	-3,66	-3,19	-2,87	-2,81	-2,70	-2,56	-2,48	-1,96	-1,78	-1,76
A03	Country-Sector	GBR_A03	GBR_C10-12	GBR_D35	ROW_B	GBR_F	GBR_N	IRL_A03	NLD_A03	GBR_C33	GBR_B	GBR_K64	NOR_B	GBR_R-S	GBR_M69_70	GBR_G46
	Loss	-243,51	-19,41	-18,49	-18,02	-17,31	-16,71	-14,81	-12,09	-12,00	-11,55	-10,79	-9,95	-9,84	-9,59	-9,58
B	Country-Sector	GBR_B	NLD_B	DNK_B	NOR_B	GBR_M69_70	GBR_N	GBR_K64	GBR_F	ROW_B	GBR_H49	GBR_C25	GBR_D35	GBR_J62-63	GBR_M71	GBR_C33
	Loss	-6439,17	-1738,05	-593,89	-293,44	-242,13	-212,87	-187,45	-170,03	-149,74	-105,05	-99,21	-96,66	-87,51	-79,46	-64,85
C10-12	Country-Sector	GBR_C10-12	IRL_C10-12	DEU_C10-12	FRA_C10-12	NLD_C10-12	GBR_A01	ITA_C10-12	BEL_C10-12	ROW_A01	FRA_A01	USA_G46	ESP_C10-12	ITA_A01	GBR_G46	ROW_B
	Loss	-5060,76	-3641,16	-1531,63	-1513,12	-1167,18	-850,43	-792,95	-737,44	-726,37	-648,86	-615,58	-609,20	-480,39	-448,37	-443,58
C13-15	Country-Sector	GBR_C13-15	ITA_C13-15	DEU_C13-15	FRA_C13-15	ESP_C13-15	BEL_C13-15	PRT_C13-15	NLD_C13-15	ITA_G46	ROW_B	ITA_L68	ITA_H49	ROU_C13-15	GBR_G46	ITA_K64
	Loss	-2041,29	-1400,90	-500,68	-489,34	-298,87	-228,88	-217,01	-151,50	-132,38	-131,74	-130,89	-129,98	-120,22	-111,60	-103,65
C16	Country-Sector	SWE_C16	GBR_C16	SWE_A02	IRL_C16	DEU_C16	POL_C16	LVA_C16	FIN_A02	ITA_C16	FIN_C16	ESP_C16	FRA_C16	PRT_C16	BEL_C16	ROW_B
	Loss	-151,64	-137,78	-132,90	-123,47	-117,38	-105,68	-84,93	-78,17	-70,36	-63,44	-39,70	-38,51	-35,59	-35,54	-33,91
C17	Country-Sector	DEU_C17	GBR_C17	SWE_C17	FIN_C17	FRA_C17	ITA_C17	SWE_A02	NLD_C17	BEL_C17	ROW_B	FIN_A02	AUT_C17	DEU_C17	POL_C17	GBR_D35
	Loss	-625,18	-623,54	-306,77	-248,03	-186,73	-129,30	-105,87	-100,47	-100,41	-90,44	-83,24	-78,66	-75,27	-68,84	-65,77
C18	Country-Sector	GBR_C18	IRL_C18	GBR_G46	GBR_C17	ITA_C18	GBR_C31-32	GBR_N	NLD_C18	GBR_H49	ESP_C18	BEL_C18	GBR_M69_70	GBR_D35	GBR_J62-63	GBR_F
	Loss	-276,97	-47,79	-23,10	-21,45	-21,23	-15,19	-12,75	-11,40	-10,27	-9,79	-9,42	-8,77	-7,19	-7,01	-6,95
C19	Country-Sector	NOR_B	ROW_B	GBR_B	RUS_B	GBR_C19	NLD_M69_70	NLD_B	DNK_B	RUS_G46	SWE_C19	NLD_G46	SWE_B	RUS_H49	ROW_D35	NLD_F
	Loss	-1782,23	-1553,48	-1471,17	-761,82	-600,06	-340,48	-279,83	-262,25	-254,19	-190,70	-187,84	-187,84	-176,07	-143,64	-132,49
C20	Country-Sector	GBR_C20	DEU_C20	FRA_C20	NLD_C20	ROW_B	BEL_C20	GBR_G46	USA_C20	NOR_B	ITA_C20	GBR_M69_70	ESP_C20	GBR_K64	GBR_N	DEU_N
	Loss	-4325,91	-2726,36	-1166,13	-960,96	-898,40	-655,43	-541,33	-361,21	-347,08	-342,62	-320,41	-310,22	-307,53	-291,80	-291,80
C21	Country-Sector	GBR_C21	DEU_C21	FRA_C21	IRL_C21	BEL_C21	ITA_C21	NLD_C21	DNK_C21	USA_N	ESP_C21	GBR_K64	ROW_N	SWE_C21	GBR_M69_70	DEU_N
	Loss	-5772,87	-3290,84	-1514,37	-1295,31	-854,67	-828,29	-801,67	-567,42	-408,40	-346,91	-269,48	-260,34	-229,51	-227,86	-212,98
C22	Country-Sector	GBR_C22	DEU_C22	FRA_C22	ITA_C22	NLD_C22	DEU_C20	ROW_B	ESP_C22	POL_C22	IRL_C22	BEL_C22	GBR_C20	DEU_N	GBR_G46	DEU_G46
	Loss	-2307,20	-1310,38	-434,61	-269,78	-238,95	-214,27	-199,18	-174,33	-169,49	-165,58	-161,23	-147,55	-146,92	-121,71	-100,59
C23	Country-Sector	GBR_C23	DEU_C23	ITA_C23	ESP_C23	FRA_C23	ROW_B	IRL_C23	POL_C23	BEL_C23	GBR_D35	GBR_B	GBR_H49	NLD_C23	GBR_N	
	Loss	-489,72	-371,33	-161,64	-143,56	-141,48	-118,84	-98,17	-96,81	-84,71	-75,37	-73,03	-71,51	-59,80	-54,86	-48,68
C24	Country-Sector	GBR_C24	DEU_C24	ROW_B	GBR_G46	GBR_B	NOR_B	GBR_D35	GBR_N	ESP_C24	GBR_E37-39	CAN_C24	ITA_C24	RUS_B	FRA_C24	GBR_H49
	Loss	-1627,99	-791,65	-489,85	-350,17	-290,71	-281,55	-231,19	-182,34	-177,40	-151,66	-150,72	-144,08	-142,48	-138,20	-136,23
C25	Country-Sector	DEU_C25	GBR_C25	ITA_C25	FRA_C25	POL_C25	NLD_C25	IRL_C25	ESP_C25	AUT_C25	BEL_C25	ROW_B	CZE_C25	DEU_C24	DEU_N	DEU_G46
	Loss	-1363,89	-1312,16	-477,93	-298,66	-197,33	-194,09	-164,72	-161,34	-160,23	-145,56	-145,25	-129,38	-112,44	-111,09	-87,45
