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The Economy as a whole: three essays on Economic Networks

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“To my beloved wife Simona, who is always there to lend a hand in everything I do”

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Contents

Introduction

The modern capitalist world economy is a globalised intricately linked network in which agents interact and make decisions simultaneously determining dynamics and emergent properties (Delli Gatti et al., 2008). Traditional macroeconomic models do not provide such granular and holistic frameworks to analyse economic systems. This remark has become even clearer when the economic crisis has definitively revealed the limits of current mainstream economic models, not only in predicting the advent of large crises but also in contemplating such an eventuality (Gallegati, 2018).

With the aim of solving the limitations of standard macroeconomic models, economists have been increasingly attracted to the field of complex systems, especially in the aftermath of the 2007 crisis. As a result, a fruitful literature applying analytical tools typical of 'complex adaptive systems' to economics, has been developed (Arthur, 2000; Rosser, 2003; Markose, 2005; Gallegati et al., 2006; Delli Gatti et al., 2010b; Sornette, 2017). In particular, two main research strands emerged from this literature, namely the interacting agent-based-models (ABMs) and the network analysis. ABMs represent the analytical and computational tools necessary to explore the properties of a complex economy (Delli Gatti et al., 2011). They are models in which a multitude of heterogeneous, adaptive economic agents interacts with each other and with the environment, following autonomous behavioural rules (Delli Gatti et al., 2018). The outcome of these interactions concurs in shaping the emergent properties of the system (Delli Gatti et al., 2008), which can be numerically computed (Caiani et al., 2016). The ABMs, though still in their growth phase, have already found widespread application in both the economic literature (see among others Farmer and Foley, 2009; Cincotti et al., 2010; Delli Gatti et al., 2010a; Dosi et al., 2010; Harras and Sornette, 2011; Ashraf et al., 2016; Russo et al., 2016; Dawid et al., 2018) and relevant institutions such as the Bank of England (Baptista et al., 2016; Haldane, 2016; Turrell, 2016; Haldane and Turrell, 2018).

The second research strand developed within the field of complex systems regards the network analysis. Economic network analysis applies models from network science (Caldarelli, 2007) to the analysis and interpretation of economic phenomena (Jackson, 2008; Schweitzer et al., 2009). Economic networks are webs where nodes represent economic agents (individuals, firms, consumers, organizations, industries, countries, etc.) and links depict market interactions. The development of this emerging research field can be seen as a response to the rise of networked organizations over the past few decades, given the proliferation of information technology and globalisation. In this sense, Castells (2005) has identified networks as the emerging fundamental organizational structure within post-industrial economies. The present work integrates the literature relating to this second line of investigation, though, as stressed in the conclusions, leaves the door open to future research aiming to model the networks analysed in this study, applying the typical tools of ABMs (on the interplay between ABMs and networks see Gualdi and Mandel, 2018; Otto et al., 2017; Bargigli and Tedeschi, 2014).

This study consists of three empirical investigation on global financial and production networks. In the first chapter, we compute the historical evolution of the global ownership network investigating the concentration, at a global level, of ownership capital over the years 2001-2016. The originality of the research lies in the fact that (1) is the first attempt to analyse the historical evolution of the global ownership network, (2) is the first investigation on the historical trend of concentration of ownership capital as a whole, (3) is the first study on the impact of the financial crisis on ownership structures and capital distribution.

Using network analysis techniques and applying them to the examination of the Thomson Reuters Eikon database, we first build the global ownership network, which includes on averages more than 30 thousand nodes and almost 830 thousand links. Second, following Vitali et al. (2011) we developed a network measure of direct and indirect corporate control, namely the net-control. By computing the net-control, we are able to verify how much economic value of companies a shareholder is able to control. In other words, we compute for each year considered, the degree of capital control centralisation within the network, i.e. we measure to what extent the control of share capital is concentred in a few nodes. In adopting this measure, we noted that the network control is highly concentrated in the world: the fraction of top holders holding cumulatively the 80% of the global economic value of the firms considered in the sample is always under the fraction of 2%. Furthermore, by inspecting the temporal dynamics of the phenomenon we observe an increase in the global centralization of capital: this trend appears to be partially dependent on the threshold chosen until 2006 whereas it assumes a more regular and general character from the financial crisis of 2007 until 2016, with an increase of more than 20% for all the samples considered. Finally, by inspecting the core of the global ownership network, containing the larger nodes for total net-control, we find that this is mainly composed of the same financial companies before and even after the 2007 financial crisis.

The second chapter challenges and complements existing papers on the economic impact of Brexit providing a detailed and holistic discussion of the UK's decision to leave the EU and how it will affect international trade networks and value-added, globally, and exploring if there are options available to policy-makers so that Brexit does not result in huge economic losses.

First, using the recently constructed World Input-Output Database (WIOD), we develop a multi-sector inter-country model that allows us to identify all the channels through which the economic effects of Brexit would propagate within and among sectors and countries. In particular, applying the input-output 'partial extraction' method (Dietzenbacher and Lahr, 2013) to the European input-output production network, we are able to include direct and indirect trade via GVCs and, hence, provide estimates of the direct and indirect impact of Brexit at the industry level. The inclusion of GVCs and indirect Brexit effects in our model leads to estimates that diverge with the results of the main literature. Indeed our findings, comparable with other studies that include indirect Brexit effects such as Vandenbussche et al. (2017) and W. Chen et al. (2018), suggest that Brexit could be risky and costly not only for the UK but also for EU countries, especially Ireland, Germany, Belgium, and the Netherlands, with Ireland facing losses similar or even greater than those of the UK.

Second, we move away from the traditional assumption underlying standard trade models, according to which trade liberalisation always increases welfare and we address the question, are there any economic policies that would mitigate or even reverse the negative Brexit effects? To address the question, we modify the first model by introducing the hypothesis that trade barriers would not necessarily mean negative economic shocks. Building on Rodrik (2018a, 2018b, 2018c) recent remarks, according to which under circumstances of weak domestic growth and growing trade deficit, trade protectionism would be preferable to unconditional free trade, we interpret Brexit as a special case in which a country implements a protectionist trade policy in order to rebalance the external accounts and boost domestic growth. Practically, we allow sectors and countries to partly substitute foreign products which are rendered less competitive due to tariffs, adopting domestic import substitution and trade diversion policies. Namely, we assume that in response to Brexit, (1) UK trade will be partly diverted to extra-EU countries, (2) EU imported products will be partly substituted by domestic purchases, (3) EU countries will partly substitute UK imported products by intra-EU purchases. The inclusion of these changes in the model results in absolute and relative losses for the UK and EU27 significantly lower.

The originality of the study conducted in chapter 2, lies in the trade models we developed, which allow verifying how the economic impact of tariffs would propagate within an input-output production network, and how domestic import substitution and trade diversion policies could affect domestic and global value added. Furthermore, the models enrich both the literature on multi-country-input-output models and the literature on the propagation of shocks in production networks.

In the third chapter, as in the previous one, we analyse Brexit but from a different perspective, combining the input-output key sectors literature with the typical network centrality measures. According to the second chapter and the main literature, Brexit would have a negative impact at a global level. Therefore, it is of a foremost relevance that a debate on the priority and choice of industries that policy-makers should safeguard emerges. In this sense, the third chapter includes the first study of the European production network (EPN) topology, and provides different rankings of the most 'systemically important' sectors involved in Brexit, according to different measures deriving from both input-output and network analysis literature. Furthermore, we develop a measure of country and sectors exposure to sectoral tariff and non-tariff barriers. We apply the 'hypothetical extraction' method (Dietezenbacher and Lahr, 2013; Los et al., 2016; W. Chen et al., 2018), 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. On closer inspection, our indicator provide 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 identifying key import sectors and key export sectors.

The main implication of our findings, in line with the second chapter results, is that Brexit would be not just a problem 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 results about the exposure to trade barriers could strengthen the position of the UK in the negotiation of a Brexit deal with EU. Indeed, we find that the UK would be less exposed than EU countries to trade barriers, as 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. Clearly, this holds if EU does not impose huge non-tariff barriers. For example, the picture would change in the extreme case in which EU forbids the UK from selling financial products to EU countries.

Considering the fact that new trade wars are on the horizon at a global level, for example between the US and China, the methodologies presented in our second and third chapters could stimulate other research, in order to develop useful tools to guide governments and institutions in implementing trade and economic policies.

Chapter 1

Centralization of capital and financial crisis: a global network analysis of corporate control

1.1 Introduction

According to an old authoritative opinion, the tendency towards the centralization of capital should have been considered among the most important Marx's laws of motion of capitalism and, as such, deserving of appropriate theoretical and empirical investigations with the most advanced techniques of economic analysis (Leontief 1938). Capital centralization in the sense of Marx, in fact, has never been a very popular subject in the academic literature. Unlike the well-known and debated thesis of the tendency of the rate of profit to fall, the idea of a progressive centralization of the capital control in just few hands has not been extensively studied. Nowadays, the citations of the centralization phenomena are scarce and sometimes even misleading. Furthermore, we see no academic studies dedicated to possible empirical links between capital centralization and economic crisis. As a consequence, the existence or not of a global tendency of capital to centralize in a few hands, and the related complex structural economic dynamics that may imply, remain an unresolved mystery.

Among the possible reasons of these gaps in the literature, there is not only the multifaceted nature of the Marxian centralization concept but also the lack of adequate datasets for the study of the phenomenon at an international level. The present work suggests a way to try to overcome these difficulties. Using network analysis techniques and applying them to the examination of the Thomson Reuters Eikon database, in the following pages we will adopt a specific definition of centralization of capital based on the concept of network control and we will study its global trend between 2001 and 2016, with particular regard to the phases preceding and following the international financial crisis that began in 2007. Although preliminarily, we will achieve a first empirical survey on the existence or not of a global tendency towards centralization of capital during the beginning of the 21st century, and of possible relations between this trend and the phenomenon of the crisis.

The work is organized as follows. In section 2 we present the Marxian concept of centralization of capital in terms of concentration of ownership and control of share capital. In section 3 we review some research from which we can deduce empirical measurements that are somehow referable to the aforementioned definition of centralization. In particular, we will focus on a measurement in terms of network control suggested by Vitali et. Al (2011): we will point out that this measure has so far been adopted in studies limited to single periods, and we will specify that our aim is to extend it to a global analysis relating to the first sixteen years of the XXI century, before and after the financial crisis started in 2007. In section 4 we examine the methodology of our study and in section 5 we describe the data used. The sixth section presents the results of the empirical analysis. The seventh section concludes.

1.2 A marxian definition of "centralization": ownership and control of share capital

The law of tendency toward centralization of capital is analyzed in various sections of Marx's *Capital* (Marx, 1867|1976|1981, Vol. I, Ch. 25, 32; Vol. III, Ch. 27). The concept was taken up and stressed by some of the leading exponents of Marxism, including Hilferding (1910), Lenin (1917|2000), Sweezy (1942) and Baran and Sweezy (1966) and later was further analyzed by other authors, both Marxists (Mandel 1975; Sau, 1979; Weeks, 1979; Shaik 1991; Desai, 2002; Bellofiore, 2014) and exponents of different schools of thought (Schumpeter 1942; Elliott, 1980). Rarely is it possible to find in the literature studies dedicated to the application of the concept of centralization to the theory of economic policy, as well as there are few theoretical and empirical researches that look close at the link between capital centralization and economic crisis (for some recent exceptions on these subjects, see Brancaccio and Fontana 2016; Brancaccio, Costantini and Lucarelli 2015).

The Marxian definition of centralization has many facets. It may concerns: dimensional economies and labor productivity, market structures and markets monopolization, the development of the credit system and, lastly, the processes of concentration in a few hands of ownership and control of share capital. Moreover, centralization is conceived by Marx as the premise for a form of transition from one mode of production to another. However, in the present study we will not investigate the issue of the transition of the mode of production and we will focus solely on centralization intended as concentration of ownership and control of capital, with particular reference to share capital. As we shall see, this latter definition is crucial in Marxian analysis and fits itself well to quantitative investigation. We leave to future analyses the study of the other declinations of the concept.

According to Marx, although competition in the capitalist mode of production sets in motion a centrifugal force that leads to a "fragmentation of the total social capital into many individual capitals, or the repulsion of its fractions from each other", it is also possible to detect a centripetal opposed tendency to the attraction among individual "capitals already formed". This tendency, which Marx calls "centralization of capital", consists in "concentration of capitals already formed, destruction of their individual independence, expropriation of capitalist by capitalist, transformation of many small into few large capitals". Therefore, the centralization of capital is a struggle that ends in the ruin of many small capitalists whose capitals partly pass into the hands of their conquerors, partly vanish. Some individual capitals become bigger by swallowing up weaker ones, and some others simply perish. This process may materialize in many ways: through bankruptcy of weak capitals and their market exit; through liquidation, merger or acquisition; through changes in the ownership and control structures of capital. In Marx's view, then, centralization implies "a change in the distribution of already available and already functioning capital". The consequence is an "alteration in the quantitative grouping of the component parts of social capital" (Marx 1867|1976, Vol. I., p. 777-779).

The process of centralization, thus defined, does not simply concern the mere concentration of ownership in a few hands but manifests itself more generally with the concentration of control of capital, which can go beyond the limits of the ownership relationships. According to Marx, private ownership becomes a limit to the development of capital itself, which, hence, tends to get around it and to go beyond it to favor a centralized control of reproduction and accumulation processes. Among the ways of circumventing the ownership constraint, Marx gives particular relevance to the formation of joint-stock companies. In these entities ownership is "in the form of shares" and then "its movement and transfer become simply the result of stock-exchange dealings, where little fishes are gobbled up by the sharks, and sheep by the stock-exchange wolves" (Marx, 1867|1981, Vol. III, p. 571). In this passage, it should be stressed that Marx does not simply refer to exchanges that determine a concentration in a few hands of the ownership shares but he also refers to the possibility that the dominant capitalist groups govern a larger mass of capital than the one they formally own. This mechanism represents a crucial aspect in overcoming the immanent limit of ownership in capitalist production: "The world would still be without railways if it had had to wait until accumulation had got a few individual capitals far enough to be adequate for the construction of a railway. Centralization, however, accomplished this in the twinkling of an eye, by means of joint-stock companies" (Marx, 1867|1976, Vol. I, p. 780). Thus, ownership fragmentation within stock companies acts as a lever for centralization as allows "the expropriation by a few" by means of concentration of capital control and in this way, according to Marx, it also promotes the process of accumulation. Centralization, therefore, gives rise to a concentration of control of capital beyond the limit of a mere ownership relationship.

We can therefore state that one of the main manifestations of the tendency towards capitalist centralization consists, for Marx, in the concentration of ownership and above all the control of share capital in the hands of a few subjects. By means of more or less visible threads, alliances, share-ownership and other links, holders of mere relative majority packages are able to govern decisions on the whole capital (on this point see also Sweezy, 1953 and Pitelis, 1980). The network of control can also extend from the parent company to the subsidiaries, located not only within the national territory but also abroad. This last aspect is crucial in Marx's analysis of centralization: "Capital grows to a huge mass in a single hand in one place, because it has been lost by many in another place" (Marx 1867|1976, vol. I, p. 777), namely, beyond the mere corporate or national boundaries. In Marx's vision, the centralization of capital thus spreads in a pervasive way, on an inter-company and international level.

As regards the possible nexus between centralization of capital and economic crisis, Marx repeatedly stresses this relationship. For example, when interprets the crisis in terms of falling profit rates, Marx argues that this latter phenomenon is at the same time a threat to the development of the capitalist production process and a lever of the centralization of capital (Marx, 1867|1981, Vol. III, p. 349). Nevertheless, the Marxian literature dedicated to the study of capitalist dynamics has often focused on the analysis of the rate of profit, almost always neglecting the process of centralization of capital (see, among many others, Shaikh, 1992; Mandel, 1980). Another key point in the link between crisis and centralization of capital is the credit system. According to Marx, together with the development of stock exchange the credit system accelerates the tendency towards centralization, favors the divorce between ownership and control of capital and along this path accentuates instability and overproduction (Marx, 1867|1981, Vol. III, p. 572). The role of credit and stock exchange in the process of centralization of capital are also stressed by Hilferding (1910), who considers them as crucial factors in the emergence of monopoly capitalism and finance capital. Notably, Hilferding asserts that centralization leads to the constitution of financial conglomerates whose control is associated with the ability of finance capital in borrowing and lending money from and to other capitals (see also Toporowsky, 2005). Unlike Marx, however, Hilferding believes that centralization of capital in a few hands reduces the erratic market movements caused by speculation and thus contributes to reducing the likelihood of a crisis. No trace in Marx can be found of this optimistic thesis, which Schumpeter considered as a clear abjuration of the collapse theory (Brancaccio and Cavallaro 2011).

1.3 Capital centralization in terms of ownership and control networks: a short review

The definition of centralization we investigate in this study is related to the tendency of the ownership and shareholders' control to go in a few hands, according to a process which overcomes the boundaries of individual companies and nations. We need then to search if in the empirical literature there are works that verify this general tendency towards centralization.

To the best of our knowledge, most studies look at the ownership and control structures within corporations (Berle and Means, 1932; La Porta et al., 1998, 1999; Zingales, 1994, 1995; see Shleifer and Vishny, 1997; Becht et al., 2001 and Denis and McConnell, 2003 for a survey). Instead, on the basis of Marx's definition, we intend to investigate centralization in terms of ownership and control not only within but also across corporations. To this end, several authors follow a "portfolio view" of a company's direct investment to compute direct and indirect ownership. Among these, using a matrix representation of the ownership quotas based on a Leontief-type input-output model, Brioschi et al. (1989) provide one of the first analyses on the direct and indirect links between shareholders and corporates. Notably, the study introduces the notions of group value and integrated ownership. The integrated ownership represents the sum of all direct and indirect ownership shares a shareholder has in the equity capital of a firm. Instead, the group value is the value of a firm within a business group, and depends on the intrinsic value of the firm plus the direct and indirect shares the firm has in the neighboring firms' value. According to the authors, once a shareholder has a direct ownership on a company it has access to cash flow or equity return, while the integrated ownership gives access also to voting rights in the company's board. This approach has been extended (see Ellerman, 1991 and Baldone et al., 1997) and used in several case studies in Japan (Flath, 1992; Hoshi and Ito, 1991), continental Europe (Chapelle, 2004, Chapelle and Szafarz,2005), and South America (Gutiérrez and Pombo, 2007; Gutiérrez et al., 2008) where business group structures are more complex than those in the United States and the United Kingdom due to the existence of cross-share holdings, rings, pyramidal cascades, interlocks with financial institutions and high concentration levels of voting rights or direct ownership stakes.

Recently, inspired by the literature on complexity economics (Delli Gatti et al., 2007; Markose, 2005), a new field of investigation has been developed in standard corporate governance literature: it draws from the input-output approach and applies network analysis to ownership and control structures (on the use of network analysis in economics see also Jackson, 2008; Schweitzer et al., 2009 and Caldarelli, 2007). Foster (2005) explains why it is necessary to approach economic analysis from a network perspective and suggests to replace prevailing "simplistic" theories based in constrained optimization with "simple" theories derived from network representations. Likewise, Delli Gatti et al. (2009, 2010), Riccetti et al. (2013) and Bargigli et al. (2016) develop a network economy in which the relationships among agents are endogenously determined and evolving. Specifically, Mizruchi (2007) and Buzgalin and Kolganov (2015) argues the relevance of the network analysis for the study of corporate power structures in the specific perspective of the classical economists and Marx. Indeed, according to Santos (2015) network analysis is a suitable way to visualize and analyze the ownership and control links in the corporate sector. Thus, in the last few years, several authors have been focused on developing novel researches based on the ownership networks (see Glattfelder, 2010 for a deep discussion on the topic). For example, Elliott et al. (2014) employing the definition of group value as in Brioschi et al. (1989), develop a general model able to unveil financial contagions and cascades of failures among organizations linked through an ownership network. On the empirical side, Rotundo and D'Arcangelis (2010) make use of a network representation in order to perform an analysis of the ownership structure of the companies listed in the Italian stock market in 2008. They develop an interesting method that reveals the final owner, and they add further knowledge to the mere analyses of the network structure examining the economic and financial relevance of companies in terms of integrated ownership and control. Pecora and Spelta (2015) analyze the network of the Euro Area banking sector in the year 2012 to assess the importance of a bank in the financial system with respect to ownership and control of other credit institutions. They focus especially to the weights of the network edges which represent shareholders relations and reflect how ownership is distributed among banks. The network ownership structure displays that control is highly concentrated in the hands of few important shareholders. Burlon (2015) employs a huge dataset of Italian firms over the period 2005-2013 and build a model where firms are connected through ownership relation in order to investigate how aggregate volatility is influenced by different ownership network structures. Among the results of the analysis, there is also evidence of a marginal increase in the concentration of ownership over time. In an IMF working paper, Santos (2015) assesses integrated ownership and control links in the corporate sector of the Gulf Cooperation Council (GCC) countries by applying input-output theory and different definitions of control on the distribution of consolidated debt. Using different ownership thresholds he identifies connected counterparties— involving entities under the direct and indirect control of shareholders—and their consolidated debt. He finds that corporate ownership is strongly concentrated in the GCC countries. Notably, public sector institutions are at the center of GCC corporate ownership networks, but holding companies, financial institutions, and family groups are also important.

Although the quoted studies are able to unveil complex ownership and control patterns across corporations, they analyze only single sectors or countries and then offer a limited view of the phenomenon with respect to the Marxian concept of capital centralization. For a more general study of the underlying phenomena, we need to investigate the architecture of the shareholders control from a global and intersectoral perspective. For this purpose, we can take advantage of a recent branch of studies dedicated to ownership and control networks. This field of research seems to provide a fruitful method of analysis (see Kogut and Walker, 2001; Garlaschelli et al., 2005; Corrado and Zollo, 2006; Glattfelder and Battiston, 2009; Battiston et al., 2010; Heemskerk and Takes, 2016).

Particularly relevant in this field is the work of Vitali et al. (2011), who examine the ORBIS database in order to provide an investigation of ownership concentration and control among 43060 trans-national corporations (TNC). The authors explore the hypothesis of indirect control taking into account two measures of network centrality, the network control and the network value, also called net-control and net-value. The network control is defined by the authors as "the value of control gained from the intrinsic value reached by all direct and indirect paths or the value of control given by the network value of directly controlled companies" (Vitali et al., 2011, p. 17), while "the network value of an economic actor is given by its intrinsic value plus the value gained from network" (ibid. p. 18). It should be noted that these measures could differ considerably. For example, in Vitali et al. (2011) Wall Mart is in top rank by intrinsic value (i.e. market capitalization, operating revenue, asset etc.) but has no equity in other firms. Hence, it has a high net-value whereas its net-control is zero. Since our aim is to study the centralization of ownership and control, in what follows we will focus on the net-control measure. Thus, computing the network control, we will be able to verify "how much economic value of companies a shareholder is able to influence" (ibid. p. 31). In a network control perspective, then, an economy is centralized to the extent that the biggest firms are able to influence a huge economic value by means of a dense web of direct and indirect controlling shareholdings. When the authors apply to the ownership network a minimum threshold for the ownership quota in the corporate shareholding amount, their definition of control as "network influence" is perfectly coincident to the control of capital. On the basis of their analysis, Vitali and coauthors show that in the year 2007 just 737 shareholders controlled the 80% of total global TNC operating revenue, and nearly 40% of TNC operating revenue was controlled by an interconnected core of 295 TNCs, just 0.7% of all the TNC included in the study (Vitali et al 2011; on this meaning and use of network control analysis see also Compston, 2013).

In the work of Vitali et al. (2011), the authors state in passing that their idea of "influence and control" is inspired by a definition of power introduced by Max Weber in 1922. This reminder raises various interpretative problems and this is not the place to deepen it. However, as we shall see, in the present study we suggest that their definition of control and its relations with the concept of power can be directly referred to the works of Marx rather than those of Weber. The measures of network control by Vitali et al. (2011) can be seen then as a representation of the centralization as defined by Marx in terms of concentration of property and control over the stock market capital.

Finally, the analysis of Vitali et al. (2011) and similar studies focus in datasets that are limited in time or in size, examining just single periods or presenting companies from individual countries or limited sectors. Our goal is a generalization of the work of Vitali et al. (2011): while they take just one year as a reference point in their analysis, we shall apply their definition of network control to an alternative dataset that allows examining the global processes of capitalistic centralization in all sectors and in a temporal perspective, with particular reference to a period of sixteen years before and after the financial crisis of 2007.

1.4 Methodology

In the present study we then adopt a methodology for network construction similar to the one used by Vitali et al. (2011). A short summary of the method is presented in the following lines.

An ownership network is a weighted directed graph where the nodes model economic entities and the edges, between shareholders and companies, represent ownership relationships. The ownership relations across firms have specific properties from a network theory point of view. In particular, we are interested in computing the net-control as in Vitali et al. (2011), namely "the value controlled by a shareholder taking into account the network of firms in which it has direct or indirect shares" (ibid. p. 17). As in literature (Laeven and Levine, 2007), we define an indirect shareholder of a company *A*, a shareholder *C* of a company *B* having an ownership quota of *A*. *C* is indirectly a shareholder of A through B. To compute the network control from a root node we need to traverse the graph avoiding cycles. In literature, the graph traversal avoiding cycles has been performed in various ways (Skiena 2012). Among the various network algorithms (details in Newman 2010, in the 10th chapter "Fundamental network algorithms"), we cite Breadth First Search and Depth First Search. The BFS algorithm is suitable for shortest path detection, cycle removal and tree/forest building. The DFS algorithm is able to detect and remove cycles, it is faster than the BFS and it can be used to create trees and forests. The main difference between BFS and DFS is that the latter is not searching for shortest paths, it works backtracking i.e. going back from the deep explorations among the paths. As a result, when two alternative paths exist between node A and node D (A - B - D and A-D) it selects the longest one (A -B -D). On the opposite, the BFS will select A-D the direct link. In the study of ownership and control, direct control is generally considered more important than indirect control. All algorithms that prefer short to long paths must be preferred. Following the approach of Vitali et al. (2011) that used the BFS we developed our exploration of the networks node by node.

The network classification reported by Vitali et al. (2011) distinguishes three main regions in a directed graph: a SCC (Strongly Connected Component), an IN region, an OUT region where the nodes can be reached in different ways. In the SCC two generic nodes are connected by a path in both directions (from node A to node B and from node B to node A), in the IN region the nodes can be reached only by ingoing links while in the OUT region the links are outgoing. The group of nodes having only outgoing links belongs to the OUT region, the group of nodes having only ingoing links are the IN region and the special region where nodes are connected in a such way that two generic nodes (A and B) can be reached by paths in both directions: from A to B and from B to A is known as strongly connected component SCC. Notice that in the ownership network nodes can have, at the same time, ingoing links and outgoing links (i.e. can be at the same time owners and owned by others), when a node has this property and belongs to a SCC region has an high connectivity. In the ownership network the SCC region corresponds to an ensemble of nodes that are at the same time shareholders of companies and participated by other ones i.e. are owners and owned at the same time, from the network perspective they have both in and out links. The nodes in the IN are companies owned by others investors with no shares of other companies. Finally, the nodes in the OUT are pure owners. During the time interval of our analysis the change in the proportion of each region will determine the evolution of the concentration and average ownership. Once performing a BFS on the various regions of the graph, several conditions can occur: a) the BFS starts with a node in the SCC due to the existence of cycles the algorithm will explore the network avoiding back links and will prefer short paths over long ones; b) when the BFS explores an OUT node the algorithm can eventually arrive to the SCC or stop before reaching it, in this case the network is probably fragmented in different communities; c) if the BFS starts on an IN node then the algorithm will stop immediately. This case coincides with a company having no shareholders or the node itself is just a shareholder of one or more companies. In our database, the presence of IN nodes representing pure shareholders is large: in these nodes the network control contributed by the tree is equal to zero.

Starting from the root node, we compute the net-control i.e. the total flow of economic value that is related to the root node via direct and indirect ownership ties. We sum up each link contribution:

$$\eta = \sum_{i=1}^{N} w_i$$

where w_i is the weight associated to each one of the links connected to the root node through the BFS algorithm. By construction, the links have the direction “out” from the root node.

With respect to other measures of indirect control (Brioschi et al., 1985), the main difference of our study is that we follow Vitali et al. (2011) in accounting in each step of the exploration for the weight of each visited link and summing up the total value generated by each ownership relation. It is worth noticing that in our definition the net-control is not normalized to the size of companies (market cap) and it is not considering the distant links as less important. The trees explored by BFS can be large in size (many nodes) and in total economic value (many large ownership relations).

Generally speaking the larger is a tree the larger its net-control. Therefore, it could be possible that a company, even not too big, has a high net-control only thanks to the neighboring firms' value. In order to limit the effects of this drawback, we follow Vitali et al. (2011) and employ minimum holding thresholds. In line with Santos (2015) we focus, mainly, on the share thresholds suggested by the literature: 5 percent according to Zingales (1994, 1995); 20 percent proposed in La Porta et al. (1999) and the 50 percent majority threshold recommended by Chapelle and Szafarz (2005). Thus, to associate the net-control with the notion of control we filter out the links having respectively less than the 5%, 20%, 50% of ownership and we compute the net-control on the remaining network. Hence, we can say that a company having a high net-control in the filtered network has a large control of capital. In the end, following Vitali et al. (2011), we will reach a crucial measure of net control: for each threshold we will calculate the fraction of top holders holding cumulatively the 80% of the total net-control. We will be allowed to say that capital centralization is high if that fraction is low, and that if that fraction decreases then the centralization of capital increases over time. As we will see, the sample obtained with a 5% threshold is much wider and more complex than those determined by adopting the thresholds of 20% and 50%. It is therefore at the 5% threshold that we will mainly refer to in this paper. However, in order to measure the significance of the results obtained, we will also provide results for samples with higher thresholds.

1.5 Data

A database for historical ownership studies must fulfil several requirements of data quality. Firstly it must be quite stable during time, i.e. the majority of the companies and their investors have to be present all long the years of analysis. Secondly, it must have a worldwide coverage to mitigate the national differences in shareholder legislations. Finally, the companies must be part of a homogeneous group having similar standards in financial accountability and in declaring the data of investors and shareholders. In our experience, those requirements can be achieved in part or completely by: 1) selecting public companies listed in stock markets worldwide and active in trading share positions; 2) selecting companies having a capitalization large enough to ensure stricter requirements in financial disclosure and accountability rules. In fact, as a rule of thumb the larger is the capitalization of a company the more likely it has a long business history and more transparency about its business, shareholders and investors.

Our ownership database of shareholders (both companies and investors) has been created querying the Thomson Reuters Eikon database, which covers one of the largest and most complete sets of world's top market capitalization companies over a long period with all financial data. The database has several internal quality checks on the data as well as data transformations to ensure consistency in the reports (for instance using USD worldwide with automatic currency adjustment for exchange and inflation).

To select the companies in the Eikon database, with worldwide coverage and adequate transparency in reporting the ownership structure we performed several queries using the market capitalization level of the firms as a filtering threshold. Increasing the minimum capitalization we retrieve less companies and less countries from the database, but we obtain better data about shareholders; conversely reducing the threshold we get more companies from more countries but their financial statement tend to be less accurate. We noticed that for low thresholds it is not rare to lose the entire ownership structure. After several experiments we determined that 1B USD is a minimum level of capitalization large enough to ensure a worldwide coverage (71 countries) retaining a good quality in the ownership details.

The initial list of 5515 companies having more than 1B USD capitalization in 2016 is searched backward in the Eikon database year by year since 2001. Not all companies available in 2016 were already traded in the initial years. Indeed, despite the large threshold used in the initial selection the companies that are present from 2001 to 2016 are only 2750. Incidentally, if we had selected a smaller threshold of 100M USD the turnover of the companies would have been much larger (90% of the companies with 100M capitalization or less that are present in 2016 were missing in 2001). The changes in the number and composition of the database require a "robustness check" to ensure that the findings on average global quantities (for example ownership concentration and network properties such as density) will remain stable. This robustness check is performed by simply adding/removing a fraction of the companies (from 2750 to 5515) in each year of the dataset and recomputing the average properties. Removing and adding at each run a set of companies in the simulation addresses also the issue of the missing or incomplete data as the effect of the lack of data does not hurt the average results. This test is giving the answers about the stability of the measures and also confirms that, with the choice of 1B USD, the average properties that are the main findings of our work will stay quite stable despite the yearly variation of the numerosity of the sample.

Starting from the database, we create an ownership network per each year. In this network the nodes can be other companies (private or public), investors such as funds, people and even countries: the links are the respective ownership relations. If available, to each node we add the attributes of market capitalization, country and city and typology of investment (i.e. strategic investor or not). Private investors are not supposed to report information about their assets while governments, institutions, or private citizens have no market capitalization. Ownership relations among investors and companies form the links. We can add two different weights to each of them: percentage of ownership or actual quota in 2016 USD. Moreover, each link (*a*-*b*) has a direction resulting from the rule: *a* (source)→*b* (target) if *b* owns a fraction of *a*. Using all information from investors and companies we were able to create larger networks having in 2016 about 45 thousand nodes and almost 1 million of ownership links including also those links that do not report a quota (i.e. shareholders that do not disclose their ownership investments).

With respect to the work of Vitali et al. (2011), the fundamental difference of our study is that we use a different database which allows to develop their analysis over several years. Vitali and her coauthors adopt the ORBIS database, which allows them to build a very large ownership network but related only to the year 2007. The drawback of having such a large database of more than 400k nodes is the long process of data assessment. The authors are forced to perform a large manual cleaning of the data to solve, for instance, the collisions of names for large corporations among different jurisdictions. Also because of these drawbacks, their study focused on a single year analysis. Differently, we adopt the Thomson Reuters Eikon database, which is smaller than ORBIS but allows a multi-year study of the network. This feature is needful to verify the validity of Marx's argument on the historical tendency to centralization of capital.

In order to consider the different ways in which the centralization of capital may materialize, our networks are not constant over time for size, i.e. in terms of number of links and number of nodes. Thus, a flexible database where economic entities are able to enter or exit allows us to verify, for example, the entry into the market of new shareholders, the exit from the market of the weak capitals and bankrupt companies and the merger or acquisition transactions, which are typical features of the different phases of capital centralization. Hence, in our analysis the number of investors (companies and shareholders) can change during years.

1.6 Results

Before dealing with our measure of capital centralization, some preliminary features of the network are presented. The first feature is a changing network in size and density from 2001 to 2016: in 2001 the network had 14694 nodes and 401247 links whereas in 2016 the nodes are 45126 and the links 1286364. Table 1.1 displays some preliminary descriptive statistics. The number of nodes and links almost increases over time, in particular during the years 2005-2006. The higher is the threshold, the smaller is the number of connections, and this is due to the fact that we select very big companies that usually are controlled even with just small percent of total share (Zingales, 1994, 1995).

	N nodes	Tot. links	5% links	20% links	50% links	ΔLinks average all samples	Δnodes
2001	14694	401247	3289	840	342	–	–
2002	16054	480607	3320	819	317	3%	9%
2003	17015	533211	3220	703	235	-8%	6%
2004	19057	575214	3355	691	245	4%	12%
2005	23981	607207	3598	691	253	4%	26%
2006	30526	665072	4581	1002	376	33%	27%
2007	32449	728840	4862	1048	377	5%	6%
2008	34449	874740	5584	1203	432	16%	6%
2009	35940	922664	5701	1293	465	6%	4%
2010	38083	935000	5737	1395	533	6%	6%
2011	38644	951261	5821	1421	560	3%	1%
2012	39569	987147	5958	1418	566	2%	2%
2013	38548	1015233	6011	1433	591	2%	-3%
2014	39803	1089509	6287	1461	586	3%	3%
2015	42269	1178747	6619	1479	586	4%	6%
2016	45126	1286364	6890	1487	580	3%	7%

Table 1.1. *Size of the network (2001-2016).*

Since the size of the networks (both number of links and number of nodes) changes during years, our analysis considers only measures rescaled by size. Thus, instead of number of nodes or number of links, we are most interested in measuring the average network density and the average degree. By rescaling by size we preliminarily investigate some elements that are not related to the size of the network but depend on its structure and composition. In this sense, Figure 1.1 summarizes simple measures of network connectivity: the network edge density; the average degree that in our weighted network is a measure of average weighted degree; the average market capitalization; the market capitalization per shareholder.

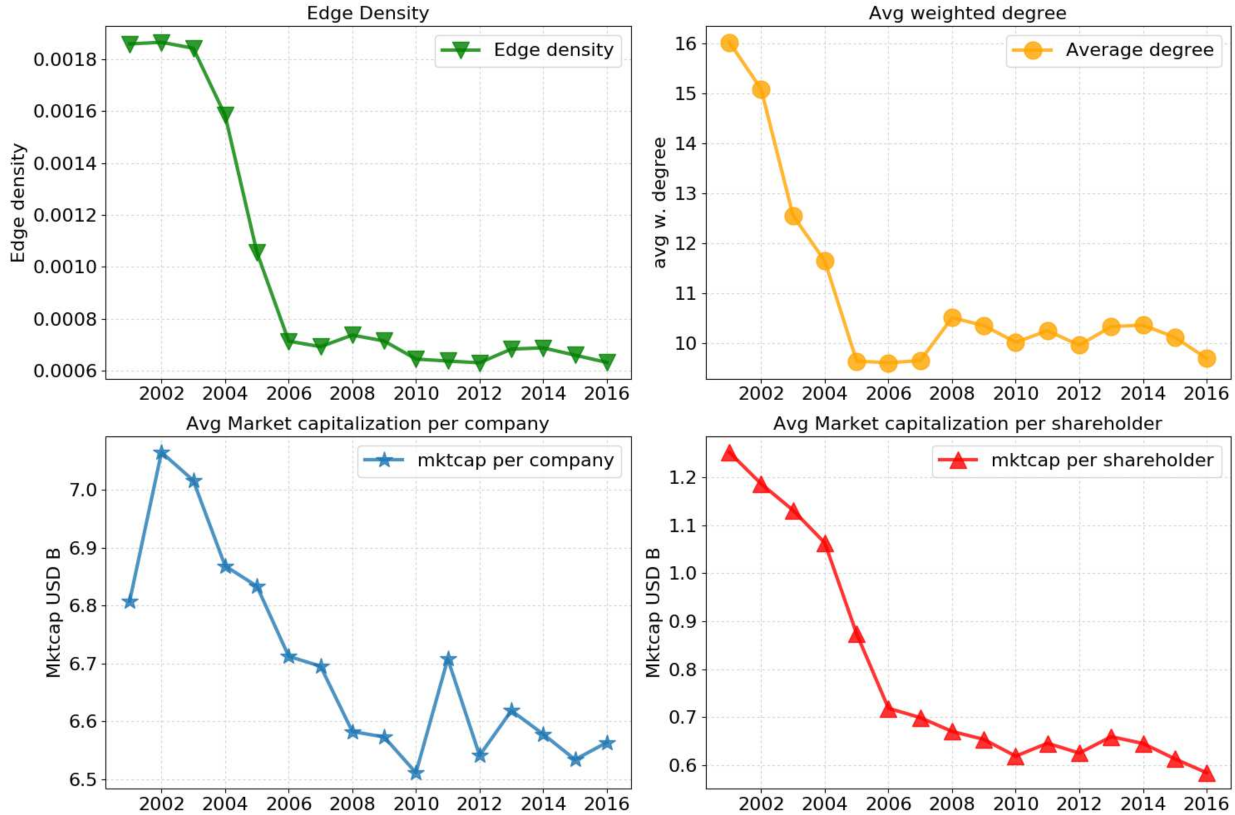


Figure 1.1. *Some simple measures of network connectivity: Edge density, Average weighted degree, Average market capitalization per company and per shareholder.*

It should be noted that all the quantities examined show a marked tendency to decrease in the years before the 2007 crisis, which seems to be exhausted or at least attenuated in the following years. A possible explanation of the changes we observe in the average network measures can be drawn from an analysis of the financial trends at the time preceding the crisis of 2007. The decrease in the edge density can be seen as the result of the arrival in the market of many new investors who diversify their portfolio of investments. Especially before the crisis of 2008, this arrival resulted in a sharp decrease of the network density (i.e. for each node many more new links were created). Similarly to the link density also the average capitalization per company and per shareholder decreased because of the entering of new investors (this second plot considers all investors including privates and institutions). The trends before 2007 can be interpreted in several ways: one interpretation which can be considered in line with the Marxian theory of centralization is inspired to Minsky's contributions to the study of the euphoria waves in the market which usually come before a collapse (Minsky, 1982; see also Stockhammer, 2004). Actually, this view finds support in Roubini and Mihm (2010), who state that in 2006 the euphoria among investors percolated upward throughout the entire financial system (see also Carvalho and Gabaix, 2013; Caverzasi, 2014; Dymski, 2010).