C26	Country-Sector	GBR_C26	DEU_C26	FRA_C26	IRL_C26	CHN_C26	NLD_C26	ROW_C26	DEU_G46	ROW_B	ITA_C26	CZE_C26	USA_C26	ROW_N	SWE_C26	GBR_G46
	Loss	-4506,59	-2968,97	-1072,46	-522,92	-436,33	-398,20	-350,77	-273,60	-265,30	-264,38	-261,10	-253,31	-240,96	-236,45	-232,45
C27	Country-Sector	GBR_C27	DEU_C27	ITA_C27	FRA_C27	POL_C27	ROW_B	NLD_C27	ESP_C27	AUT_C27	GBR_C25	DEU_G46	GBR_G46	DEU_N	CZE_C27	BEL_C27
	Loss	-1984,36	-1900,57	-458,80	-407,29	-235,41	-197,53	-183,19	-163,00	-160,24	-153,99	-150,03	-149,76	-146,75	-142,22	-127,67
C28	Country-Sector	GBR_C28	DEU_C28	ITA_C28	FRA_C28	NLD_C28	GBR_C25	GBR_G46	DEU_C25	DEU_N	ROW_B	SWE_C28	DEU_G46	BEL_C28	ITA_C25	DEU_M69_70
	Loss	-4425,64	-4147,68	-1173,65	-895,37	-739,88	-619,09	-406,76	-364,24	-349,79	-348,58	-298,05	-287,96	-262,63	-259,92	-259,67
C29	Country-Sector	DEU_C29	GBR_C29	ESP_C29	FRA_C29	DEU_G45	DEU_N	GBR_G45	DEU_C25	ROW_B	DEU_L68	ITA_C29	DEU_G46	DEU_C28	BEL_C29	DEU_M69_70
	Loss	-10074,39	-3760,00	-1050,31	-966,67	-902,75	-870,50	-854,10	-775,60	-718,97	-670,20	-653,75	-642,40	-639,57	-586,29	-572,01
C30	Country-Sector	GBR_C30	DEU_C30	FRA_C30	ESP_C30	USA_C30	ITA_C30	GBR_C33	GBR_C25	FRA_C33	ROW_B	FRA_N	DEU_N	BEL_C30	GBR_N	DEU_C25
	Loss	-2128,49	-1258,85	-1194,11	-624,22	-599,58	-461,55	-273,66	-272,28	-206,91	-195,51	-188,58	-185,36	-182,08	-168,48	-168,06
C31-32	Country-Sector	GBR_C31-32	DEU_C31-32	FRA_C31-32	ITA_C31-32	NLD_C31-32	IRL_C31-32	POL_C31-32	ESP_C31-32	DEU_G46	ROW_B	GBR_G46	DEU_N	DNK_C31-32	BEL_C31-32	GBR_N
	Loss	-2424,04	-1257,29	-608,58	-587,06	-347,83	-189,45	-158,90	-128,08	-126,63	-117,94	-103,53	-101,24	-95,43	-95,33	-83,19
C33	Country-Sector	FRA_C33	DEU_C33	GBR_C33	ITA_C33	POL_C33	NLD_C33	BEL_C33	AUT_C33	ESP_C33	FRA_G46	CZE_C33	FRA_N	ROW_B	GBR_N	DEU_N
	Loss	-293,77	-92,41	-88,82	-70,92	-59,02	-49,08	-40,93	-39,32	-27,47	-21,04	-20,00	-18,28	-17,07	-16,16	-14,74

Table A.7. Top 15 most affected country-sectors in terms of LiVA (expressed in millions of US dollars) as a result of goods sectors hypothetical extraction.







	AUS	BRA	CAN	CHE	CHN	IDN	IND	JPN	KOR	MEX	NOR	RUS	TUR	TWN	USA	ROW	WORLD
A01	-2	-5	-6	-5	-18	-2	-4	-5	-3	-2	-18	-16	-4	-2	-36	-71	-1879
A02	0	0	0	0	-1	0	0	0	0	0	-1	-1	0	0	-2	-4	-74
A03	-1	-1	-2	-2	-7	-1	-2	-2	-1	-1	-11	-9	-1	-1	-17	-46	-629
B	-10	-12	-26	-16	-56	-4	-11	-15	-9	-5	-321	-78	-9	-6	-110	-259	-9765
C10-12	-15	-37	-38	-38	-125	-16	-29	-33	-19	-11	-111	-76	-24	-12	-243	-441	-12310
C13-15	-6	-5	-7	-7	-59	-3	-21	-9	-14	-2	-18	-14	-30	-4	-49	-89	-3473
C16	0	-1	-2	-1	-8	-1	-1	-1	-1	0	-3	-3	-1	0	-7	-11	-326
C17	-2	-4	-4	-4	-20	-2	-4	-5	-3	-1	-24	-12	-5	-2	-30	-45	-1439
C18	-1	-1	-1	-1	-7	0	-1	-2	-1	0	-4	-3	-1	-1	-10	-14	-569
C19	-18	-22	-41	-15	-59	-8	-15	-16	-11	-9	-993	-229	-9	-6	-139	-663	-5837
C20	-30	-41	-55	-62	-265	-23	-64	-85	-59	-32	-226	-171	-39	-23	-505	-678	-13358
C21	-8	-8	-19	-76	-66	-5	-10	-18	-9	-6	-32	-23	-6	-5	-180	-185	-9214
C22	-8	-11	-17	-16	-81	-8	-18	-23	-15	-8	-47	-40	-15	-7	-123	-165	-4892
C23	-2	-3	-7	-4	-20	-1	-4	-5	-3	-2	-48	-17	-4	-2	-33	-61	-1460
C24	-39	-38	-291	-29	-146	-11	-24	-48	-25	-31	-242	-240	-43	-18	-308	-516	-7460
C25	-6	-6	-44	-5	-30	-2	-6	-10	-5	-5	-17	-32	-8	-4	-48	-67	-2305
C26	-23	-14	-50	-57	-413	-10	-22	-87	-69	-12	-44	-44	-20	-61	-233	-404	-8744
C27	-13	-12	-53	-22	-171	-6	-18	-41	-23	-10	-36	-50	-24	-18	-130	-183	-4796
C28	-26	-27	-126	-42	-266	-11	-36	-75	-34	-22	-82	-110	-49	-27	-265	-345	-10712
C29	-37	-38	-159	-63	-412	-23	-69	-169	-68	-38	-100	-155	-122	-50	-414	-586	-14315
C30	-13	-18	-65	-25	-127	-9	-62	-64	-24	-27	-36	-41	-19	-21	-711	-214	-6337
C31-32	-7	-7	-27	-12	-91	-5	-11	-18	-13	-5	-32	-29	-13	-9	-77	-117	-4345
C33	0	-1	-1	-1	-4	0	0	-1	-1	0	-1	-1	0	0	-3	-4	-179

Table A.11. Aggregate LiVA (expressed in millions of US dollars) in all Extra-EU countries and ROW as a result of UK outflows to EU extraction. Goods.