We can now focus on the main result of our analysis: a measure of centralization of capital during the period 2001-2016 in terms of ownership and control concentration around the world. In order to present our results we use the Lorenz-like curve already adopted by Vitali et al. (2011). This curve is obtained by inverting the order on the *x*-axis of the usual Lorenz curve, ranking the shareholders according to their relevance and reporting the fraction they represent with respect to the whole set of shareholders. The *y*-axis represents the corresponding percentage of network control (more details in

Glattfelder, 2010). We then select a threshold of ownership of the 80% of cumulative net control. In the choice of such a threshold, we follow Vitali et al. (2011) and more in general the literature about income and wealth distribution (see: Atkinson and Bourguignon, 2000; Clementi and Gallegati, 2016). The black line at 80% *y*-axis level, intersecting the curves of net-control, allows determining on the *x*-axis the fraction of companies owning the 80% of the cumulative net-control. We can say that the smaller this fraction, the higher the centralization of capital; and if this fraction decreases, then the centralization increases over time. Furthermore, it is important to remember that we analyse the net-control in three different samples: with 5%, 20% and 50% control thresholds. Hence, summarizing, we first compute the net-control with three different control thresholds as measures of capital centralization. Then, for each of these three samples we determine the fraction of investors who hold the 80% of the cumulative net-control. Thus, as in Marx's interpretation, we can discover if a huge mass of capital represented by the net-control with control quota is actually concentrated in a few hands or not.

The following Figure 1.2 provides a graphical representation of the centralization of capital referred to the case of network control measured with a minimum ownership threshold of 5%. This means that within the network the links relating to ownership shares below this threshold are eliminated. Figure 1.2 is a Lorenz-like curve with an inset plot that is a zoom of a region of the plot where the curves are crossing the 80% total net-control line. To build each curve (one per year since 2001) we ranked the companies according to their net-control and we computed their cumulative net-control by reporting in the *x*-axis (log-scale) the fraction of companies, and in the *y*-axis, the total held net-control. For example, when the total held net-control is equal to 80% of the total, then the fraction of companies having such value is around 10^{-2}, i.e. 1%. The inset plot allows to explore the intersection at the reference level of 80% of total net-control and to study how the corresponding fraction of companies has changed in time.

The first findings that can be drawn from Figure 1.2 are consistent with Vitali et al. (2011). Indeed, network control is highly concentrated: the fraction of top holders holding cumulatively the 80% of the total net-control, is always within the range between 1% and 2%. Therefore, the control of capital is highly centralized and is much more unequally distributed than income and wealth. Nevertheless, in addition to these results, the temporal character of our investigation allow us to unveil for the historical trend of capital centralization. In order to draw this trend, here we introduce a variant with respect to the representations of the Lorenz-like curves proposed by Vitali et al. (2011), in the sense that while they show a single curve referring to 2007, we display on the same graph many curves for each of the examined years. Then, we need to analyse Figure 1.2 in the light of these aspects: a) the Lorenz-like curves are intersecting the 80% line represent the fraction of companies cumulatively holding the 80% of the net-control; b) to get the behaviour year by year in the inset plot of Figure 1.2 we can read the intersection values at 80%; c) the range of greys curves is changing from light to dark across the years.

As we have previously specified, the sample obtained with a 5% threshold appears to be wider and more complex than those determined by adopting the thresholds of 20% and 50%. For this reason, we mainly refer to the 5% threshold and only comment a graph built on it. However, in order to measure the significance of the results obtained, in what follows we will also provide information on samples with higher thresholds. Based on these elements, we can draw the following results.

First, for each threshold considered (5%, 20%, 50%) the Lorenz-like curves are bunched in two groups: interval 2001-2005 and interval 2007-2016, with 2006 that belongs to this second group but can be considered as a watershed.

Second, in the case of a threshold of 5%, we can see an increase in capital centralization over the entire period. From 2001 to 2016 the fraction of companies owning the 80% of the market net-control changes from an initial 1.25% to a final 1.0%, with an increase in centralization of about 25%.

Third, during the period 2001-2005 the curves related to each threshold examined tend to be dissimilar less, there is variability in their shape.

Fourth, for each of the three threshold considered the interval 2007-2016 always shows a systematic and regular increase in centralization over time, i.e. the curves always move from right to left. In particular, during these years, for the three samples examined the measure of capital centralization always increases of more than 20%.

In conclusion, in the main case of a threshold of 5%, between 2001 and 2016 we find a global tendency toward centralization of capital. After 2006 this trend assumes a more regular and general character and is confirmed for all the thresholds considered.

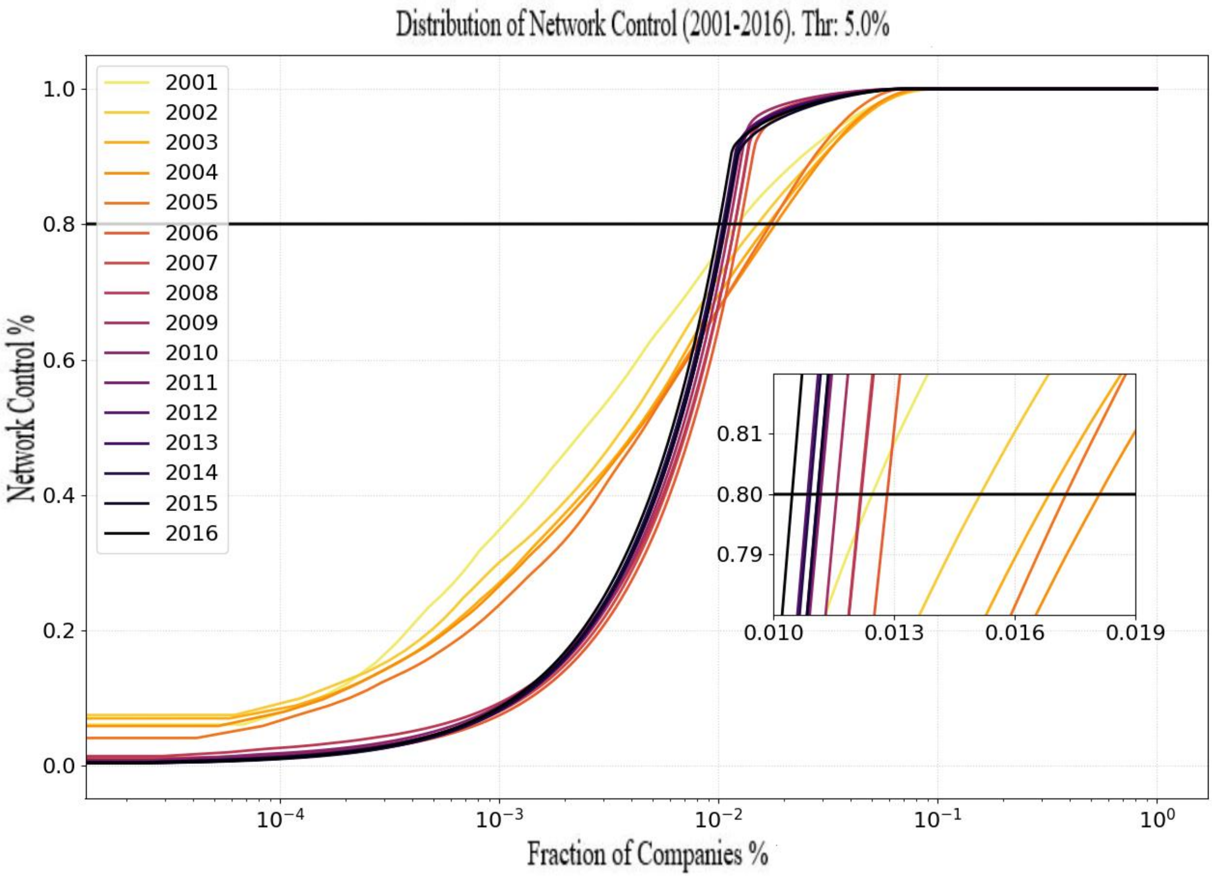


Figure 1.2. *The Lorenz-like curve of network control n with minimum share quota of 5% (least most strict rule for control). The net-control of each node is ordered cumulatively and plotted versus the rank of the node (x-axis). The black line at 0.8 represents the 80% of the net-control held by companies. On the inset plot, we can read the fraction of companies owning the 80% of the market net-control: from 2001 to 2016, fractions change from an initial 1.25% to a final 1.0%.*

In the domain of financial networks literature it is customary to study the so called "core-periphery structure" of the network distinguishing the nodes that, for their connectivity, tend to stay on the centre of the graph, known as "core", and the nodes that are weakly connected to others and stay apart, on the "periphery". A precise statistical test to determine whether or not a node belongs to the core is beyond the scopes of this paper (the reader can see Csermely et al., 2013). Here we just want to stress the change in the local density for the cores due to the different "strength" of the nodes in 2007 and 2016. Strength is defined as the sum of the weighted degree of a node *i*:

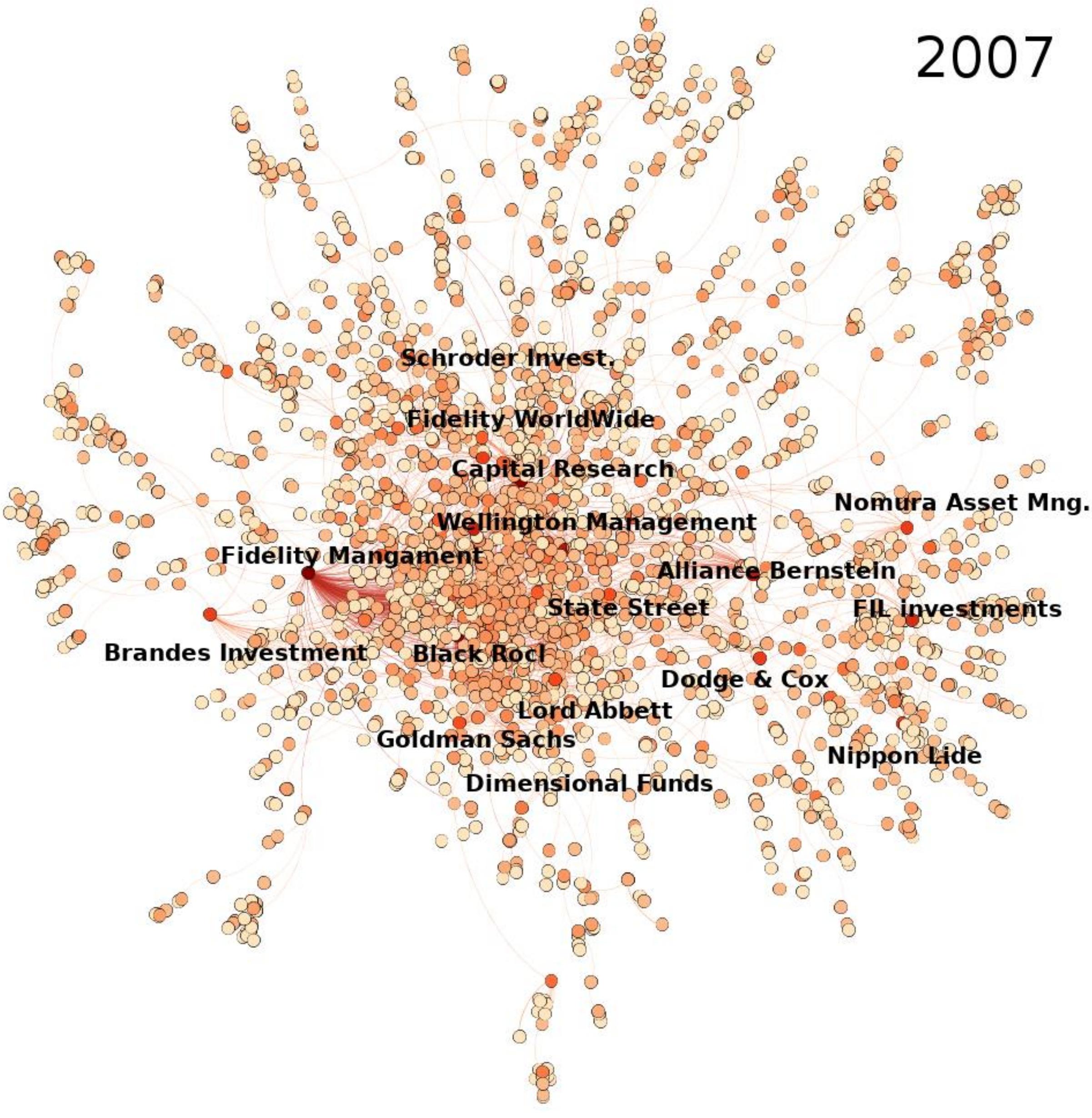
$$S_{(i)} = \sum_k w_k(i)$$

where k is an index running on the neighbours and w_k is the weight of the link around the node i. This measures take into account the real effect of each node in terms of ownership (notice that here the weight here is the absolute value of the ownership computed in Billions of USD; for further details, see Newman, 2010).

Figures 1.3a and 1.3b represent the ownership networks in 2007 and 2016 with a minimum shareholder quota of 5%. It is interesting to note that the network of 2016 is larger in size and visually denser but has a lower average density. This finding seems to contrast the results about the increase in the centralization of capital between 2007 and 2016 that we have shown before. This puzzle can be overcome by studying the "strength" distribution of the two networks 2007 and 2016. The analysis in Figure 1.4 reveals that in 2016 the strength of the most powerful nodes has increased compared to the year 2007 (the darker curve of 2016 is above the lighter line of 2007 for strong nodes). Vice versa, the weak nodes have diminished their strength in the more recent network (the darker line is below the lighter one in the left part of plot). In sum, weak nodes become weaker and strong stronger. This shift in the strength of the nodes is responsible for the change in the density we observe in 2016 and is related to the increase in capital centralization calculated as the fraction of companies who hold 80% of net control. As a summary of the comparison between 2007 and 2016, while the general average link density is lower the network core is more dense and capital centralization is higher.

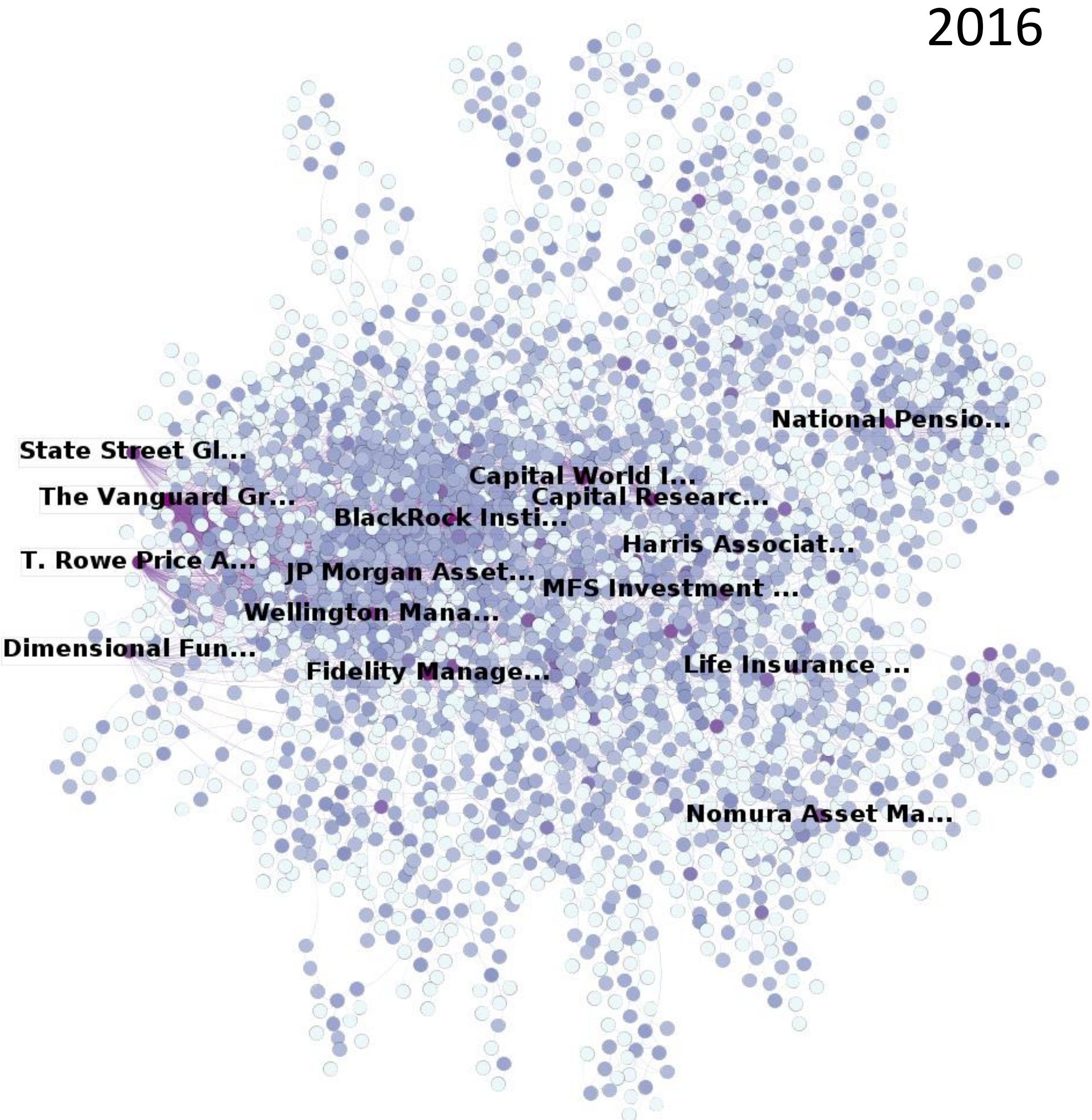
The names of the companies shown in the network plots of Figures 1.3a and 1.3b have been selected according to their large net-control. In line with Vitali et al. (2011), the financial companies are in all the networks among the largest nodes for total net-control. Notably, the top 3 control-holders in 2007 are Fidelity Management & Research Company, Capital Research & Management Company and BlackRock Institutional Trust Company, N.A.. In 2016, the top 3 control-holders ranking is similar: the Vanguard Group, Inc., BlackRock Institutional Trust Company, N.A., Fidelity Management & Research Company. It is interesting to note that financial companies still mainly compose the core of the global ownership network even after the financial crisis of 2007.

Figure 1.3a



2007
Schroder Invest.
Fidelity WorldWide
Capital Research
Nomura Asset Mng.
Wellington Management
Fidelity Mangament
Alliance Bernstein
State Street
FIL investments
Brandes Investment
Black Rocl
Dodge & Cox
Lord Abbett
Goldman Sachs
Nippon Lide
Dimensional Funds

Figure 1.3b



Figures 1.3a & 1.3b. *Ownership networks in 2007 and 2016. The links represent ownership relations with a minimum threshold of 5%, the nodes are the companies. A classical algorithm of network layout (force layout) adjusts the node positions according to the strength of their mutual relationships. Nodes that are closer in the graph are connected by strong ownership quota. The graphical layout arranges the nodes "naturally" in a core-periphery structure as the strongest nodes tend to be on the centre of the distribution, the weaker in the periphery.*

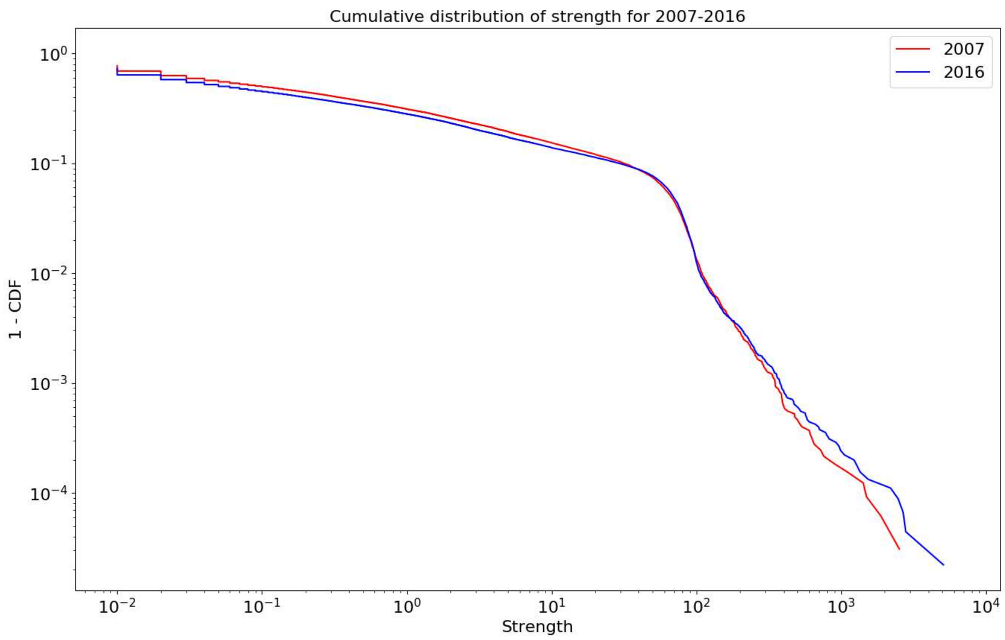


Figure 1.4. *Strength distribution for 2007 and 2016. The nodes with large strength in 2007 increase their relevance in 2016. The nodes with weak links have even weaker links in 2016.*

1.7 Conclusion

The purpose of this paper has been to explore the historical trend of centralization of capital in the world. In order to do that, the study extends the analysis of Vitali et al. (2011) from one to many years providing, to the best of our knowledge, the first global empirical investigation of the phenomenon.

We interpreted centralization as a concentration in a few hands of the control of share capital and we measured it in terms of network control filtered by minimum shareholding thresholds. In adopting this measure, we noted that the network control is highly concentrated in the world: the fraction of top holders holding cumulatively the 80% of the global economic value of the firms considered in the sample is always under the fraction of 2%. Furthermore, by inspecting the temporal dynamics of the phenomenon we observe an increase in the global centralization of capital: this trend appears to be partially dependent on the threshold chosen until 2006 whereas it assumes a more regular and general character from the financial crisis of 2007 until 2016, with an increase of more than 20% for all the samples considered. In the early years of the 21st century, especially since the 2007 crisis, Marx's thesis of a global tendency towards the centralization of capital seems to find empirical confirmation.

Our findings contrast with the arguments proposed, a few years ago, by Paul De Grauwe. Indeed, in a co-signed paper De Grauwe refused a particular interpretation of Marx's centralization thesis, namely that relating to the process of markets monopolization and power concentration by a few large multinational corporations. In support of this view, De Greuwe and Camerman (2003) reported some data which showed that the multinationals are very small compared to the gross domestic product of the countries that host them, and that these companies are also relatively smaller than in the past.

According to De Grauwe these results would also be valid for the future and should be seen as a denial, not only of the law of the tendency evoked by Marx, but also of those political movements which, inspired by it, identify a potential threat to present democracy in the centralization of capitalist power. The aforementioned study is attractive since it represents one of the rare analysis in which Marx's theory of centralization is taken into consideration by leading exponents of the prevailing theoretical paradigm and above all is subjected to some sort of empirical validation. On closer inspection, however, the measure of centralization employed by De Grauwe and Camerman is atypical and somewhat misleading. Indeed, the Marxian 'law of motion' cannot be reduced to a mere calculation of the weight of the multinationals on the gross domestic product. Nevertheless, beyond the accuracy of De Grauwe's approach, with the present work we have been able to verify that all evaluations on the validity and relevance of the concept of capital centralization can change drastically if we adopt a more complex measure and, in many respects, more faithful to Marx's original definition.

This study did not investigate the possible determinants of centralization processes. Our results, however, could open the way to possible future research. In our view, further analyses should be dedicated to a clarification of the theoretical nexus between the law of centralization and the Marxian schemes of reproduction: a possible solution could come from an interpretation of the changes in ownership and control associated to centralization in terms of structural change and economic dynamics (on the concepts and method of structural dynamics analysis see Scazzieri, 2009 and Baranzini and Scazzieri, 2012; on the Marxian schemes of reproduction see Trigg 2006, among others). Further studies may also verify the existence of causal links between the tendency toward centralization of capital measured in terms of network control and the economic crisis. By an exhaustive examination of these links, evidence could emerge on the possible role played by economic policies, with particular regard to the rules of conduct of central bankers conceived as regulators of solvency and related processes of centralization of capital (on this theme see Brancaccio and Suppa, 2012; Brancaccio and Fontana, 2013, 2015; Brancaccio, Califano, Lopreite, Moneta, 2017).

Chapter 2

Tariffs, Domestic Import Substitution and Trade Diversion in Input-Output Production Networks: how to deal with Brexit

2.1 Introduction

The United Kingdom (UK) decision to leave the European Union (EU) took many by surprise. Since then, the debate around Brexit, focused on the reasons and consequences of this decision. Several scholars and political commentators attempted to explain the support for the Leave option in the referendum, emphasizing the role played by political issues such as those of immigration and sovereignty, and the growing trade deficit the UK runs with many European countries. In particular, the adverse trade relationships with Europe helped to spread a feeling of intolerance towards Europe (Los et al., 2017) and to develop a rejection of globalisation (Colantone and Stanig, 2018; Rodrik, 2018a), which resulted in the victory for the Leave campaign. It is therefore not surprising that most of the studies regarding the likely economic implication of such an extraordinary event focus on the impact Brexit will have on international trade.

The trade effects of Brexit are particularly complex, as in the age of globalisation, production processes and global value chains (GVCs) are increasingly fragmented and often involve intermediate inputs crossing borders several times until they are sold as a final product. However, the predictions on the implications of Brexit often fall short in understanding the effect of any trade shocks within these highly complex and interconnected systems. Rather, the main analyses conducted so far are wholly UK centric and hence conclude that Brexit will result in heavy losses especially for the UK. The present paper challenges and complements these studies in two directions.

First, using the recently constructed World Input-Output Database (WIOD), a comprehensive and granular model is developed that offers detailed information on the distributional effects of Brexit as a trade shock and the impact it will have on the value-added of the UK, EU, and extra-EU countries. The model includes direct and indirect trade via GVCs and provides estimates of the direct and indirect impact of Brexit at the industry level. Include indirect effects means consider the implications Brexit will have on third-party countries. For example, let us consider an Italian car that to be assembled requires components such as steel, glass, plastic, rubber, etc., which are provided by different sectors in different countries. Thus, if the UK demand for Italian cars will reduce due to Brexit, this means that production losses would propagate indirectly in all sectors and countries providing inputs embedded in Italian cars. The inclusion of GVCs and indirect Brexit effects in our model leads to estimates that diverge with the results of the main literature. Indeed our findings, comparable with other studies that include indirect Brexit effects such as Vandenbussche et al. (2017) and W. Chen et al. (2018), suggest that Brexit could be risky and costly not only for the UK but also for EU countries, especially Ireland, Germany, Belgium, and the Netherlands, with Ireland facing losses similar or even greater than those of the UK. Furthermore, the predictions show that the total value-added losses for the EU27, ranging from $54 billion under a free trade agreement scenario to $218 billion under a no-deal scenario, are greater than in the UK. However, in line with the results that circulate in the literature, our model simulation shows that the UK, as single country, is still the most affected by Brexit, facing value-added losses of $36 billion and $135 billion for the soft and hard Brexit scenarios, respectively.

The second novelty of the paper is to challenge the theoretical framework of traditional trade models. In particular, we move away from the traditional assumption underlying standard trade models, according to which trade liberalisation always increases welfare and we address the question, are there any economic policies that would mitigate or even reverse the negative Brexit effects? Rodrick (2018a, 2018b, 2018c) states that under circumstances of weak domestic growth and growing trade deficit, trade protectionism would be preferable to unconditional free trade. Building on this remark, we develop a second model that considers Brexit as a special case in which a country implements a protectionist trade policy in order to rebalance the external accounts and boost domestic growth. Hence, we introduce the hypotheses that in response to Brexit, UK trade will be partly diverted to extra-EU countries and EU imported products will be partly substituted by domestic purchases. Conversely, on the other side of the Channel, we assume that EU countries will partly substitute UK imported products by intra-EU purchases. The inclusion of domestic import substitution and trade diversion policies in the model leads to different estimates about the potential impact of Brexit on both macro-regions. In particular, we find the absolute and relative losses in value-added production for the UK and for each EU27 member state to be significantly lower compared to the results shown in the Brexit literature and in our first model. Notably, estimated losses in the UK ranging from $1.4 billion in the soft Brexit scenario to a surprisingly gain of $10.6 billion in the hard Brexit scenario. Outside the UK, losses are larger, although significantly below to the first model estimates. A potential explanation for these lower estimates is that in our second model trade barriers would not necessarily mean negative economic shocks, because we allow sectors and countries to partly substitute foreign products which are rendered less competitive due to tariffs.

The models developed are highly influenced by Koopman et al. (2014), Los et al. (2016), Dietzenbacher and Lahr (2013) and W. Chen et al. (2018), whose insightful work on IO data analysis provides the fundamentals for our analysis. Dietzenbacher and Lahr (2013), in particular, inspire the hypothetical partial extraction and partial expansion methods that are used in the models. The methodology follows most closely that of Vandenbussche et al. (2017) who, like in this paper, allow for tariff and elasticity heterogeneity across countries and sectors. This is particularly important as potential post-Brexit tariffs vary greatly across sectors and differences in elasticities can heavily influence the outcome of a trade shock.

The work is organised as follows. The second section explores and discusses the relevant literature. The third and fourth section examines the historical trend of UK bilateral trade relationships, and the main features of the current trade relationships, respectively. The fifth section describes the model and methodology used for analysis. The sixth and seventh section present and discuss the results and lastly, the paper offers some concluding remarks.

2.2 The Economic Impact of Brext: Literature Review

The UK's decision to leave the EU has led to an extensive body of work by academics and governing institutions that attempt to quantify the economic and trade impacts of Brexit on the UK, the EU and the rest of the world. This section reviews some of that literature and discusses how it has influenced the work in this paper.

2.2.1 Gravity Models in Brexit Impact Studies

The models employed in much of the relevant literature can be broadly lumped into four main groups: gravity models, computable general equilibrium models (CGE), new quantitative trade models (NQTM) and econometric models. A gravity model is a well-known and well-established econometric approach for estimating the economic impact of trade agreements on trade flows between countries (Piermartini and Teh, 2005; Plummer et al., 2010; Head and Mayer, 2014). It is an ex post method that relies on existing data to evaluate the effects of changes in variables that in some way affect barriers to trade between countries. Gravity models for trade are analogous to Newton's physical law of gravity in which the attraction of planetary bodies is directly proportional to their size and inversely proportional to their distance apart (Gudgin et al., 2017a). Gravity models likewise assume that bilateral trade flows are increasing in relation to the size of the trade partner's economy and decreasing in relation to its geographic distance. The results of the econometric analysis indicate how far the estimated model can be used to explain past trade flows and how important free trade agreements are in this context.

For all these reasons, gravity models sound suitable to study the consequences of Brexit. In fact, in their assessments, published shortly before the referendum, both the UK Treasury (2016) and OECD (Kierzenkowski et al., 2016) employ gravity models to quantify post-Brexit trade between UK and EU. The UK Treasury report calculates the benefit of UK's membership in terms of extra trade with the EU and assumes that most of this trade would be lost to the UK on leaving the EU and adopting WTO rules. Likewise, the study computes the change in foreign direct investment (FDI) and the impact on productivity resulting from the changes in trade and FDI. Then, the results are entered into the NiGEM, a multi-national general equilibrium-forecasting model, to calculate the likely impact on GDP and unemployment. The OECD's approach parallels the Treasury in computing the change in trade, FDI and their impact on productivity, in addition, the OECD study considers the potential changes in regulation, migration, investment in R&D and reduced managerial quality. Again, the results of these changes are entered into the NiGEM macro-economic model to predict overall impacts on GDP, incomes, and unemployment. The mid-range estimates of the reduction in GDP in 2030 under a WTO scenario are 6.2 percent for the Treasury and 5.1 percent for the OECD. However, as pointed out by Gudgin et al. (2017a, b) these pessimistic predictions depend essentially on the assumptions of the underlying gravity models adopted. Changing the method of obtaining the gravity equation, the authors suggest that the impact on UK's GDP is substantially smaller ranging from 1 percent in the milder Brexit scenario to 4 percent in the more severe scenario (Gudgin, 2017a). Therefore, their conclusion is that the gravity model approach lacks the degree of precision needed to make a definitive estimate of the impact of EU membership on trade. Furthermore, although gravity models have a firm theoretical foundation, they do not include the interaction between sectors and markets and are able to explain only trade flows and not welfare or employment. Also for these reasons, some scholars have preferred CGE and NQTM models.

2.2.2 CGE and NQTMs in Brexit Impact Studies

CGE models are standard tools to estimate the impact of trade policy measures such as trade agreements (Piermartini and Teh, 2005; Plummer et al., 2010). Thus, they are also suited to simulate a Brexit or to quantify the benefits for the UK from free trade of goods and services with other EU member states. As in Walrasian theory, CGE models aim to mimic a simplified version of the whole economy (general equilibrium) – and not only of a single sector or market (partial equilibrium).

Therefore, they usually take into account many countries and sectors as well as the main relevant existing channels of economic transactions. Booth et al. (2015) in their report for the think tank Open Europe apply a CGE trade model and present a very detailed study on the impact of Brexit. The authors differentiate between four scenarios resulting in a range of possible effects by 2030: in the worst case, World Trade Organization (WTO) rules between UK and European countries, the UK will bear a loss of 2.2 percent of GDP; in the best case, free trade agreement (FTA) with EU and an extremely ambitious deregulation approach, the UK will gain 1.6 percent of GDP. In the middle, the more political realistic range forecast a 0.8 percent loss of GDP in a pessimistic scenario and a gain of 0.6 percent of GDP in an optimistic scenario.

Rojas-Romagosa (2016) employs a CGE model focusing on trade relationship between the UK and EU countries, especially the Netherlands. In the worst scenario (WTO rules) total trade decrease dramatically for the UK leading to a fall in GDP of about 4 percent. This loss becomes more modest in the FTA scenario. However, in CGE modelling, results heavily depend on the assumptions made, the structure of the model, and data used. The complexity of CGE models makes it difficult to understand the extent to which the results depend on these features. Finally, beside the high complexity characterizing this model, CGE are 'comparative static' models, meaning that results derive from a comparison of the economy equilibrium today with the one achieved when the economic shock is absorbed. The way towards this new equilibrium is not modelled and it is not exactly clear how long the adaptation phase takes (Busch and Matthes, 2016).

Starting from the insight that usual CGE models and several other trade models have a common core under certain assumptions, recently, a new class of trade models has become popular in estimating the effects of FTAs: the NQTMs. These models are based on both gravity equations and basic assumptions of CGE models. The advantage of NQTM over CGE models is a much simpler construction of the model itself, requiring fewer and more straightforward equations than CGE models. This allows for a better understanding of the effect of each parameter taken into consideration. The main idea behind these models is that trade liberalisation tend to increase welfare because it allows countries specialisation in their comparative advantages areas leading to a reduction of costs of goods, services and intermediate input. Thus, considering this underlying claim it is quite simple to imagine the assessment that these models propose of Brexit.

Three of the most comprehensive and sophisticated Brexit studies (Ottaviano et al., 2014; Aichele and Felbermayr, 2015; Dhingra et al., 2017) use this new method. In particular, influenced by the work of Costinot et al. (2014), Ottaviano et al. (2014) quantify the impact of Brexit on multiple sectors of the UK distinguishing between two different scenarios one optimistic and another pessimistic. In the pessimistic case, they assume that the UK will apply the most favourite nations (MFN) tariffs. In the optimistic scenario, authors imagine that the UK will be able to negotiate a better tariff deal in the medium term such as Norway or Switzerland. Hence, they consider that tariffs on goods continue to be zero between the two parts. In both scenarios, UK will face non-tariff barriers (see section 4) in trading with EU, notably, they amount to one-quarter of the reducible non-tariff barriers faced by US exporters to the EU, in the optimistic scenario, and to two-thirds of the reducible non-tariff barriers of US exports to the EU in the pessimistic scenario. The estimates suggest that, in the optimistic case, the level of the UK's GDP will be reduced by 1.1 percent, in the pessimistic case by 3.1 percent in the longer term. In an updated version of the study with broadly similar assumptions, Dhingra et al. (2017) come to comparable results: 1.3 percent loss in the optimistic case, 2.7 percent loss in the pessimistic case. Minor changes apply to the assumptions concerning fiscal benefits which are reduced compared to Ottaviano et al. (2014), particularly in the optimistic (Norwegian) case, and to the non-tariff barriers in the pessimistic case which are higher compared to Ottaviano et al. (2014). Further, Dhingra et al. (2017) also calculate the economic impact of Brexit on other countries. In both scenarios the UK experiences the largest welfare losses, but some countries other than the UK, such as Ireland, Netherlands, Belgium, Denmark, Sweden, and Germany have relatively great welfare losses. In aggregate, the EU27 will experience a GDP loss ranging between 0.1 to 0.4 percent. However, although NQTMs should be regarded as a step forward in estimating the impact of free trade agreements or other trade policy measures ex-ante, still the quantitative results rest on important assumptions (Coutts et al., 2018; W. Chen et al., 2018). As listed by Ottaviano (2014) these micro-foundations are: Dixit-Stiglitz consumer preferences; one factor of production; linear cost function; perfect or monopolistic competition. Whilst macro restrictions are: trade is balanced; aggregate profits are a constant share of aggregate revenues; and the import demand system exhibits constant elasticity of substitution. Therefore, results should be interpreted with caution and taken as qualitative indications (Busch and Matthes, 2016).