	AUS	BRA	CAN	CHE	CHN	IDN	IND	JPN	KOR	MEX	NOR	RUS	TUR	TWN	USA	ROW	WORLD
D35	-0.92	-1.12	-2.31	-1.14	-5.47	-0.36	-0.82	-1.32	-0.75	-0.45	-46.96	-9.42	-0.76	-0.48	-7.16	-27.85	-482.40
E36	-0.01	-0.01	-0.01	-0.02	-0.05	0.00	-0.01	-0.01	-0.01	0.00	-0.07	-0.03	-0.01	-0.01	-0.08	-0.13	-10.24
E37-39	-3.42	-4.72	-13.40	-9.90	-26.33	-1.58	-4.31	-8.67	-5.89	-2.27	-17.44	-12.35	-4.05	-2.99	-124.97	-76.01	-4418.33
F	-0.51	-0.73	-1.65	-1.09	-5.80	-0.40	-0.98	-1.39	-0.80	-0.33	-3.75	-2.26	-1.02	-0.49	-6.70	-10.66	-536.59
G45	-2.46	-2.74	-6.71	-5.51	-25.37	-1.63	-5.62	-11.47	-5.30	-2.02	-10.84	-9.55	-8.34	-3.03	-38.75	-57.39	-3414.47
G46	-32.24	-42.44	-80.48	-71.32	-198.15	-16.18	-40.04	-61.41	-41.92	-14.61	-161.10	-133.57	-41.22	-20.77	-460.29	-694.75	-34320.49
G47	-3.61	-4.94	-7.01	-6.83	-18.95	-1.82	-3.98	-5.21	-3.59	-1.29	-15.97	-10.97	-3.55	-1.80	-36.86	-79.34	-4335.10
H49	-0.68	-0.78	-1.64	-1.32	-4.56	-0.42	-0.97	-1.58	-0.98	-0.39	-4.42	-4.13	-1.00	-0.51	-8.95	-18.75	-675.25
H50	-0.58	-0.67	-1.18	-1.04	-3.11	-0.26	-0.62	-0.93	-0.59	-0.25	-2.93	-2.31	-0.97	-0.37	-11.35	-15.72	-510.82
H51	-2.52	-2.98	-6.58	-3.97	-12.53	-1.69	-5.09	-5.21	-3.07	-2.34	-16.19	-17.28	-2.34	-1.76	-69.15	-81.41	-1718.13
H52	-2.39	-2.88	-5.82	-5.75	-13.11	-1.00	-2.84	-4.36	-3.01	-0.98	-9.60	-7.70	-2.65	-1.54	-40.04	-49.43	-2614.71
H53	-1.03	-1.31	-2.97	-2.49	-7.19	-0.57	-1.45	-2.44	-1.58	-0.62	-5.68	-4.91	-1.56	-0.83	-22.21	-26.90	-1149.32
I	-1.02	-2.03	-2.54	-2.40	-6.94	-0.96	-1.85	-1.90	-1.31	-0.63	-6.13	-4.58	-1.27	-0.67	-14.79	-30.79	-1293.85
J58	-1.65	-2.61	-2.92	-4.96	-10.30	-0.76	-2.10	-2.85	-1.97	-0.71	-6.39	-4.78	-1.76	-1.04	-33.01	-44.63	-2018.16
J59-60	-2.78	-2.88	-9.38	-6.21	-23.05	-1.08	-3.16	-5.67	-4.35	-1.09	-8.66	-6.59	-2.44	-2.18	-64.44	-52.40	-3293.96
J61	-8.57	-5.89	-15.77	-19.67	-123.96	-4.12	-8.58	-26.37	-20.85	-3.82	-23.33	-20.57	-7.90	-17.28	-93.51	-150.11	-6359.01
J62-63	-2.88	-4.52	-10.47	-10.30	-19.95	-1.01	-3.82	-8.04	-6.26	-1.03	-11.38	-6.64	-2.35	-2.49	-38.90	-57.85	-4414.41
K64	-5.52	-6.58	-14.20	-14.82	-27.13	-1.87	-5.29	-8.69	-6.71	-1.72	-17.68	-12.80	-3.98	-2.89	-91.49	-101.13	-7018.96
K65	-3.19	-3.63	-6.43	-6.77	-14.54	-1.22	-2.86	-5.01	-3.59	-0.89	-8.13	-6.09	-2.09	-1.61	-47.70	-79.72	-3097.79
K66	-10.52	-9.09	-20.24	-20.96	-57.32	-3.73	-9.10	-17.06	-12.82	-3.26	-40.15	-27.18	-6.71	-6.71	-199.97	-217.06	-14684.86
L68	-0.14	-0.15	-0.35	-0.57	-0.87	-0.05	-0.17	-0.25	-0.16	-0.05	-0.64	-0.35	-0.14	-0.09	-2.36	-2.65	-427.65
M69-70	-4.89	-6.74	-17.71	-15.56	-24.20	-1.57	-5.18	-10.12	-7.95	-1.43	-16.70	-10.16	-3.24	-2.57	-62.85	-90.36	-8467.04
M71	-2.35	-3.41	-6.52	-6.63	-14.53	-0.88	-6.02	-5.32	-4.26	-0.88	-9.69	-6.01	-1.74	-1.75	-39.96	-47.74	-3543.94
M72	-1.18	-2.10	-4.73	-4.41	-7.70	-0.49	-1.43	-4.41	-3.70	-0.62	-5.22	-3.58	-1.12	-0.98	-24.67	-27.01	-1770.31
M73	-1.65	-1.79	-3.58	-3.88	-10.23	-0.65	-2.18	-3.07	-2.26	-0.60	-5.85	-4.36	-1.40	-1.06	-24.37	-32.45	-2177.35
M74-75	-7.17	-9.25	-41.92	-22.36	-54.53	-3.27	-10.96	-42.20	-32.07	-3.46	-38.68	-19.45	-6.44	-7.49	-125.92	-196.35	-11568.40
N	-20.30	-34.90	-84.65	-75.55	-119.84	-7.88	-27.62	-53.32	-36.59	-8.50	-77.73	-49.33	-23.77	-13.10	-267.27	-383.81	-25271.90
O84	-0.60	-0.55	-1.41	-1.37	-6.76	-0.27	-0.86	-1.75	-1.36	-0.66	-1.77	-1.38	-0.56	-0.95	-10.34	-11.22	-568.37
P85	-0.52	-0.53	-1.28	-1.07	-3.81	-0.24	-0.51	-1.16	-0.91	-0.19	-2.21	-1.37	-0.47	-0.43	-5.61	-11.01	-1078.36
Q	-0.26	-0.25	-0.44	-1.42	-2.37	-0.16	-0.25	-0.55	-0.40	-0.12	-0.60	-0.50	-0.16	-0.28	-3.69	-7.07	-203.72
R-S	-2.41	-3.53	-7.87	-7.50	-17.54	-1.05	-3.15	-5.51	-4.24	-1.00	-10.17	-6.37	-2.61	-1.82	-34.30	-51.18	-4220.32

Table A.12. Aggregate LiVA (expressed in millions of US dollars) in all Extra-EU countries and ROW as a result of UK outflows to EU extraction. Services.

Extracted Sector		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A01	Country-Sector	GBR_A01	GBR_C10-12	GBR_G45	GBR_K64	GBR_G46	GBR_F	GBR_N	ROW_B	GBR_D35	GBR_M69_70	GBR_H49	GBR_B	GBR_J61	GBR_C25	NOR_B
	Loss	-891,46	-97,02	-56,66	-55,38	-40,32	-37,23	-30,93	-25,64	-24,97	-23,95	-20,30	-16,48	-16,22	-14,28	-13,66
A02	Country-Sector	GBR_A02	GBR_G45	GBR_A01	GBR_H49	GBR_N	IRL_A02	GBR_G46	GBR_F	ROW_B	GBR_K64	GBR_D35	GBR_C31-32	GBR_M69_70	GBR_B	GBR_H52
	Loss	-17,30	-4,50	-2,78	-2,76	-2,55	-2,31	-2,21	-1,70	-1,55	-1,51	-1,29	-1,10	-1,06	-0,94	-0,87
A03	Country-Sector	GBR_A03	GBR_C10-12	GBR_D35	GBR_F	GBR_N	ROW_B	GBR_C33	GBR_B	GBR_K64	GBR_R-S	GBR_M69_70	GBR_G46	NOR_B	ROW_A03	GBR_K65
	Loss	-243,51	-19,25	-18,45	-17,25	-16,52	-16,46	-11,99	-11,22	-10,68	-9,81	-9,45	-9,23	-9,20	-8,72	-7,79
B	Country-Sector	GBR_B	NOR_B	GBR_M69_70	GBR_N	GBR_K64	GBR_F	ROW_B	GBR_H49	GBR_C25	GBR_D35	GBR_J62-63	GBR_M71	GBR_C33	GBR_G46	GBR_G45
	Loss	-6438,78	-279,14	-239,90	-211,06	-186,56	-169,71	-132,38	-104,68	-98,71	-96,40	-86,77	-78,85	-64,71	-48,59	-37,06
C10-12	Country-Sector	GBR_C10-12	GBR_A01	GBR_N	GBR_K64	GBR_H49	GBR_M69_70	GBR_D35	GBR_G45	GBR_C25	GBR_C22	GBR_J62-63	GBR_C17	GBR_B	GBR_F	
	Loss	-5050,93	-819,23	-322,21	-291,13	-284,56	-279,98	-271,64	-248,02	-183,40	-161,39	-146,99	-136,07	-133,77	-116,14	-115,93
C13-15	Country-Sector	GBR_C13-15	GBR_G46	GBR_K64	GBR_M69_70	GBR_N	GBR_H49	GBR_D35	GBR_J62-63	GBR_F	GBR_M71	GBR_C10-12	GBR_C20	GBR_H52	ROW_B	GBR_G45
	Loss	-2040,86	-86,69	-66,08	-63,53	-57,76	-51,56	-40,49	-33,38	-26,42	-26,26	-25,17	-22,69	-22,34	-21,65	-20,40
C16	Country-Sector	GBR_C16	GBR_H49	GBR_K64	GBR_N	GBR_C25	GBR_G46	GBR_D35	GBR_M69_70	GBR_G45	GBR_F	ROW_B	GBR_J62-63	GBR_C22	GBR_B	GBR_C28
	Loss	-137,71	-9,02	-8,53	-8,52	-5,92	-5,41	-4,67	-4,02	-3,78	-3,44	-3,05	-2,83	-2,76	-2,64	
C17	Country-Sector	GBR_C17	GBR_D35	GBR_G46	GBR_H49	GBR_N	GBR_K64	GBR_B	GBR_M69_70	NOR_B	ROW_B	GBR_J62-63	GBR_F	GBR_C20	GBR_C18	GBR_H52
	Loss	-623,19	-64,47	-50,16	-35,89	-25,33	-25,17	-20,22	-18,12	-16,02	-14,48	-14,48	-13,16	-12,07	-11,36	
C18	Country-Sector	GBR_C18	GBR_G46	GBR_C17	GBR_C31-32	GBR_N	GBR_H49	GBR_M69_70	GBR_D35	GBR_F	GBR_J62-63	GBR_K64	GBR_M71	GBR_G45	GBR_C20	GBR_H52
	Loss	-276,94	-22,48	-20,96	-15,14	-12,28	-10,13	-8,30	-7,07	-6,85	-6,80	-6,08	-5,66	-4,71	-4,43	-4,24
C19	Country-Sector	GBR_B	NOR_B	GBR_C19	ROW_B	GBR_K64	RUS_B	NLD_B	NLD_M69_70	GBR_D35	GBR_N	GBR_M69_70	GBR_F	GBR_C25	GBR_J62-63	GBR_H49
	Loss	-1302,43	-874,36	-599,73	-414,48	-104,99	-102,03	-93,90	-93,07	-91,73	-83,41	-80,89	-70,86	-43,21	-41,99	-38,51
C20	Country-Sector	GBR_C20	GBR_G46	GBR_M69_70	GBR_K64	GBR_N	GBR_D35	GBR_H49	ROW_B	GBR_G45	DEU_C20	GBR_B	GBR_J62-63	USA_C20	GBR_F	
	Loss	-4323,45	-492,20	-297,86	-297,58	-276,78	-275,91	-263,76	-259,22	-255,67	-245,04	-207,76	-175,18	-162,54	-142,78	-128,74
C21	Country-Sector	GBR_C21	GBR_K64	GBR_M69_70	GBR_N	GBR_J62-63	GBR_G46	DEU_C21	GBR_M71	GBR_D35	GBR_H53	GBR_M73	GBR_H52	GBR_H49	GBR_G45	CHE_C21
	Loss	-5771,10	-260,15	-208,45	-151,00	-148,14	-136,86	-106,99	-71,82	-71,13	-70,24	-58,90	-58,78	-50,86	-48,41	-48,13