2.2.3 Econometric Models in Brexit Impact Studies

Standard econometric studies have also been conducted to assess the economic consequence of Brexit. The economic consultants Cambridge Econometrics (2018), for example, using actual historic data generates estimates for five different scenarios. The report predicts, in the worst case, a global value added 3 percent lower for the UK in 2030. However, the results have to be combined with the decreasing population. The conclusion is that even if global value added in UK will be lower, no substantial reduction in living standards will occur, as measured by per capita global value added. Coutts et al. (2018) and Gudgin et al. (2017a) obtain similar results predicting, in the milder Brexit scenarios, a minor loss of GDP but no loss of per capita GDP and in the worst case a loss of GDP nearer 4 percent.

In a recent IMF Country Report, J. Chen et al. (2018) apply an econometric model to assess the economic impact of Brexit on the other side of the Channel, i.e. on EU27. The IMF researchers develop a multidimensional index that captures the integration between the UK and the EU and use this index to estimate the impact of several Brexit scenarios on EU27 countries. Their findings suggest that the level of output of EU27 countries falls by between 0.06 and up to 1.5 percent, according to the respective scenarios. The data-driven approach typical of econometric studies has the advantage to limit the assumptions which dominate general equilibrium models used in most other Brexit studies. However, the general drawback of econometrics models is that they do not consider global intersectoral production linkages. This limit would represent a relevant weakness. Indeed, according to Johnson (2014) and Acemoglu et al. (2012) the emergence of global production networks implies that one can no longer consider bilateral trade in isolation when evaluating trade policy or idiosyncratic shocks. This is particularly true in the case of Brexit considering that most trade between the UK and EU countries is in intermediate inputs (see section 4; Mulabdic et al., 2017; J. Chen et al., 2018). Therefore, neglecting the indirect links via these value chains bring about a partial understanding of the issue and a likely underestimation of the costs of Brexit, especially for EU27 countries. These last observations represent the underlying starting point of the present study.

2.2.4 Global Value Chains and Brexit

To the best of our knowledge, to date, only two studies incorporate supply chain links between countries in their Brexit impact estimation models. Vandenbussche et al. (2017) develop an Input-

Output (IO) model of trade that comprises domestic and global value chain linkages between goods and service sectors. Including IO linkages allows considering indirect trade flows, for example domestic production of intermediates can serve as inputs in foreign products and then be exported indirectly to a final destination. Considering the scenarios adopted by Dhingra et al. (2017), Vandenbussche et al. (2017) find that Brexit hits the UK harder than the EU27, in relative terms. However, they find EU27 losses to be substantially higher than other studies pointed out. Another study by W. Chen et al. (2018) examined the exposure of EU regions to Brexit incorporating all effects due to geographically fragmented production processes within the UK, the EU and beyond. Using global IO tables, they link trade to value added and find that UK is far more exposed to Brexit risks than the rest of the EU. At the same time, regions in Ireland, Malta, Netherlands, Belgium and Germany are also likely to be heavily affected by Brexit.

As stressed in section 4 and 5, the present study builds on the contributions of Vandenbussche et al. (2017) and W. Chen et al. (2018) and provides a method to incorporate trade frictions within an IO framework. Furthermore, we challenge the usual claim underlying the studies reviewed above according to which trade liberalisation always tend to increase welfare and we propose a method to quantify the impact of trade diversion and domestic import substitution policies.

2.3 The UK Bilateral Trade Relations

To illustrate the UK-World trade relations we employ the World Input-Output Database (WIOD). Using this dataset has several advantages: it covers trade in goods and services at the bilateral level allowing for a sectoral investigation, a decomposition of gross exports in value added terms, and a granular analysis of global value chains (see Dietzenbacher et al., 2013 for more details).

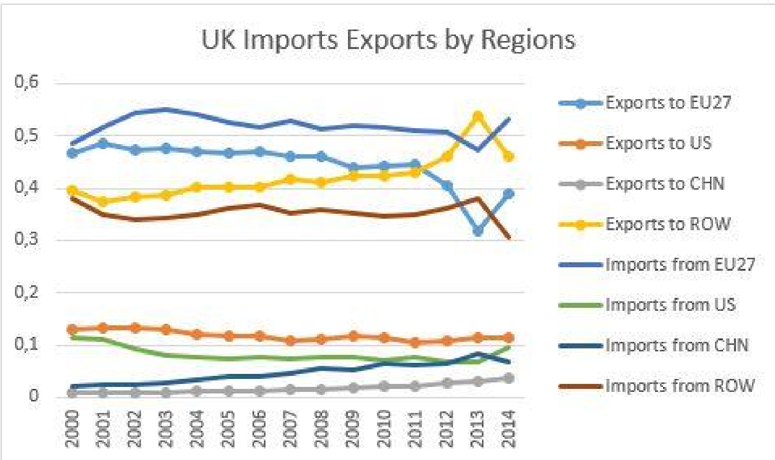


Figure 2.1. *UK imports and exports (as a percentage of total imports/exports) from 2000 to 2014. Decreasing exports from the EU-27 have coincided with increasing exports to ROW and China.*

At the time of writing the data set covers 43 countries and a model for the rest of the world for the period 2000-2014 and data for 56 sectors classified according to the International Standard Industrial Classification revision 4 (ISIC Rev. 4).

The UK plays an important role in trade relations with the rest of the world. In 2014, the UK records for 3.2% of world exports and 3.4% of world imports. As the Figure 2.1 shows, the EU is the most important UK's trading partner accounting for 39% of UK exports and 53% of UK imports.

However, although the EU is by far the most important source of imports for UK, its significance as destination region has steadily declined over time. This trend has ended up tightening the UK trade deficit with the EU. To gain a deeper understanding of this issue, the UK's net exports (computed on total trade in goods and services) are shown in Figure 2.2.

On closer inspection, the UK's total trade balance, as Figure 2.2 highlights, has been in deficit since 2001, due to deficits in trade with EU countries and China that are partly offset by surpluses in trade with the rest of the World, in particular the US.

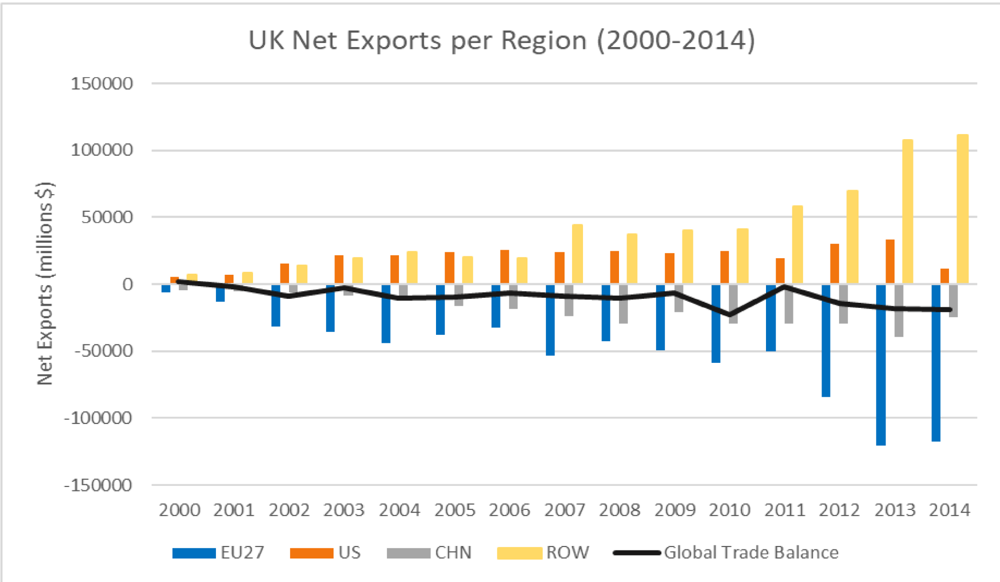


Figure 2.2 *UK net exports and global trade balances from 2000-2014, including trade balances with EU-27, US, China and ROW. Gradually increasing UK trade deficits with the EU have been mostly offset by trade surpluses with US and ROW.*

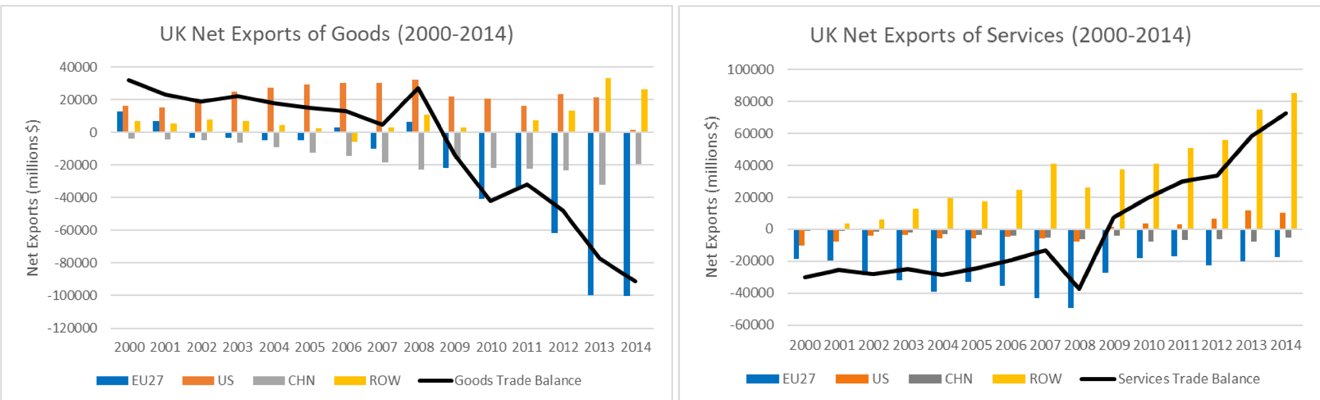


Figure 2.3. *UK goods and services trade balances from 2000-2014. Increasing trade deficits in goods from EU-27 and China has been offset by an increasing trade surplus in services with the US and ROW.*

Utilising the disaggregation of goods and service sectors as in Mulabdic et al. (2017), Figure 2.3 shows trade balances broken down into goods and services. During the period considered the UK has accumulated an ever-increasing goods trade deficit with the EU, which has been financed by the increase in exports of services in the rest of the world. This is consistent with what Mulabdic et al.

(2017) call ‘servification’ of UK trade: the level of total UK trade in goods as a proportion of total trade in goods and services has been gradually declining since 2000, replaced by the rising share of UK trade in services (Figure 2.4).

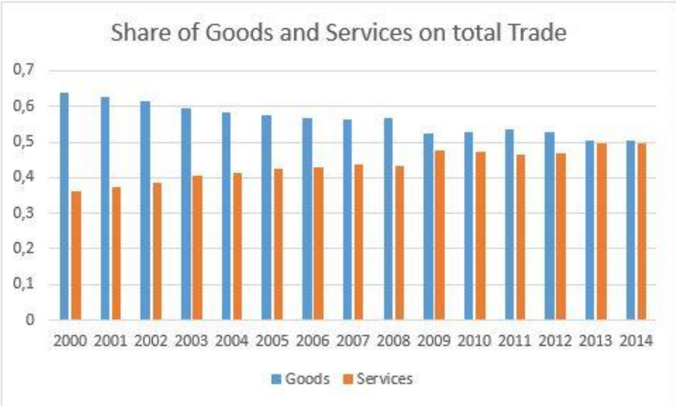


Figure 2.4. *UK trade in goods and services from 2000-2014. The ‘servification’ of UK trade*.

This also supports the work of Rowthorn and Coutts (2004) which reveals that the UK needs large net earnings from the export of services in order to afford a growing manufacturing trade deficit. As suggested by the authors and on closer inspection, those goods sectors from which the UK imports heavily are mostly manufacturing sectors. Figure 2.5 shows that a whole range of service activities has filled the gap left by the decline of traditional industries. In particular, the UK trade deficit is largely comprised of manufacturing sectors whilst the UK’s trade surplus includes mostly knowledge-based service sectors such as Financial and Administrative Services.

The evolution over time of the sectoral balances would suggest a financialisation of UK exports and a 'manufactorisation' of UK imports. As stressed by Coutts and Rowthorn (2013) the substantial shifts that have occurred in the composition of UK trade represent a unique experience. Indeed, the deterioration in the UK manufacturing trade balance has been much greater than in any other advanced economy as well as no other major advanced economy has enjoyed a so huge trade surplus in services. These remarks bring to the fore the debate about the decisive role of manufacturing in the paths of development and growth (Kaldor, 1966, 1975) and about the process of de-industrialisation of the UK denounced by Joseph Chamberlain at the end of the XIX century in his contributions on tariff reforms (Kamitake, 1990). The process of de-industrialisation features the economies, in which the share of manufacturing is declining, in terms of contribution to GDP, employment and export earnings, with respect to other sectors (Rowthorn and Coutts, 2004). A long debate on the reasons for the deterioration in the UK manufacturing trade balance ended with the awareness that a substantial reorientation away from manufacturing towards other activities was inevitable due to technological structural changes (Singh, 1977; Rowthorn and Wells, 1987; Rowthorn and Coutts, 2004). However, Rowthorn and Coutts (2004) warn that it is wrong to relegate manufacturing to the past thinking that it is no longer important in a modern economy. According to a more recent contribution by the same authors, this is true especially for the UK economy. Coutts and Rowthorn (2013), indeed, highlight the importance of manufacturing industry for the UK balance of payments, calling for a safeguard and an improvement of the trade performance of this sector.

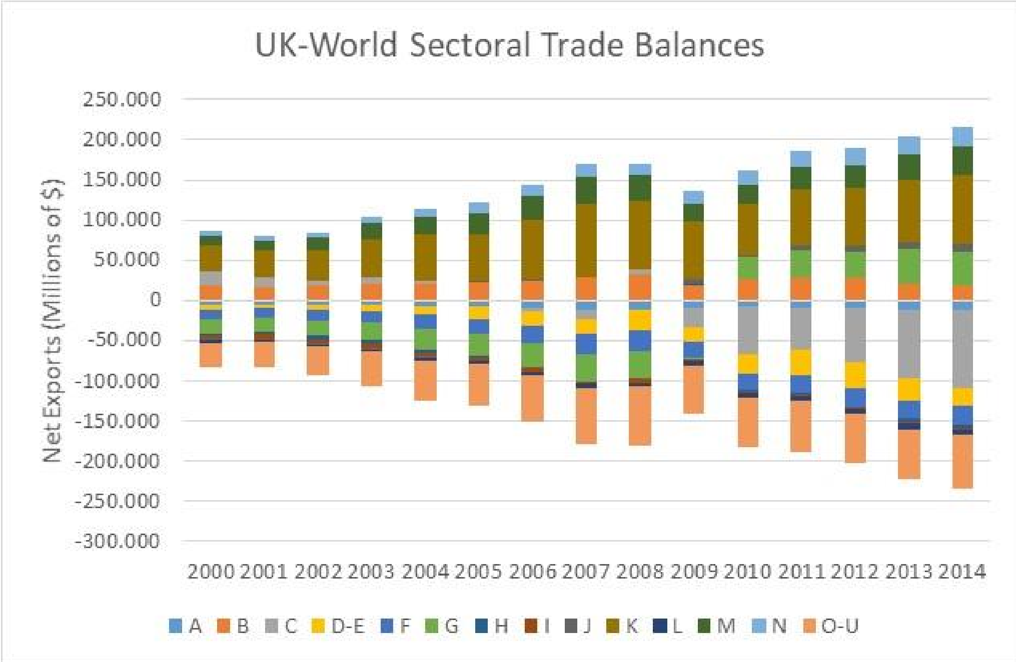


Figure 2.5. *UK sectoral trade balances between 2000 and 2014. Increasing trade deficits in manufactured goods (C), have been offset by trade surpluses in knowledge-based service sectors (K,N,M). Legend codes: A- Agriculture and Fishing, B- Mining, C- Manufacturing, D-E- Electricity, Gas and Water Supply, F- Construction, G- Wholesale Trade, H- Transportation, I- Accommodation and Food Services, J- ICT Services, K- Finance and Insurance Services, L-Real Estate activities, M- Scientific Activities, N- Administrative Services, O-U- Public and Other Services*.

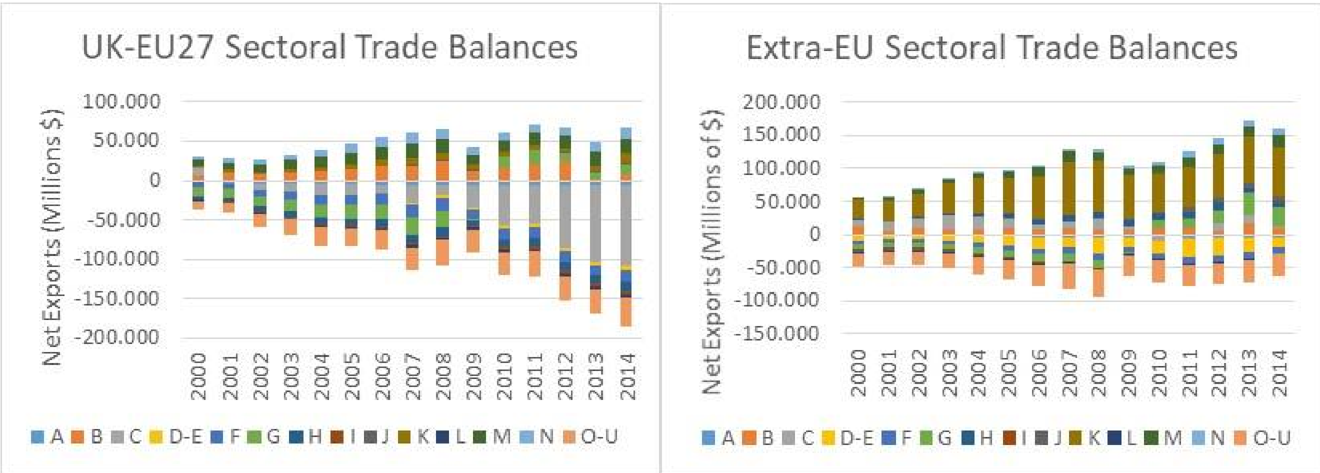


Figure 2.6. *UK sectoral trade balances between 2000 and 2014 by regions. Increasing trade deficits in European manufactured goods (C), have been partly offset by trade surpluses in knowledge-based service sectors (K,N,M) with extra-EU countries.*

Looking at the sectoral trade balances by regions, Figure 2.6 shows that the United Kingdom has accumulated a year-on-year deficit against the European manufacturing sector, which is partially compensated by a surplus in the financial sector towards non-European countries. According to Los et al. (2017) findings, these evidence suggest one of the main reasons for which UK voted to leave EU. Indeed regions that are more economically interdependent with EU markets and driven by manufacturing sectors, tended to vote leave (Becker et al., 2017 and Springford et al., 2016); regions that are the least dependent on EU markets and were perceived to have most benefited from globalisation displayed the strongest pro-remain votes (Springford et al., 2016). As known, the referendum established that the former prevailed on the latter.

2.4 Static Analysis of UK Trade

Whilst the analysis of time series is useful in understanding developments in the composition of UK trade, the main scope of the present study is to simulate the economic impact of Brexit and historical data would be helpless because cannot incorporate information about such an extraordinary event (Bush and Matthes, 2016). Thus, rather than a structural time series analysis, we prefer a comparative input-output analysis, which also allows us to consider the indirect impact of Brexit by means of global value chains. Therefore, from now on we will focus only on the last available World Input-Output Table provided by the WIOD project (Timmer et al., 2015).

In 2014, Germany and US are respectively the main source and destination country of goods and services, accounting together for 23 percent of the UK's imports and 18 percent of UK's exports (Figure 2.7). The other top source countries in the EU are France, Netherlands, Ireland, Italy, Belgium and Spain. As to the destination of UK's exports, the same countries are in the top 10 with the exception of Spain and with the addition of Luxembourg, which is one of the leading importers of UK financial services. Outside the EU, beside US, China results one of the best source and destination for UK's goods. UK imports from outside the EU come also from Norway and Switzerland. The latter, as well as Canada, represents a top destination country for UK services, especially financial, while Russia is among the main destination for UK goods.