C22	Country-Sector	GBR_C22	GBR_C20	GBR_G46	GBR_D35	GBR_N	GBR_K64	GBR_C25	GBR_G45	GBR_M69_70	ROW_B	GBR_H49	DEU_C20	GBR_B	GBR_J62-63	GBR_F
	Loss	-2305,93	-126,47	-102,28	-89,43	-87,91	-85,12	-84,21	-71,38	-68,84	-58,13	-55,69	-52,52	-41,45	-40,33	-36,35
C23	Country-Sector	GBR_C23	GBR_D35	GBR_B	GBR_H49	GBR_N	GBR_K64	NOR_B	GBR_G46	ROW_B	GBR_M69_70	GBR_C25	GBR_F	GBR_J62-63	GBR_C20	GBR_H52
	Loss	-489,56	-74,46	-60,85	-58,47	-43,66	-41,21	-40,95	-34,84	-27,23	-25,88	-20,74	-17,07	-16,31	-14,41	-13,60
C24	Country-Sector	GBR_C24	GBR_G46	GBR_B	ROW_B	GBR_D35	NOR_B	GBR_N	CAN_C24	GBR_E37-39	GBR_H49	GBR_K64	GBR_J62-63	GBR_M69_70	GBR_C25	GBR_F
	Loss	-1627,32	-336,95	-269,92	-231,41	-229,57	-193,68	-170,44	-144,01	-138,15	-132,87	-124,37	-105,28	-103,62	-98,13	-70,09
C25	Country-Sector	GBR_C25	GBR_G46	GBR_G45	GBR_N	GBR_K64	GBR_D35	GBR_M69_70	ROW_B	GBR_H49	CAN_C24	GBR_J62-63	GBR_F	GBR_B	GBR_H52	GBR_M71
	Loss	-1310,09	-55,00	-46,75	-43,69	-42,88	-34,41	-27,07	-26,17	-25,45	-21,76	-17,42	-14,95	-14,58	-13,32	-12,59
C26	Country-Sector	GBR_C26	GBR_G46	GBR_N	CHN_C26	GBR_C25	GBR_M71	DEU_C26	USA_C26	GBR_M69_70	GBR_I	GBR_K64	ROW_B	GBR_J62-63	ROW_C26	GBR_D35
	Loss	-4504,38	-198,26	-153,41	-115,57	-113,48	-105,31	-91,88	-84,75	-83,18	-79,95	-69,26	-68,75	-68,15	-65,06	-61,13
C27	Country-Sector	GBR_C27	GBR_C25	GBR_G46	GBR_N	GBR_K64	GBR_M69_70	GBR_C33	ROW_B	GBR_H49	GBR_D35	GBR_J62-63	GBR_G45	GBR_C20	GBR_C28	GBR_C22
	Loss	-1983,98	-149,49	-133,83	-103,32	-82,07	-69,41	-67,04	-58,24	-55,95	-52,18	-51,42	-49,79	-37,73	-37,21	-34,29
C28	Country-Sector	GBR_C28	GBR_C25	GBR_G46	GBR_N	GBR_C33	GBR_K64	GBR_M69_70	GBR_D35	GBR_C31-32	GBR_G45	ROW_B	GBR_J62-63	GBR_C22	DEU_C28	GBR_M71
	Loss	-4423,48	-608,53	-377,64	-217,03	-168,00	-158,60	-150,91	-146,01	-143,77	-139,33	-114,82	-113,65	-91,74	-89,85	-85,59
C29	Country-Sector	GBR_C29	GBR_G45	GBR_C25	GBR_G46	GBR_K64	GBR_M69_70	GBR_N	GBR_C22	DEU_C29	GBR_C33	ROW_B	GBR_J62-63	GBR_D35	GBR_C28	GBR_H49
	Loss	-3758,04	-837,80	-541,78	-357,68	-311,75	-309,47	-306,24	-295,88	-239,80	-173,81	-171,99	-158,84	-147,88	-136,70	-132,81
C30	Country-Sector	GBR_C30	USA_C30	GBR_C33	GBR_C25	GBR_N	GBR_K64	GBR_J62-63	GBR_M71	GBR_G46	GBR_M69_70	GBR_G45	GBR_D35	GBR_F	ROW_B	GBR_C22
	Loss	-2123,01	-306,84	-271,87	-267,13	-149,20	-125,74	-120,47	-119,73	-108,23	-102,22	-65,59	-62,96	-60,80	-56,91	-48,19
C31-32	Country-Sector	GBR_C31-32	GBR_G46	GBR_K64	GBR_N	GBR_C25	GBR_M69_70	GBR_H49	GBR_C16	GBR_G45	GBR_F	GBR_J62-63	GBR_C22	ROW_B	GBR_D35	GBR_C13-15
	Loss	-2423,63	-89,66	-74,73	-72,07	-62,84	-61,06	-50,17	-48,19	-42,64	-42,14	-41,66	-40,54	-35,27	-32,84	-32,75
C33	Country-Sector	GBR_C33	GBR_N	GBR_M69_70	GBR_G46	GBR_K64	GBR_J62-63	GBR_C25	GBR_G45	GBR_M71	GBR_C22	GBR_C31-32	GBR_D35	GBR_F	GBR_H49	GBR_C28
	Loss	-88,53	-13,95	-3,31	-3,07	-2,92	-2,53	-2,51	-2,07	-1,78	-1,61	-1,44	-1,35	-1,30	-1,16	

Table A.13. Top 15 most affected country-sectors in terms of LiVA (expressed in millions of US dollars) as a result of UK goods exports to EU hypothetical extraction.