Analysing the data further to investigate specific sectors, Figure 2.8 shows the top 10 UK import and export sectors. Whilst the most important imports principally come from the EU, a larger fraction of the top exports goes to extra EU countries. Supporting earlier discussion, the top exports are mostly service industries with Financial, Auxiliary Financial and Administrative Services make up 17 percent of the UK's total exports. Exports are driven by extra EU countries whereas, in line with what above mentioned, the most significant UK's imports are manufactured goods from the EU. The largest imports belongs to motor vehicles sector, food and beverage and transport equipment that together represent 22 percent of total imports.

In Figure 2.9 the 56 WIOD sectors are grouped into 4 main sectors: Raw material, Manufacturing, Services, Financial (plus final demand), in order to show the UK sectoral overseas trade balance in 2014. Green edges represent surplus relationship whilst red edges depict sectoral deficits. Nodes size is proportional to the amount of money that flows in and out through each sector. The network shows again that the main item of imports of final products is represented by manufacturing goods, coming mainly from Germany, China, Italy and other EU countries. The overseas manufacturing plays an important role also in terms of intermediate inputs. Indeed, the UK manufacturing sector has a trade deficit with all the other foreign manufacturing industries, with the exception of Ireland and ROW manufacturing. Other main surplus sources for the UK manufacturing sector are the US Services and ROW Services. This latter represents, actually, an important source of surplus for all the UK sectors.

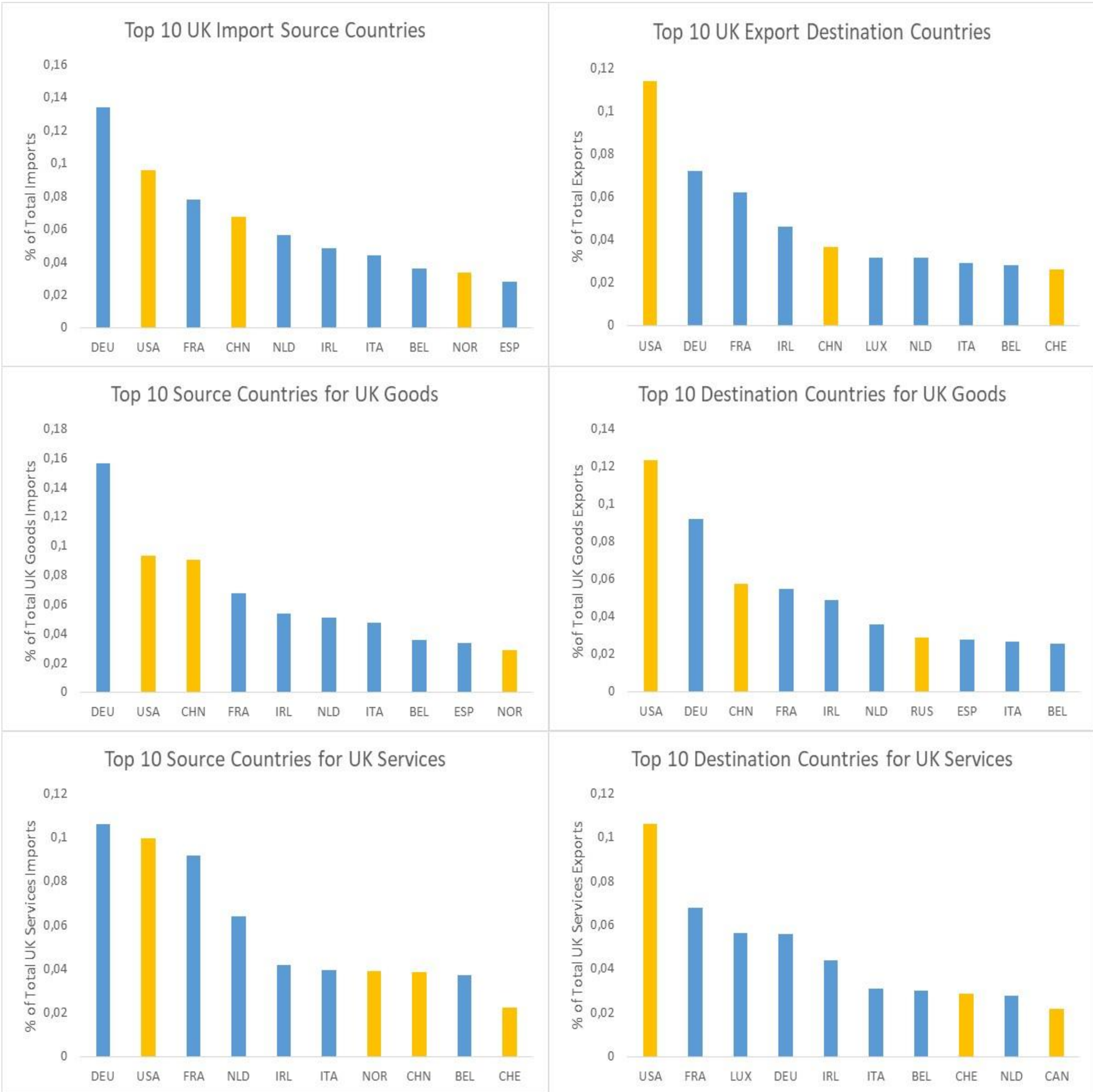


Figure 2.7. *Top 10 import and export countries in total, in goods and in services in 2014. Note: orange shows extra-EU countries. For country codes, see Table A.1.1 in Appendix 1.*

The UK Services sector shows massive trade deficits, mostly towards the manufacturing sectors in Germany, China, ROW and ROW Raw material, that are partly covered by income from ROW final demand, and ROW and US Services sectors. The strategic sector in the UK's trade relations is undoubtedly the Financial sector. The UK sectoral and final trade deficits are mainly financed by overseas investment and by the earnings from financial services. Unlike the manufacturing sector, the UK Financial sector shows a surplus with almost all the foreign industries. In particular, the UK financial services records huge surplus towards the Financial and Services ROW sectors, ROW final demand, US Services and Luxembourg Financial sector. Finally, the Raw material sector, with respect to the others, plays a much less important role in the UK trade relationships.

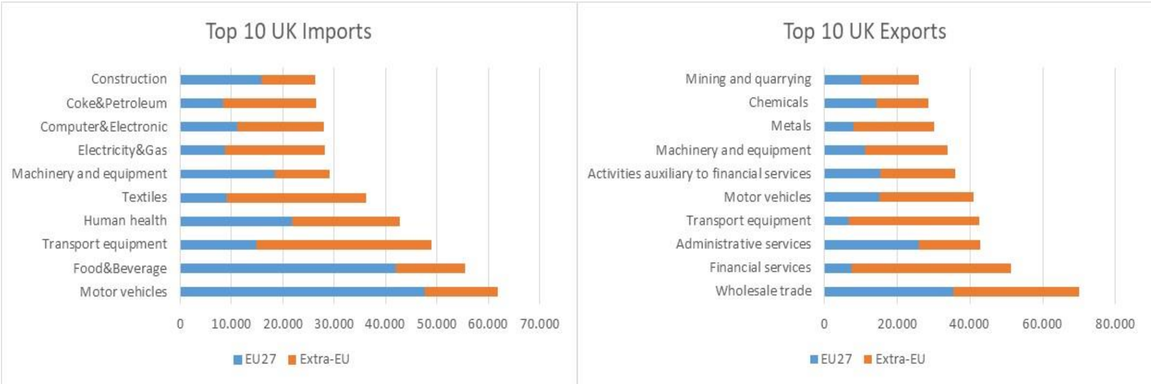


Figure 2.8. *Top 10 imports and exports by sectors in 2014.*

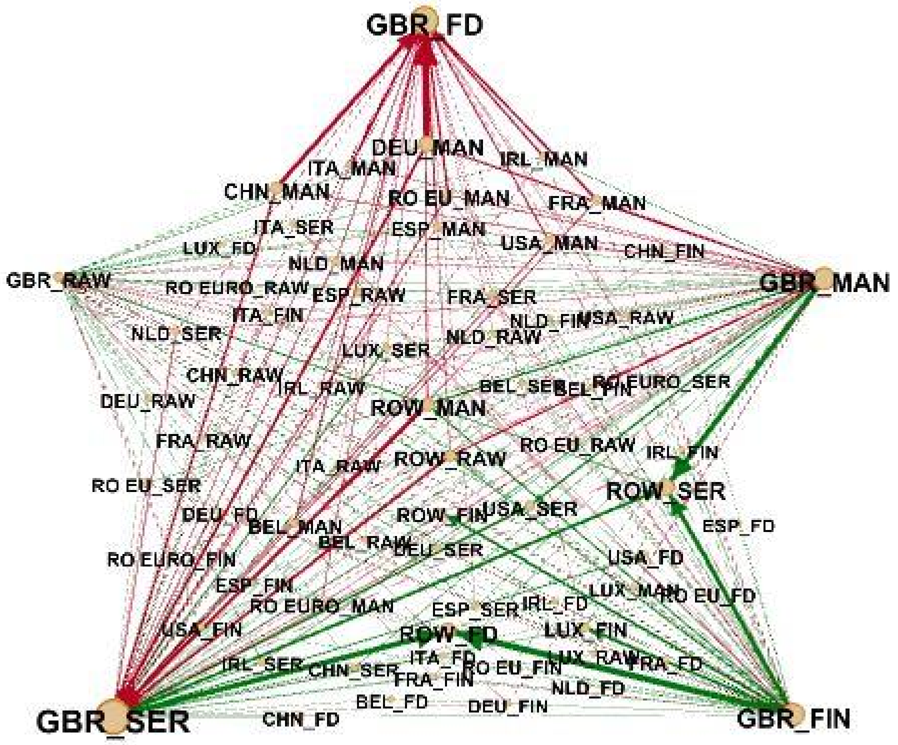


Figure 2.9. *UK trade network. Green edges represent surplus relationship whilst red edges depict sectoral deficits.*

Figure 2.9 provides a simplified version of the inter-sectoral linkages within the UK external production network and suggests that UK is involved in a complex value chains. This remark is supported by the fact that most UK trade is in intermediate inputs rather than final products: 61 percent of UK total trade is, indeed, in intermediate. In particular, 57 percent of UK total imports and 64 percent of UK total exports are intermediate inputs. Therefore, to assess the economic impact of Brexit, one can no longer ignore the relevance of the global value chains in the transmission of shocks. Hence, it is essential starting from an IO framework in order to capture the indirect links via these value chains.

Summarising, in this section we showed that the UK imports a huge amount of goods, mainly manufacturing, and partly covers these imports by exporting services, mainly financial. The primary source for goods and services imports is the EU, whilst the exports of both goods and services are destined for extra EU countries. These remarks suggest a relevant exposure for the EU countries to a scenario in which WTO tariff rules apply. If we also consider the high trade integration and interconnection between UK and EU, it would seem that there will be no Brexit winners. However, as we discuss in sections 2.5.1.4, 2.6 and 2.7, some economic policy options seem promising.

2.5 An Inter-Country-Input-Output Analysis of Brexit: Model and Methodology

In this section, the model used to quantify the impact of Brexit on value added is outlined from first principles. This is followed by a discussion of the different elements of the model: the data used; the counterfactual scenarios modelled; the potential tariffs and non-tariff barriers facing the UK post Brexit and the elasticities of sectors/countries in the model.

2.5.1 The Model

2.5.1.1 A Two Country Input-Output Example

This section will offer a basic introduction to IO tables along with an explanation of the foundations of the model in a two country, one sector setting. Overall, this will help the reader to gain an understanding of the matrix algebra involved and will eventually lead on to the next section which explains the N country, K sector model used in the analysis. The notation given in this paper follows most closely that given by Koopman et al. (2014) and Los et al. (2016)[1].

The WIOD table gives intermediate and final bilateral trade between all countries in the database: it also gives figures for value added and gross output in each country/sector. Figure 2.10 shows an IO table for a two-country world in which each country produces in a single sector. In the sector, goods can either be consumed as a final product or used as an intermediate input and both countries export intermediate and final goods to the other country. This is shown, along with the value added and gross output for each country in Figure 2.10. Observing Figure 2.10, it is clear that all gross output produced in either country is used as an intermediate good or final good, domestically or abroad.

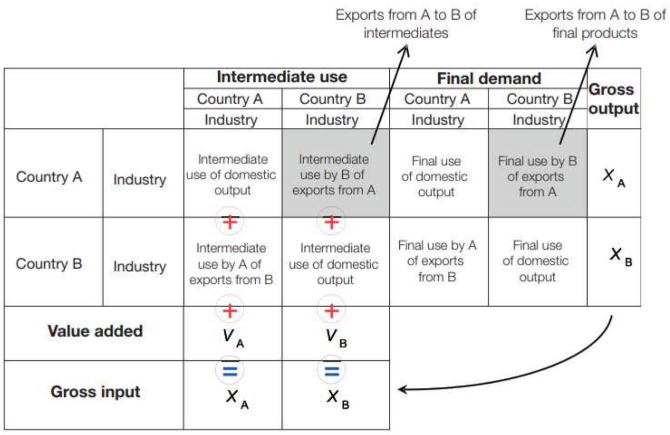


Figure 2.10. *A simple two country, one sector input-output table. Gross output for each country can be calculated by summing domestic and imported intermediate use and value added in each country or by summing total intermediate and final use in each country. Source: UNCTAD (2013).*

[1] Matrices are indicated by bold capitals, vectors by bold lowercases and scalars by italic lowercases. Diagonal matrices are indicated by a hat over the vector containing the elements on the main diagonal. Primes indicate transposition.

Therefore, country p's gross output, x_p, is given by:

$$x_p = a_{pp}x_p + a_{pq}x_q + f_{pp} + f_{pq} \qquad p, q = 1,2 \tag{2.1}$$

where f_{pq} is the quantity of country p's output consumed as a final good in country q and $a_{pq}$is the units of intermediate inputs produced in country p needed to produce one unit of the good in country q. These are the well-known IO coefficients or technology coefficients that in a multi country IO framework are not only determined by technological input but also by interregional and international trade patterns (W. Chen et al., 2018). The input coefficients can be found by divided the total intermediate use in country q of country p's product, z_{pq}, given in the intermediate section in the IO table, by the gross output of country p, that is $a_{pq} = z_{pq}/x_p$. Equation (2.1) can then be written in matrix form as:

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} f_{11} + f_{12} \\ f_{21} + f_{22} \end{bmatrix} \tag{2.2}$$

which can be summarised as:

$$\mathbf{x} = \mathbf{Ax} - \mathbf{Fi} \tag{2.3}$$

where $\mathbf{F} = \begin{bmatrix} f_{11} & f_{12} \\ f_{21} & f_{22} \end{bmatrix}$ and $\mathbf{i}$ is column vector in which all elements are 1, which when multiplied by $\mathbf{F}$ sums each of the rows in $\mathbf{F}$, as shown in the last component of equation (2.2). Rearranging equation (2.2), to make the $\mathbf{x}$ vector the subject, we have:

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} I - a_{11} & -a_{12} \\ -a_{21} & I - a_{22} \end{bmatrix}^{-1} \begin{bmatrix} f_{11} + f_{12} \\ f_{21} + f_{22} \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} f_{11} + f_{12} \\ f_{21} + f_{22} \end{bmatrix} \tag{2.4}$$

or, more simply:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{Fi} = \mathbf{LFi} \tag{2.5}$$

where $\mathbf{L}$ is known as the (global) Leontief inverse matrix. Each element of $\mathbf{L}$, l_{pq}, is a Leontief coefficient and gives the amount of country p's output required to produce one more unit of the final good in country q.

In order to relate equation (2.5) to the value-added and GDP of each country, the figures of value-added for each country (as given in the last row of Figure 2.10) are used. The fraction of gross output that represents domestic value-added in country 1, given as $v_1$is the value-added of country 1, w_1, divided by country 1's total gross output, that is, $v_1 = w_1/x_1$. These are called the value-added coefficients. For ease of future calculation, the value-added coefficient matrix, $\widehat{\mathbf{V}}$, is formed by putting the value-added coefficients on the diagonal elements of the matrix and zeros on the off-diagonals. Therefore:

$$\widehat{\mathbf{V}} = \begin{bmatrix} v_1 & 0 \\ 0 & v_2 \end{bmatrix} \tag{2.6}$$

In this two country, one sector model, a country's GDP is, by definition, the total domestic value-added within its gross output which is the total amount paid to all factors of production in each country. We therefore have that, utilising the result of equation (2.4), each country's GDP is given by:

$$\begin{bmatrix} GDP_1 \\ GDP_2 \end{bmatrix} = \begin{bmatrix} v_1 & 0 \\ 0 & v_2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} v_1 & 0 \\ 0 & v_2 \end{bmatrix} \begin{bmatrix} I - a_{11} & -a_{12} \\ -a_{21} & I - a_{22} \end{bmatrix}^{-1} \begin{bmatrix} f_{11} + f_{12} \\ f_{21} + f_{22} \end{bmatrix} = \begin{bmatrix} v_1 & 0 \\ 0 & v_2 \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} f_1 \\ f_2 \end{bmatrix} \tag{2.7}$$

which can be summarised as:

$$GDP = \widehat{\mathbf{V}}\mathbf{x} = \widehat{\mathbf{V}}(\mathbf{I} - \mathbf{A})^{-\mathbf{1}}\mathbf{Fi} = \widehat{\mathbf{V}}\mathbf{LFi} \tag{2.8}$$

This is the equation used to calculate the static GDP using the N country, K sector model which will be explained in detail in the next section.

2.5.1.2 The N Country, K Sector Model

When there are multiple sectors and countries, rather than the simple IO table presented in Figure 2.10, the IO table now has the structure shown in Figure 2.11. This is a large, complex matrix comprised of individual bilateral matrices that show each country's sectoral trade with each of the other $N - 1$ countries in the database.

Now each matrix described in the previous example becomes larger and more complex. Using block matrix notation to show bilateral matrices/vectors, we now have that $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-\mathbf{1}}\mathbf{Fi}$ from equation (2.5) is given by:

$$\begin{bmatrix} \mathbf{x_1} \\ \mathbf{x_2} \\ \vdots \\ \mathbf{x_N} \end{bmatrix} = \begin{bmatrix} \mathbf{I} - \mathbf{A_{11}} & -\mathbf{A_{12}} & \dots & -\mathbf{A_{1N}} \\ -\mathbf{A_{21}} & \mathbf{I} - \mathbf{A_{22}} & \dots & -\mathbf{A_{2N}} \\ \vdots & \vdots & \ddots & \vdots \\ -\mathbf{A_{N1}} & -\mathbf{A_{N2}} & \dots & \mathbf{I} - \mathbf{A_{NN}} \end{bmatrix}^{-1} \begin{bmatrix} \sum_{\mathbf{q}}^{\mathbf{N}} \mathbf{F_{1q}} \\ \sum_{\mathbf{q}}^{\mathbf{N}} \mathbf{F_{2q}} \\ \vdots \\ \sum_{\mathbf{q}}^{\mathbf{N}} \mathbf{F_{Nq}} \end{bmatrix} \tag{2.9}$$

With N countries and K sectors. Where $\mathbf{x}_p$ is country p's $K \times 1$ output vector which shows gross output in each of the K sectors in country p, $\mathbf{A}_{pq}$is the $K \times K$ bilateral coefficient matrix that shows the IO coefficients for the K sectors that country p exports to country q and $\mathbf{F}_{pq}$ is the $K \times 1$ vector that shows final goods produced in p and consumed in q. Overall, equation (2.9) can be summarised, again as in equation (2.5).