	AUS	BRA	CAN	CHE	CHN	IDN	IND	JPN	KOR	MEX	NOR	RUS	TUR	TWN	USA	ROW	WORLD
A01	-14	-46	-48	-70	-113	-21	-20	-39	-18	-26	-77	-124	-15	-11	-888	-698	-9047
A02	0	0	0	-1	-1	0	0	0	0	0	-1	-1	0	0	-9	-6	-172
A03	0	0	0	-1	-1	0	0	0	0	0	-1	-1	0	0	-6	-6	-106
B	-2	-4	-3	-12	-19	-1	-2	-4	-2	-1	-19	-23	-2	-1	-63	-79	-3362
C10-12	-71	-309	-147	-229	-459	-115	-105	-121	-61	-55	-194	-306	-88	-37	-2783	-2563	-36256
C13-15	-20	-39	-18	-48	-294	-26	-48	-35	-43	-11	-27	-67	-145	-17	-180	-508	-9262
C16	-3	-7	-8	-15	-48	-4	-6	-9	-6	-3	-27	-62	-6	-3	-98	-132	-3034
C17	-7	-23	-15	-39	-92	-8	-15	-20	-13	-6	-60	-102	-18	-7	-180	-247	-6112
C18	0	-1	-4	-2	-3	0	0	-1	-1	0	-1	-2	-1	0	-33	-14	-301
C19	-51	-72	-86	-68	-200	-35	-46	-49	-37	-64	-1085	-1493	-36	-15	-452	-1886	-11547
C20	-49	-97	-84	-201	-480	-74	-110	-153	-93	-58	-259	-519	-70	-35	-1032	-1741	-21265
C21	-19	-40	-41	-271	-275	-27	-39	-65	-37	-23	-61	-108	-29	-19	-1333	-932	-19954
C22	-14	-24	-22	-70	-177	-20	-39	-52	-36	-15	-52	-122	-40	-14	-299	-445	-8746
C23	-5	-7	-9	-19	-48	-4	-7	-12	-7	-7	-39	-82	-10	-4	-95	-205	-3489
C24	-17	-35	-37	-45	-141	-14	-25	-33	-23	-25	-142	-281	-39	-14	-248	-580	-7338
C25	-11	-22	-22	-44	-129	-9	-20	-34	-24	-10	-49	-119	-33	-15	-181	-327	-7914
C26	-37	-39	-53	-167	-1175	-33	-46	-320	-286	-24	-59	-131	-43	-176	-973	-1516	-17874
C27	-16	-23	-26	-82	-339	-15	-29	-87	-63	-16	-52	-125	-45	-37	-241	-465	-10358
C28	-28	-52	-55	-167	-611	-25	-57	-175	-91	-27	-106	-216	-123	-59	-530	-827	-21586
C29	-64	-103	-107	-330	-1132	-69	-155	-438	-279	-78	-221	-513	-386	-122	-1020	-2060	-45820
C30	-18	-38	-80	-89	-324	-17	-39	-102	-53	-32	-54	-100	-53	-56	-839	-534	-12654
C31-32	-9	-17	-18	-55	-178	-12	-21	-33	-23	-10	-34	-78	-33	-14	-194	-318	-8586
C33	-2	-3	-4	-10	-37	-2	-4	-10	-6	-2	-6	-13	-6	-4	-39	-57	-1676

Table A.17. Aggregate LiVA (expressed in millions of US dollars) in all Extra-EU countries and ROW as a result of UK inflows from EU extraction. Services.

	AUS	BRA	CAN	CHE	CHN	IDN	IND	JPN	KOR	MEX	NOR	RUS	TUR	TWN	USA	ROW	WORLD
D35	-1	-2	-2	-7	-11	-1	-1	-2	-2	-1	-21	-26	-1	-1	-20	-64	-964
E36	0	0	0	0	-1	0	0	0	0	0	0	-1	0	0	-3	-3	-142
E37-39	-2	-6	-9	-14	-33	-3	-5	-7	-5	-3	-10	-21	-6	-3	-160	-88	-3122
F	-4	-11	-9	-20	-82	-6	-9	-19	-9	-3	-18	-33	-9	-6	-88	-140	-3121
G45	-1	-2	-3	-7	-21	-1	-3	-7	-3	-1	-5	-11	-5	-2	-37	-49	-2278
G46	-15	-31	-35	-98	-210	-13	-25	-43	-24	-10	-55	-97	-27	-15	-442	-601	-21626
G47	-2	-3	-5	-14	-26	-2	-4	-7	-4	-2	-9	-21	-4	-2	-91	-98	-4353
H49	-4	-7	-9	-23	-34	-4	-5	-8	-6	-4	-20	-49	-7	-3	-85	-166	-3558
H50	-10	-17	-13	-24	-59	-7	-12	-16	-10	-5	-54	-75	-19	-6	-163	-391	-3914
H51	-15	-28	-41	-47	-107	-16	-20	-34	-21	-22	-85	-172	-21	-12	-525	-781	-7848
H52	-2	-3	-3	-11	-21	-1	-3	-4	-2	-1	-8	-16	-5	-2	-42	-75	-2041
H53	-1	-2	-2	-7	-13	-1	-1	-2	-1	-1	-2	-4	-1	-1	-57	-36	-1228
I	-1	-6	-3	-6	-13	-4	-2	-3	-2	-2	-4	-8	-3	-1	-32	-61	-2361
J58	-1	-1	-2	-4	-8	0	-1	-2	-1	-1	-5	-7	-1	-1	-49	-34	-844
J59-60	0	0	0	-1	-2	0	0	0	0	0	-1	-1	0	0	-7	-7	-273
J61	-5	-7	-11	-32	-123	-4	-15	-30	-20	-3	-15	-21	-7	-14	-168	-217	-6696
J62-63	-4	-4	-9	-16	-34	-2	-7	-15	-7	-3	-6	-9	-2	-5	-623	-348	-3502
K64	-6	-5	-46	-151	-59	-2	-7	-12	-8	-2	-18	-23	-32	-4	-716	-372	-8192
K65	-2	-1	-3	-6	-9	-1	-2	-4	-2	-1	-2	-3	-1	-1	-68	-197	-940
K66	0	0	-1	-2	-3	0	-1	-1	-1	0	-1	-1	0	0	-24	-18	-419
L68	-1	-1	-2	-7	-15	-1	-1	-2	-4	-1	-3	-20	-2	-1	-16	-35	-4466
M69-70	-6	-11	-7	-45	-118	-3	-7	-9	-6	-2	-8	-10	-3	-4	-220	-170	-5303
M71	-1	-3	-3	-6	-18	-1	-4	-3	-2	-1	-4	-5	-2	-1	-49	-34	-1794
M72	-1	-1	-2	-5	-11	-1	-1	-2	-2	0	-3	-4	-1	-1	-23	-24	-1322
M73	-1	-2	-3	-7	-17	-1	-2	-3	-2	-1	-4	-6	-2	-1	-61	-51	-1838
M74-75	-2	-3	-5	-11	-29	-1	-3	-6	-5	-1	-5	-11	-3	-2	-72	-81	-3464
N	-11	-23	-34	-61	-154	-9	-23	-27	-19	-7	-43	-59	-21	-12	-303	-452	-21013
O84	-1	-2	-1	-5	-12	-1	-1	-2	-1	0	-2	-3	-1	-1	-26	-24	-1343
P85	0	0	0	-1	-2	0	0	0	0	0	-1	-1	0	0	-4	-5	-508
Q	0	0	0	-2	-3	0	0	0	0	0	-1	-1	0	0	-5	-7	-450
R-5	-3	-5	-30	-20	-44	-3	-7	-8	-8	-2	-11	-20	-15	-4	-113	-184	-4770

Table A.18. Aggregate LiVA (expressed in millions of US dollars) in all Extra-EU countries and ROW as a result of UK inflows from EU extraction. Services.

Extracted Sector		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A01	Country-Sector	IRL_A01	ESP_A01	NLD_A01	FRA_A01	IRL_J58	ITA_A01	DEU_A01	USA_N	USA_G46	IRL_C31-32	ROW_A01	USA_M72	ROW_B	ROW_N	IRL_Q
	Loss	-1325.03	-559.03	-476.61	-352.16	-330.78	-157.61	-155.73	-138.39	-129.74	-115.69	-106.97	-103.84	-90.29	-88.80	-88.80
A02	Country-Sector	IRL_A02	SWE_A02	DEU_A02	IRL_J58	POL_A02	SVK_A02	USA_N	LVA_A02	USA_G46	ESP_A02	IRL_C31-32	USA_M72	CZE_A02	IRL_Q	ROW_B
	Loss	-92.76	-9.95	-4.24	-3.60	-2.56	-1.96	-1.63	-1.55	-1.45	-1.41	-1.41	-1.16	-1.04	-0.97	-0.95
A03	Country-Sector	IRL_A03	NLD_A03	ESP_A03	SWE_A03	DNK_A03	DEU_A03	FRA_A03	IRL_J58	ROW_B	GRC_A03	USA_N	ITA_A03	USA_G46	NOR_B	IRL_C31-32
	Loss	-14.81	-12.09	-5.73	-4.39	-4.09	-3.30	-2.34	-1.70	-1.59	-1.58	-0.87	-0.81	-0.79	-0.76	-0.67
B	Country-Sector	NLD_B	DNK_B	POL_B	IRL_B	NLD_D35	SWE_B	NLD_K64	NLD_N	DEU_B	FRA_B	ROW_N	ROW_B	USA_N	NLD_G46	NOR_B
	Loss	-1736.47	-592.08	-60.89	-55.13	-50.11	-42.56	-31.76	-30.26	-26.37	-25.04	-19.43	-17.66	-17.38	-16.26	-14.68
C10-12	Country-Sector	IRL_C10-12	DEU_C10-12	FRA_C10-12	NLD_C10-12	ITA_C10-12	BEL_C10-12	ROW_A01	FRA_A01	ESP_C10-12	USA_G46	ITA_A01	DEU_A01	POL_C10-12	DNK_C10-12	USA_N
	Loss	-3640.85	-1530.44	-1511.52	-1165.50	-792.55	-736.91	-672.99	-640.75	-608.56	-598.78	-478.37	-402.83	-399.08	-374.27	-366.49
C13-15	Country-Sector	ITA_C13-15	DEU_C13-15	FRA_C13-15	ESP_C13-15	BEL_C13-15	PRT_C13-15	NLD_C13-15	ITA_G46	ITA_L68	ITA_H49	ROU_C13-15	ROW_B	ITA_K64	ITA_M69_70	ROW_C13-15
	Loss	-1400.53	-500.53	-489.28	-298.80	-228.86	-216.98	-151.49	-130.71	-129.81	-129.17	-120.20	-111.52	-102.93	-89.48	-84.25
C16	Country-Sector	SWE_C16	SWE_A02	IRL_C16	DEU_C16	POL_C16	LVA_C16	FIN_A02	ITA_C16	FIN_C16	ESP_C16	FRA_C16	PRT_C16	BEL_C16	EST_C16	ROW_B
	Loss	-151.63	-132.77	-123.47	-117.36	-105.67	-84.92	-78.14	-70.35	-63.43	-39.69	-38.51	-35.58	-35.54	-31.28	-30.81
C17	Country-Sector	DEU_C17	SWE_C17	FIN_C17	FRA_C17	ITA_C17	SWE_A02	NLD_C17	BEL_C17	FIN_A02	AUT_C17	ROW_B	DEU_N	POL_C17	DEU_G46	ESP_C17
	Loss	-624.98	-306.68	-247.97	-186.68	-129.23	-105.68	-100.43	-100.39	-83.13	-78.63	-75.67	-73.36	-68.81	-63.04	-61.27
C18	Country-Sector	IRL_C18	ITA_C18	NLD_C18	ESP_C18	BEL_C18	DEU_C18	USA_N	POL_C18	USA_M73	FIN_C18	USA_M72	ROW_N	DNK_C18	USA_G46	DEU_C17
	Loss	-47.78	-21.18	-11.39	-9.78	-9.41	-6.86	-5.48	-4.94	-4.92	-3.96	-3.46	-3.19	-3.16	-2.72	-2.49
C19	Country-Sector	ROW_B	NOR_B	RUS_B	NLD_M69_70	SWE_C19	NLD_B	DNK_B	RUS_G46	GBR_B	SWE_B	NLD_G46	RUS_H49	NLD_K64	ROW_D35	DEU_C19
	Loss	-1159.95	-932.82	-670.05	-262.28	-253.96	-232.00	-247.24	-232.00	-189.95	-185.44	-156.92	-155.94	-112.18	-110.23	-105.07
C20	Country-Sector	DEU_C20	FRA_C20	NLD_C20	ROW_B	BEL_C20	ITA_C20	ESP_C20	IRL_C20	DEU_N	USA_C20	DEU_G46	FRA_G46	SWE_C20	NLD_G46	NOR_B
	Loss	-2718.18	-1163.41	-958.34	-696.92	-653.84	-344.27	-319.02	-291.04	-239.26	-227.75	-226.27	-223.75	-201.05	-189.64	-189.64
C21	Country-Sector	DEU_C21	FRA_C21	IRL_C21	BEL_C21	ITA_C21	NLD_C21	DNK_C21	USA_N	ESP_C21	ROW_N	SWE_C21	DEU_N	DEU_G46	ROW_B	CHE_C21
	Loss	-3287.43	-1513.57	-1291.74	-854.35	-826.28	-801.52	-567.25	-399.90	-346.23	-254.02	-229.44	-203.79	-161.81	-156.70	-151.04