Similarly, we can extend the value-added coefficient matrix given in equation (2.6) in the two-country example, to calculate the static GDP of the K sectors in the N countries which is given again by the equation (2.8), with the difference that now the coefficient matrix $\mathbf{A}$ and the final demand matrix $\mathbf{F}$, are partitioned matrices.

$$GDP_O = \widehat{\mathbf{V}}(\mathbf{I} - \mathbf{A})^{-\mathbf{1}}\mathbf{Fi} \tag{2.10}$$

			Use by country-sectors							Final Use by countries			Total Use
			Country 1			…	Country N			Country 1	…	Country N	
			Sector 1	…	Sector K	…	Sector 1	…	Sector K		…		
Supply from country-sectors	Country 1	Sector 1											
		…											
		Sector K											
	…												
	Country N	Sector 1											
		…											
		Sector K											
Value Added													
Gross Output													

Figure 2.11. *An N country K sector IO table. Similar to Figure 2.10, the gross output of each sector in each country can be found by summing the values in each row or column. Source: Timmer et al. (2015).*

where GDP_O is the $NK \times 1$ vector showing the GDP of each of the K sectors in the N countries. We start from equation (2.10) to calculate the post-Brexit GDP_1 for each of the 56 sectors in each of the countries in our dataset. In order to assess the economic impact of Brexit a method called partial extraction is used, which is described in the next section.

2.5.1.3 The Partial Extraction Method in the Case of a Trade Shock

Building on Los et al. (2016) work, W. Chen et al. (2018) employ the hypothetical extraction method in order to estimate the share of GDP exposed to Brexit for EU regions. In the traditional IO literature, the objective of the hypothetical extraction approach is to quantify how much the total output of an n-sector economy would be affected by the removal of a particular j sector from that economy (further details in Miller, 1966; Miller and Lahr, 2001 and Miller and Blair, 2009). Dietzenbacher et al. (1993), instead of extract one sector from a sector-based model, consider the effects of hypothetically extracting a region from a many-region model. Similarly, W. Chen et al. (2018) hypothetically extract the trade between UK and EU regions. In their paper, the authors set certain elements of the coefficient **A** matrix and the final demand **F** matrix to zero to create a hypothetical world in which region *(p)* does not export anything to region *(q),* while leaving the rest of the economic structure of the world unaffected. That is, they set the coefficients that represent exports from region p to region q to zero. Using the modified matrices, denoted $\mathbf{A}^{\#}$ and $\mathbf{F}^{\#}$, they calculate the new hypothetical GDP given as:

$$GDP^{\#} = \hat{\mathbf{V}}(\mathbf{I} - \mathbf{A}^{\#})^{-1}\mathbf{F}^{\#}\mathbf{i} \qquad (2.11)$$

The authors then calculate the effect of the hypothetical trade change in the **A** and **F** matrices on GDP, using equations (2.10) and (2.11) they calculate:

$$DVA^{\#} = GDP_O - GDP^{\#} \qquad (2.12)$$

This gives the change in value-added as a result of the hypothetical reduction in exports. In this paper, we build on the extraction method employed in Los et al. (2016) and W. Chen et al. (2018), adopting the so-called partial extraction method introduced by Dietzenbacher and Lahr (2013). In their explanation of the partial extraction method, Dietzenbacher and Lahr (2013) assume that an establishment of an industry, consisting of a number of identical establishments, ceases to exist so that the industry capacity reduces. In this case, a total extraction (nullification) will not occur, simply the intermediate and final deliveries sold by this industry, decrease by a percentage $\alpha \cdot 100\%$. Hence, the new coefficient will be equal to $a_{kj}^{*} = z_{kj}^{*}/x_j = (1-\alpha)z_{kj}^{*}/x_j = (1-\alpha)a_{kj}$ and the new final demand will be equal to $f_k^{*} = (1-\alpha)f_k$[2]. Similarly, in this study, rather than setting elements of the **A** and **F** matrices equal to zero (as in W. Chen et al. 2018), an import demand function is used to predict how import demand between the UK and the EU will change post-Brexit. This change is then applied to elements of the **A** and **F** matrices to calculate the new GDP post-Brexit. This is explained in detail below.

Let us consider a simple import demand function (Thirlwall, 1979) for a specific commodity in a specific country:

$$M_i = \left(\frac{eP_{Fi}}{P_i}\right)^{\varepsilon_{Di}} Y_D \eta_{Di} \tag{2.13}$$

where M_i is the domestic import demand for commodity i, e is the exchange rate, P_{Fi} is the foreign price for commodity i, P_i is the domestic price of commodity i, ε_{Di} <0 is the domestic relative price elasticity of commodity i, $Y_D$is domestic income and η_{Di}>0 is the income elasticity of demand for imports of commodity i. This suggests that the volume of imports of commodity i demanded is a combination of these variables. In order to find the change in demand over time, the natural logarithms of equation (2.13) are taken and the equation is differentiated with respect to time:

$$\dot{M_i} = \varepsilon_{Di}(\dot{e} + \dot{P_{Fi}} - \dot{P_i}) + \eta_{Di}\dot{Y}_D \tag{2.14}$$

where $\dot{x} = \frac{\partial lnx}{\partial t}$. Assuming that e, P_i and Y_D are fixed, import demand is given solely by the relative price elasticity, ε_{Di} and the foreign price for commodity i, P_{Fi}:

$$\dot{M_i} = \varepsilon_{Di}\dot{P_{Fi}} \tag{2.15}$$

Following on from the assumption that P_i is fixed, we also assume that the only channel by which the foreign price of commodity i can change is through the introduction of new post-Brexit tariffs (or an increase in NTBs) on the commodity. Therefore, the change in import demand between the UK and the EU is simply given by:

$$\dot{M_i} = \varepsilon_{Di}\tau_i \tag{2.16}$$

Where τ_i is the post-Brexit EU tariffs (plus NTBs) on sector i and $\varepsilon_{Di}$is the import elasticity of sector i in the domestic country. Since elasticities are always negative, any increase in tariffs results in a reduction of import demand. Since the WIOD only gives data on sectors not specific commodities, equation (2.16) is the change in demand for all the products of a specific sector i, in a particular country (given as D).

[2] In their model 3 Alatriste-Contreras and Fagiolo (2014) present a similar approach to explain the propagation of economic shocks in Input-Output networks.

We assume that both intermediate and final import demands for goods and services respond negatively to foreign price increases. Equation (2.16) is then split in two reduced equations. The intermediate (17) and final (18) import demand functions:

$$\dot{im_i} = \varepsilon_{Di}\tau_i \tag{2.17}$$

$$\dot{fm_i} = \varepsilon_{Di}\tau_i \tag{2.18}$$

which are then used to alter elements of the **A** and **F** matrices to take into account the tariffs and NTBs post-Brexit.

The elements of the matrices that are altered are any elements which involve interaction between the UK and the EU. To aid understanding, consider a three country, one sector IO model, the three countries/regions being the UK (G), EU (E) and ROW (R). The **A** and **F** matrices for this model will be given as:

$$\mathbf{A} = \begin{bmatrix} a_{GG} & a_{GE} & a_{GR} \\ a_{EG} & a_{EE} & a_{ER} \\ a_{RG} & a_{RE} & a_{RR} \end{bmatrix} \qquad \mathbf{F} = \begin{bmatrix} f_{GG} & f_{GE} & f_{GR} \\ f_{EG} & f_{EE} & f_{ER} \\ f_{RG} & f_{RE} & f_{RR} \end{bmatrix} \tag{2.19}$$

where a_{pq} gives the units of intermediate goods produced in country p needed to produce one unit of the good in country q, or alternatively, the import demand in country q for intermediate goods produced in country p. Similarly, f_{pq} is the quantity of final products produced in country p demanded in country q, or the import demand in country q for final products produced in country p. So, in this three-country example, the elements that involve interaction between the UK and the EU will be affected by tariffs post Brexit, namely, the elements a_{GE}, a_{GU}, f_{GE} and f_{EG}. Using equations (2.17) and (18) we know that import demand for UK products in the EU and EU products in the UK will change by the trade elasticity of demand in the respective country-sector, ε_{Di} multiplied by the new sectoral tariffs in each country τ_i, given by $\dot{im_i}$ and $\dot{fm_i}$. Since there is only one sector in each country, the modified **A** and **F** matrices are then:

$$\mathbf{A}^* = \begin{bmatrix} a_{GG} & \boldsymbol{a_{GE}}^* & a_{GR} \\ \boldsymbol{a_{EG}}^* & a_{EE} & a_{ER} \\ a_{RG} & a_{RE} & a_{RR} \end{bmatrix} \qquad \mathbf{F}^* = \begin{bmatrix} f_{GG} & \boldsymbol{f_{GE}}^* & f_{GR} \\ \boldsymbol{f_{EG}}^* & f_{EE} & f_{ER} \\ f_{RG} & f_{RE} & f_{RR} \end{bmatrix} \tag{2.20}$$

where ${a_{pq}}^* = a_{pq} + \dot{im_p}$ and ${f_{pq}}^* = f_{pq} + \dot{fm_p}$.

This method can then be extended to the $NK \times NK$ coefficient matrix **A** and $NK \times N$ final demand matrix **F** used in our 56 sector 18 country model, which are shown in equation (2.9). Using these matrices those elements that show interaction between UK and EU countries are extracted and adjusted as in the previous 3 country example, according to equations (2.17) and (2.18). The modified **A** and **F** matrices are then employed to calculate the new post-Brexit GDP for each sector in each country:

$$GDP^* = \hat{\mathbf{V}}(\mathbf{I} - \mathbf{A}^*)^{-\mathbf{1}}\mathbf{F}^*\mathbf{i} \tag{2.21}$$

where GDP^* is the $NK \times 1$ vector showing the post-Brexit GDP of each sector in each country and the other elements are defined in equations (2.9) and (2.11). Following Los et al. (2016), and using the original GDP given in equation (2.10), the change in value-added as a result of Brexit can be calculated as:

$$DVA^* = GDP_O - GDP^* \tag{2.22}$$

Where DVA is the $NK \times 1$ vector with each element showing the change in value-added as a result of Brexit in all K sectors in all N countries. Considering that this difference is negative by construction, we define DVA^* as the absolute loss in value-added (LiVA) and the percentage change $(GDP_O - GDP^*)/GDP_O$ as the relative LiVA.

2.5.1.4 Hypothetical Expansion in the Case of Domestic Import Substitution and Trade Diversion

Following the literature, our first model interprets Brexit as a trade shock. The theoretical framework of a trade shock model, predicts that an increase in import tariffs will result in production losses all along the supply chain (Dhingra et al., 2017; Vandenbussche et al., 2017; Noguera, 2012). Specifically, the increase in prices due to the introduction of tariffs and non-tariff barriers between the UK and EU would translates in a collapse of respective exports (Baldwin, 2016). With these premises, many Brexit studies, have predict a deep drop of UK's exports to EU and a relative crash of GDP. These predictions, however, depend largely on two key convictions. The first is that the economic performance of the UK improved appreciably after joining the EU (Crafts, 2016; Kierzenkowski et al., 2016). Therefore, leaving the EU would be risky and costly for the UK. However, in a recent study, Gudgin et al. (2017a) question this claim, showing that there is no clear evidence that joining the EU improved the rate of economic growth in the UK. Furthermore, the authors show that the impact of EU membership on the level of exports to the EU is much smaller for the UK than for other EU members. The implication would be that the EU membership has fostered the growth of the UK trade deficit with Europe. This trend has led to widespread calls for rebalancing the economy (Coutts and Rowthorn, 2013), and helped to spread a feeling of intolerance towards Europe, which resulted in the victory for the Leave campaign (Los et al., 2017). Indeed, a number of empirical papers show that the support for the Leave option in the Brexit referendum can be labelled as a rejection of globalisation (Rodrik, 2018a; Colantone and Stanig, 2018).

These findings bring us to the second belief behind the results of standard trade shock models. As we mentioned the underlying claim of these models is that trade liberalisation increases welfare. Therefore, any free trade restriction would generate a welfare loss. On the other hand, as well explained by Rodrik (2018a) trade liberalisation generically produces losers and the simple economics of globalisation is bound to intensify inequality of income because it often leads to increased market failures. Indeed, ‘compensation’ cannot credibly address the longer-term erosion of distributional bargains entailed in trade agreements and financial globalisation. Therefore, trade liberalisation is not necessarily auspicious; rather, under circumstances of weak domestic growth trade protectionism policies would be preferable (Rodrik, 2018b, 2018c). The debate about free trade or protection is controversial and unsolved, but this is not the place to deepen the topic. What is noteworthy is that these last remarks question the usual conclusion of standard trade models, according to which Brexit surely will result in great losses for the UK. Thus, one would wonder: are there any political alternatives that would allow the UK to take advantage of Brexit?

In line with Rodrik observations, one can consider Brexit as a special case in which a country implements a protectionist trade policy in order to rebalance the external accounts and boost domestic growth. Indeed, sooner or later a country whose balance of payments is habitually adverse will have to get its spending in balance with its income (Stone 1970). This means that it will have to export more in relation to its imports. However rather than trade policies, the typical intervention to balance a country's external accounts is currency devaluation. This is also the case for the UK which has manipulated the real exchange rates in order to boost exports, curb imports and counter the current recession (Gagnon, 2013; Joyce et al. 2011). Nevertheless, the UK external deficit persists and the domestic economy has not improved significantly. One reason behind the ineffectiveness of pound depreciation is that the price elasticity of demand for UK exports is low. Thus, as pointed out by Aiello et al. (2015), the level of UK exports appears to be unrelated to the real exchange rate for the UK.

According to Skidelsky (2016) in such circumstances, the solution would be the substitution of goods currently imported with domestically produced goods. Indeed, as Godley and May (1977) find, the economic gain brought about by import restrictions is extremely large compared with a policy of devaluation, particularly in the short run. The trade and economic scheme, which advocates replacing foreign imports with domestic production, is known as import substitution. This policy has been the object of a long and popular debate among economists in the late 20th century, and especially in the UK (see Bruton, 1998; Norman, 1996 and Cripps and Godley, 1976, for further insight). The rest of this section aims to give a simplified exposition of the implications of this alternative trade strategy within an Inter-Country-Input-Output framework.

To the best of our knowledge, so far the analysis of import (and export) substitution in IO schemes has occurred, substantially, considering a national economy, more than in multi-regional or multi-country schemes. Furthermore, this literature has been mainly focused on measuring the trend of import substitution starting from structural accounting exercises, rather than hypothesizing changes in the structure and assessing its consequences through scenarios (Desai, 1969; Balassa, 1979). One exception is provided by Richard Stone (1970) that proposes a model in which a change in the coefficient matrix ($\mathbf{A}$) is assumed in the face of a substitution of imported intermediate inputs for households and recalculates the aggregate consistency of the whole IO system (solving the problems linked to changes in value added, etc.). However, here we refer again to Dietzenbacher and Lahr (2013) as benchmark. In their last section, the authors briefly explain that the partial extraction method works equally well in cases where coefficients increase in magnitude (or where some increase while others decrease). Such a manipulation is labelled as hypothetical expansion and provides that the new coefficient will be equal to $a_{kj}^* = z_{kj}^*/x_j = (1+\alpha)z_{kj}^*/x_j = (1+\alpha)a_{kj}$ and the new final demand will be equal to $f_k^* = (1+\alpha)f_k$.

Building on the intuition of Dietzenbacher and Lahr (2013), in our second Brexit model we consider the case in which the UK substitutes imports from EU with domestically or extra-EU produced products. At the same time, we also allow EU countries to substitute imports from UK with products from other EU countries. Hence, in a post-Brexit world, we take into account that both regions, the UK and EU may divert their trade. Indeed, under Brexit, the only tariffs that are likely to be imposed are on products traded between the UK and EU. This means that the tariffs the UK imposes on its extra-EU trade partners will not change. Hence, as pointed out by Dhingra et al. (2017) and Vandenbussche et al. (2017), the extra-EU goods will become relatively less expensive for the UK as well as the EU goods will become relatively less expensive among EU countries. The reason is that Brexit actually decreases the relative UK-extra-EU and EU-EU trade costs compared to UK-EU trade costs. Therefore, some trade will be diverted from the UK-EU channel to UK-extra-EU and EU-EU. The model can be summarised as follow. We assume that firms would leave fixed the amount of intermediate inputs and unaltered the production lines. Equally, the final consumption is left fixed. Hence, let us consider a column of the coefficient matrix $\mathbf{A}$, with intermediate deliveries. For example, car production in Germany. It needs many inputs one of them is steel. We keep to total input of steel fixed. Then we replace some of the inputs of UK steel by steel from other EU countries. The same is done for the final demands of Germany. We leave the final consumption unchanged, assuming, for example, that German consumers buying less UK clothes and more clothing from other EU countries. Of course, we handle the production processes in the UK in a similar way, replacing French inputs (or final products) by UK, US, China and ROW inputs (or final products). The assumption that only the UK will substitute some imports with domestic products is based on two main reasons. First, in line with the trade shock model we assume that UK exports to 27 countries will be reduced and this will bring about the formation of excess inventory. Second, leaving the EU, the UK would be able to implement a policy that favours the consumption of some of these inventories. In contrast, the reduction of exports for EU countries is not prominent as in the UK. Furthermore, European treaties do not allow the protection of domestic goods, but rather encourage the free movement of goods. Hence summarising, in the UK: domestic, US, China and ROW intermediate and final products, will replace some imports from EU. On the other side of the Channel, EU countries will replace some UK inputs and final products with intra-EU purchases. How do these substitutions take place? We assume that input and final consumption source shares remain constant after Brexit. For example, let us consider only intermediate deliveries. Suppose that the reduction of European steel in the UK car production process is \$150. Looking at the coefficient matrix, we calculate the amount of steel used in the car production process in the UK, coming from the UK, US, China and ROW. Suppose that the UK car sector employs 30% of UK steel, 15% of US steel, 35% of Chinese steel and 20% of steel from ROW. Thus, we imagine that European steel will be replaced in UK by \$45 of UK steel, \$22.5 of US steel, \$52.5 of Chinese steel and \$30 of steel from ROW. On the other hand, suppose that the reduction of UK steel in Germany car production process is \$30. Looking at the coefficient matrix, we calculate the amount of steel used in the car production process in Germany, coming from all the EU countries. Suppose that German car sector employs 30% of Spanish steel, 15% of Belgian steel, 10% of Italian steel, 5% of French steel, 10% of Portuguese steel, 10% of Irish steel, and 20% from Poland. Thus, we suppose that UK steel will substitute in Germany by \$9 of Spanish steel, \$4.5 of Belgian steel, \$3 of Italian steel, \$1.5 of French steel, \$3 of Portuguese steel, \$3 of Irish steel and \$6 of steel from Poland.