C22	Country-Sector	DEU_C22	FRA_C22	ITA_C22	NLD_C22	ESP_C22	POL_C22	IRL_C22	DEU_C20	BEL_C22	ROW_B	DEU_N	CZE_C22	DEU_G46	DEU_L68	FRA_C20
	Loss	-1308.65	-433.62	-269.17	-238.69	-173.95	-169.21	-165.54	-164.11	-161.07	-143.20	-137.07	-93.65	-86.99	-85.37	-68.47
C23	Country-Sector	DEU_C23	ITA_C23	ESP_C23	FRA_C23	IRL_C23	POL_C23	ROW_B	BEL_C23	NLD_C23	CZE_C23	DEU_N	RUS_B	AUT_C23	DEU_G46	NOR_B
	Loss	-371.17	-161.56	-143.52	-141.41	-98.16	-96.77	-92.30	-84.68	-54.80	-47.44	-44.66	-34.15	-32.82	-32.65	-30.93
C24	Country-Sector	DEU_C24	ROW_B	ESP_C24	ITA_C24	FRA_C24	NLD_C24	BEL_C24	SWE_C24	NOR_B	RUS_B	DEU_N	DEU_G46	DEU_D35	DEU_E37-39	DEU_H49
	Loss	-787.72	-278.07	-176.45	-142.93	-137.30	-126.35	-113.93	-106.24	-95.71	-94.69	-87.57	-87.27	-76.72	-73.46	-69.47
C25	Country-Sector	DEU_C25	ITA_C25	FRA_C25	POL_C25	NLD_C25	IRL_C25	ESP_C25	AUT_C25	BEL_C25	CZE_C25	ROW_B	DEU_N	DEU_C24	DEU_G46	SVK_C25
	Loss	-1362.79	-477.34	-298.20	-197.11	-193.86	-164.70	-160.11	-145.43	-129.26	-119.78	-108.24	-103.64	-83.62	-78.90	-78.90
C26	Country-Sector	DEU_C26	FRA_C26	IRL_C26	NLD_C26	CHN_C26	ROW_C26	ITA_C26	CZE_C26	DEU_G46	SWE_C26	ROW_N	POL_C26	USA_N	DEU_N	NLD_G46
	Loss	-2965.90	-1071.33	-522.73	-397.93	-329.70	-293.16	-263.84	-260.97	-250.67	-235.87	-234.10	-222.57	-218.93	-217.86	-203.30
C27	Country-Sector	DEU_C27	ITA_C27	FRA_C27	POL_C27	NLD_C27	ESP_C27	AUT_C27	CZE_C27	ROW_B	DEU_N	DEU_G46	BEL_C27	DEU_M69_70	DEU_L68	DEU_C25
	Loss	-1898.06	-458.29	-406.94	-235.24	-183.02	-162.78	-160.03	-142.04	-141.82	-137.19	-135.39	-127.59	-92.01	-91.88	-84.30
C28	Country-Sector	DEU_C28	ITA_C28	FRA_C28	NLD_C28	DEU_N	DEU_C25	SWE_C28	BEL_C28	DEU_G46	DEU_M69_70	ITA_C25	DNK_C28	ROW_B	AUT_C28	DEU_L68
	Loss	-4140.80	-1171.17	-894.51	-739.04	-331.96	-328.89	-297.49	-262.37	-262.27	-250.55	-248.56	-246.25	-239.40	-236.37	-222.07
C29	Country-Sector	DEU_C29	ESP_C29	FRA_C29	DEU_G45	DEU_N	DEU_C25	ITA_C29	DEU_L68	DEU_G46	BEL_C29	DEU_C29	ROW_B	CZE_C29	DEU_M69_70	POL_C29
	Loss	-10067.66	-1049.84	-965.99	-896.57	-840.53	-737.42	-652.67	-651.18	-597.73	-586.18	-578.12	-567.66	-557.25	-555.34	-459.95
C30	Country-Sector	DEU_C30	FRA_C30	ESP_C30	ITA_C30	USA_C30	FRA_C33	BEL_C30	FRA_N	DEU_N	NLD_C30	FRA_G46	DEU_C25	ROW_B	POL_C30	FRA_M69_70
	Loss	-1257.57	-1192.50	-623.91	-460.75	-306.03	-197.93	-181.90	-176.29	-176.10	-156.53	-156.21	-152.09	-142.38	-136.07	-116.77
C31-32	Country-Sector	32	FRA_C31-32	ITA_C31-32	NLD_C31-32	IRL_C31-32	POL_C31-32	ESP_C31-32	DEU_G46	DNK_C31-32	BEL_C31-32	DEU_N	ROW_B	AUT_C31-32	DEU_L68	FRA_G46
	Loss	-1257.05	-608.53	-586.90	-347.75	-189.27	-158.85	-128.01	-118.56	-95.41	-95.30	-95.25	-82.97	-76.96	-72.86	-70.52
C33	Country-Sector	FRA_C33	DEU_C33	ITA_C33	POL_C33	NLD_C33	BEL_C33	AUT_C33	ESP_C33	FRA_G46	CZE_C33	FRA_N	ROW_B	HUN_C33	FRA_C25	DEU_N
	Loss	-293.75	-92.38	-70.91	-59.01	-49.06	-40.93	-39.31	-27.46	-20.82	-20.00	-17.79	-16.00	-14.45	-14.42	-14.32

Table A.19. Top 15 most affected country-sectors in terms of LiVA (expressed in millions of US dollars) as a result of UK goods imports from EU hypothetical extraction.