The aforementioned example can be formalised as follows. Adding another EU country (U) to the three-country one sector model in equations (2.19) and (2.20), let us suppose that the modified **A** and **F** matrices, which take into account the effect of Brexit are given as:

$$\mathbf{A}^* = \begin{bmatrix} a_{GG} & \boldsymbol{a_{GE}}^- & \boldsymbol{a_{GU}}^- & a_{GR} \\ \boldsymbol{a_{EG}}^- & a_{EE} & a_{EU} & a_{ER} \\ \boldsymbol{a_{UG}}^- & a_{UE} & a_{UU} & a_{UR} \\ a_{RG} & a_{RE} & a_{RU} & a_{RR} \end{bmatrix} \qquad \mathbf{F}^* = \begin{bmatrix} f_{GG} & \boldsymbol{f_{GE}}^- & \boldsymbol{f_{GU}}^- & f_{GR} \\ \boldsymbol{f_{EG}}^- & f_{EE} & f_{EU} & f_{ER} \\ \boldsymbol{f_{UG}}^- & f_{UE} & f_{UU} & f_{UR} \\ f_{RG} & f_{RE} & f_{RU} & f_{RR} \end{bmatrix} \tag{2.23}$$

where $a_{pq}{}^* = a_{pq} + i\dot{m}_p$, $f_{pq}{}^* = f_{pq} + f\dot{m}_p$ and the negative superscripts mean partially extractions. Focusing on the UK, the country-sector substitution coefficient for intermediate and final goods will be equal respectively to:

$$is_{GG} = -\frac{a_{GG}(i\dot{m}_{EG} + i\dot{m}_{UG})}{a_{GG} + a_{RG}} \tag{2.24}$$

$$fs_{GG} = -\frac{f_{GG}(f\dot{m}_{EG} + f\dot{m}_{UG})}{f_{GG} + f_{RG}} \qquad (2.25)$$

Therefore, the new coefficient a^*_{GG} will be equal to $a_{GG} + is_{GG}$ and the new final demand f^*_{GG} will be equal to $f_{GG} + fs_{GG}$. Adding all the hypothetical expansions to the **A*** and **F*** matrices we finally get:

$$\mathbf{A}^s = \begin{bmatrix} \boldsymbol{a_{GG}}^+ & \boldsymbol{a_{GE}}^- & \boldsymbol{a_{GU}}^- & a_{GR} \\ \boldsymbol{a_{EG}}^- & a_{EE} & \boldsymbol{a_{EU}}^+ & a_{ER} \\ \boldsymbol{a_{UG}}^- & \boldsymbol{a_{UE}}^+ & a_{UU} & a_{UR} \\ \boldsymbol{a_{RG}}^+ & a_{RE} & a_{RU} & a_{RR} \end{bmatrix} \qquad \mathbf{F}^s = \begin{bmatrix} \boldsymbol{f_{GG}}^+ & \boldsymbol{f_{GE}}^- & \boldsymbol{f_{GU}}^- & f_{GR} \\ \boldsymbol{f_{EG}}^- & f_{EE} & \boldsymbol{f_{EU}}^+ & f_{ER} \\ \boldsymbol{f_{UG}}^- & \boldsymbol{f_{UE}}^+ & f_{UU} & f_{UR} \\ \boldsymbol{f_{RG}}^+ & f_{RE} & f_{RU} & f_{RR} \end{bmatrix} \qquad (2.26)$$

The column sums of these new matrices are equal to the column sums of the pre-Brexit **A** and **F** matrices, which means that the change in import demand in the UK for EU products is replaced by the same amount, with products from UK and ROW industries. Similarly, the change in import demand in the EU countries for UK products is replaced by the same amount, with products from other EU countries. The four-country one sector model can be extended to the $NK \times NK$ matrices used in the analysis as given in equation (2.9). Using these new matrices, it is then possible to calculate the new GDP as a result of import substitution and trade diversion policies:

$$GDP^s = = \hat{\mathbf{V}}(\mathbf{I} - \mathbf{A^s})^{-1}\mathbf{F^s i} \qquad (2.27)$$

This can then be used to find the country-sector absolute loss in value-added:

$$LiVA^s = GDP_O - GDP^s \qquad (2.28)$$

and the relative LiVA as the fraction $LiVA^s/GDP_O$.

2.5.2 Methodology

2.5.2.1 Data

The data used is the WIOD database, which is described in detail in the previous section. This database provides information on bilateral trade and global value chains of 44 countries, including one rest of the world (ROW) estimate. Values are given for 56 goods and services sectors with the most recent year being 2014. For our analysis, the database remained at the 56-sector level but was condensed into 18 countries/regions, for details of these and WIOD country codes see Table A.1.1 in the Appendix 1.

2.5.2.2 Counterfactual Scenarios

As outlined previously, this paper considers two counterfactual scenarios, a soft and a hard Brexit as outlined in Dhingra (2017). In the soft Brexit scenario, the UK remains in the single market and therefore there are no tariffs on goods traded between the UK and the EU. In the hard Brexit scenario, the UK does not establish a trade deal with the EU, leaves the single market and the UK and the EU trade under WTO terms, each applying MFN tariffs. These are the tariffs that WTO members must apply when trading with other WTO members (with whom they do not have some form of preferential trade arrangement). Like Dhingra et al. (2017), it is assumed that the UK applies the same MFN tariffs as the EU post-Brexit.

2.5.2.3 Tariffs

This section offers a detailed analysis of any tariff changes that the UK and EU could face post-Brexit. In particular, in the hard Brexit scenario, in which the UK will be forced to trade with the EU according to MFN tariffs. To find the MFN tariffs imposed by the EU, EU tariff data was downloaded from the WTO Integrated Database (IDB). Individual product tariffs were then aggregated into sectors according to the Reference and Management of Nomenclatures (RAMON) classification, this allowed for the conversion of six-digit product codes (given in the WTO data) from the Harmonized Commodity Description and Coding System (HS 2007) to the Statistical Classification of Products by Activity in the European Economic Community (CPA 2008) system whose product codes' first two digits correspond to the WIOD sectoral classification.

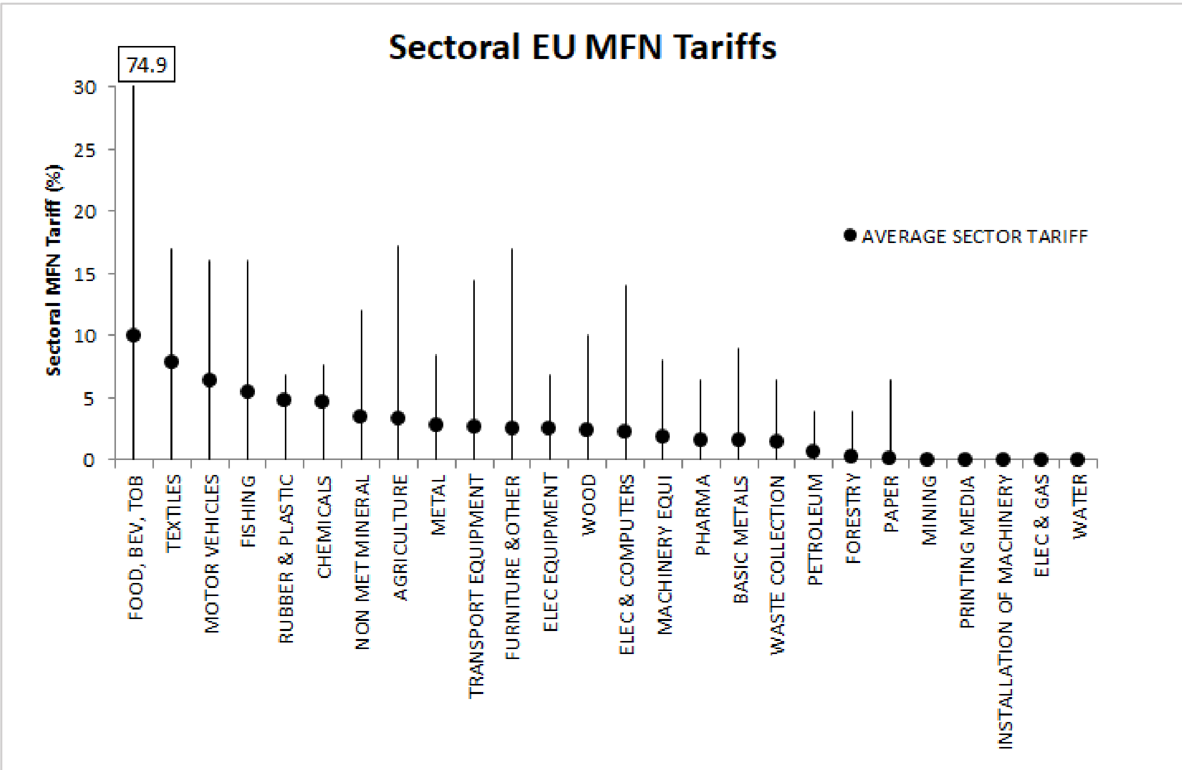


Figure 2.12. *EU MFN Tariffs facing the UK in hard Brexit scenario. Note: The upper and lower bounds correspond to the lowest and highest tariff values in each sector. Dots show the unweighted average tariff in each sector, which will be used in the analysis.*

Figure 2.12 summarises the EU sectoral tariffs. Due to downward pressure on tariffs across the WTO in the past 20 years, EU tariffs are relatively low for many sectors although remain high for some. Food, Beverage and Tobacco faces the highest tariffs, with an average sector tariff of 10% and a maximum sector tariff of 74.9% for the import of Tobacco. Agriculture and Fishing also faces high tariffs, particularly for the trade of animal and dairy products. Other sectors facing high tariffs are Textiles and Motor Vehicles with average tariff rates of 8.2 and 6.4, respectively. Earlier analysis in section 4 of this paper (Figure 2.8) showed that Food, Beverage and Tobacco, Textiles and Motor Vehicles were amongst the UK's most imported sectors from the EU. This suggests that those sectors that the UK relies most heavily on for EU imports will also face the highest tariffs.

2.5.2.4 Non-Tariff barriers

In all scenarios, there will be an increase in non-tariff barriers (NTBs) given a more distant relationship with the EU, post-Brexit. We use the NTBs given by Dhingra (2017) in our analysis. The authors use estimates of tariff equivalents of NTBs, given by Berden et al. (2009) between the US and the EU. Since it is unlikely that the UK will face the same barriers than the US, in the optimistic scenario the UK face 1/4 of the non-tariff barriers faced by the US, whilst in the pessimistic scenario, the UK will face 3/4 of the non-tariff barriers. In the hard Brexit scenario, these non-tariff barriers are summed with the tariffs as outlined in the previous section to provide τ_i , the expected change in the price of trade, in equations (2.17) and (2.18). In the soft Brexit scenario, the only increase in trade costs are the NTBs, therefore, τ_i represents the increase in NTBs. This information is summarised below in Figure 2.13.

	Soft Brexit	Hard Brexit
	0%	MFN tariff
	2.77%	8.31%

Figure 2.13. *Summary of tariffs and NTBs in soft and hard Brexit scenarios.*

2.5.2.5 Elasticity

Tariffs increase the prices of goods and services crossing borders, as a result, the demand for these goods and services can change. The responsiveness of import and export demand to changes in the price of trade are known as trade elasticities. Imbs and Mejean (2017) provide a comprehensive list of sector/country specific trade elasticities for 28 developed and developing countries, showing that trade elasticities vary greatly across different countries and sectors. Hence, it is important to include heterogenous elasticities in the analysis. They do not provide elasticities for all the sectors/countries in our database. Therefore, following Vandenbussche et al. (2017) for sectors of which no elasticity value is provided, an elasticity of -4 is used, which is a lower end estimate of the trade elasticity. These are the trade elasticities used to provide value ε_{Di} in equations (2.17) and (2.18).

2.6 Results

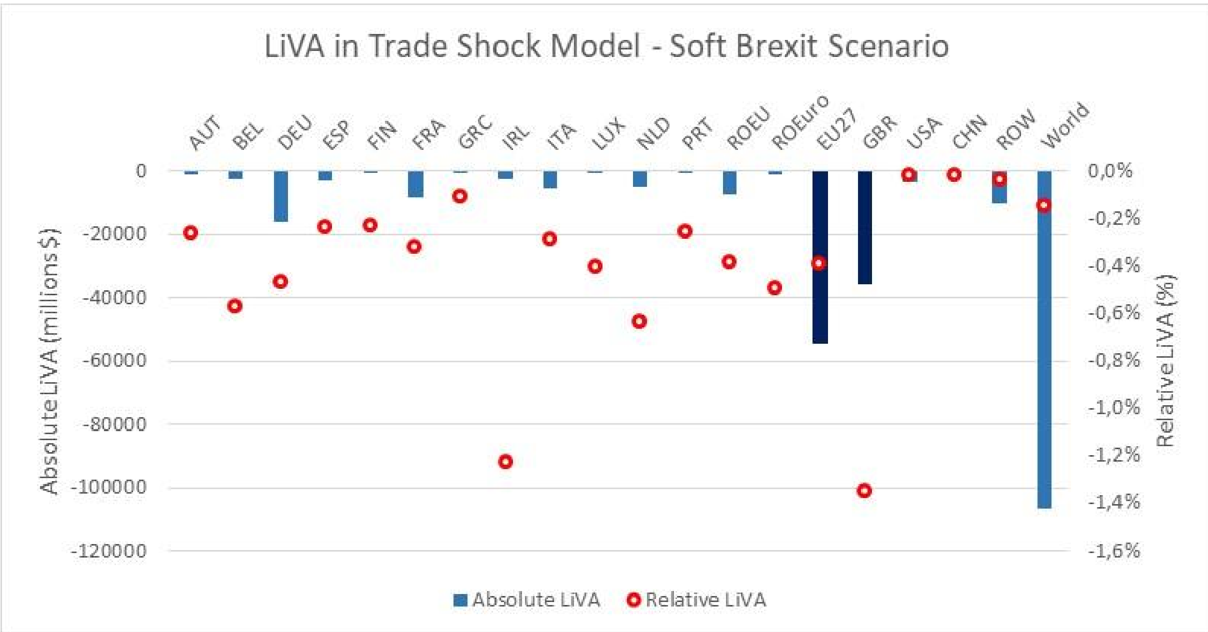
In this section, we present the soft and hard Brexit results related to the trade shock model and to the domestic import substitution and trade diversion model.

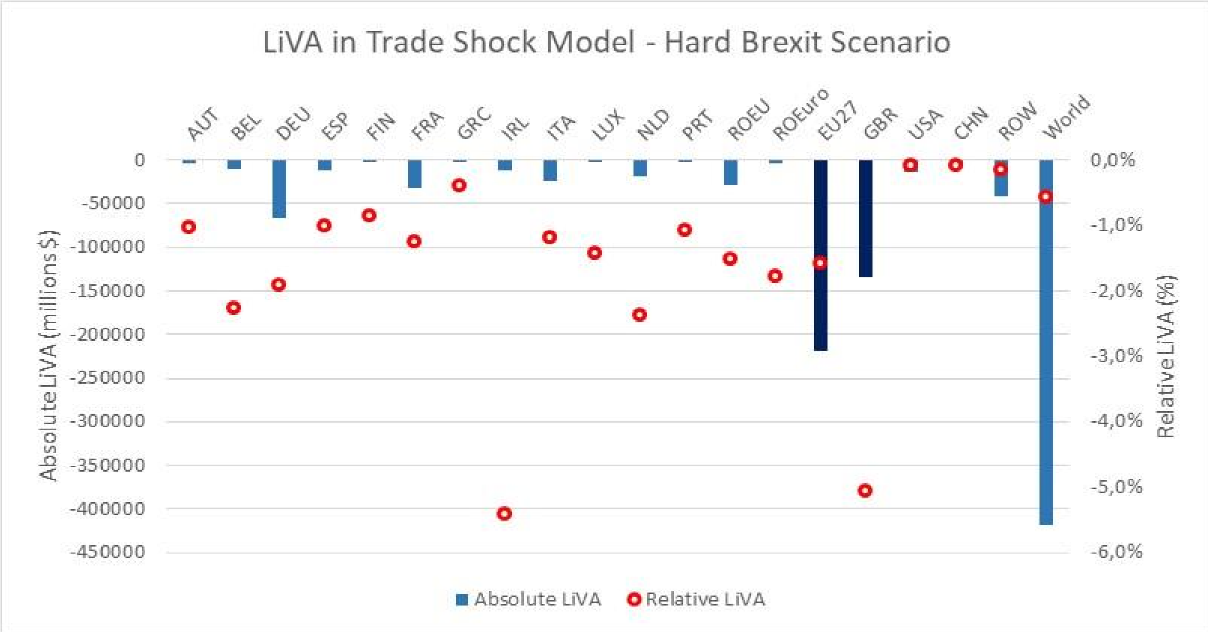
2.6.1 Trade Shock Model Results

Table A.1.2 in the Appendix 1 presents the LiVA for all 18 countries in the dataset, in all four scenarios. The results for the trade shock model soft and hard scenarios are summarised in figures

2.14 and 2.15. Table A.1.2 and figures 2.14 and 2.15 aggregate the results for the 27 countries within the EU (excluding the UK), presented as EU27. In order to find LiVA for a country as whole, individual sector losses were summated. In Table A.1.2, we provide the LiVA both in absolute terms and as a percentage of each country/sectors original value added. W. Chen et al. (2018) use the relative LiVA as an indicator of domestic value added exposed to the negative trade-related consequences of Brexit. Here the relative LiVA allows for an understanding of the relative effect of value added losses on sectors/countries, relative to the size of the sector/country.

The results showed in figures 2.14 and 2.15 suggest that the UK will be among those countries that are hit hardest in absolute and relative terms. Estimated LiVA in the UK ranging from $36 billion in the soft Brexit scenario to $135 billion in the hard Brexit scenario. This corresponds to a drop in value added production as percentage of GDP of 1.35 percent under a soft Brexit and up to 5.07 percent under a hard Brexit scenario. Whilst the UK is the most affected individual country, when aggregating the EU27, as a region, the EU27 faces larger absolute losses than the UK, namely $55 billion and $219 billion in the soft and hard scenarios respectively. These losses, however, are due to EU27 size as they constitute only 0.39 percent and 1.57 percent of the EU27's original value added. The absolute and relative LiVA differ substantially across EU27 member states. The most affected EU27 countries in terms of absolute losses are Germany, France, Italy, the Netherlands and the region we labelled Rest of Europe, for both the soft and hard Brexit scenarios. The picture is not so different if we consider the relative LiVA. EU27 member states that lost most of their GDP are countries with close historical and political ties to the UK, e.g. Ireland and Germany, and small open economies close to the UK, Belgium, and the Netherlands. In particular, Ireland suffers losses, in terms of relative LiVA, slightly below the UK in the soft Brexit scenario and even higher than the UK in the hard Brexit scenario.





Figures 2.14 & 2.15. *Per Country value added losses in the soft and hard Brexit scenarios. Note: blue charts correspond to absolute losses in value added, as given on the left-hand axis. Red dots correspond to percentage losses to value added, as given on the right-hand axis. For country codes see Table A.1.1 Appendix 1.*

Tables 2.1 and 2.2 show, for each country, the sector that will be the most affected under the soft and hard Brexit scenarios. Under a soft Brexit scenario the worst affected sectors, in absolute and relative terms, are the UK (GBR) sector Administrative Service and the Irish sector Paper products, respectively. The German Motor Vehicles sector as well as the Administrative Service industry in France and the Wholesale Trade sector in the Netherlands, also face particularly large absolute LiVA.

Trade Shock Model Soft Brexit

	Most affected sectors in absolute terms				Most affected sectors in relative terms			
	Sector	**WIOD Code**	**Absolute LiVA**	**Relative LiVA**	**Sector**	**WIOD Code**	**Absolute LiVA**	**Relative LiVA**
AUT	Wholesale Trade	G46	-92,56	-0,40%	Transport Equipment	C30	-21,12	-1,80%
BEL	Legal and Accounting	M69_70	-225,24	-0,66%	Transport Equipment	C30	-44,28	-4,28%
DEU	**Motor Vehicles**	**C29**	**-2492,85**	**-1,78%**	Transport Equipment	C30	-321,36	-1,80%
ESP	Motor Vehicles	C29	-254,45	-2,21%	Motor Vehicles	C29	-254,45	-2,21%
FIN	Paper products	C17	-48,02	-1,27%	Petroleum products	C19	-7,13	-1,50%
FRA	Administrative Service	N	-1383,37	-1,01%	Textiles	C13-15	-139,07	-2,02%
GRC	Water Transport	H50	-52,75	-0,70%	Basic Metals	C24	-19,01	-0,97%
IRL	Food, Beverage and Tobacco	C10-12	-587,35	-5,12%	**Paper products**	**C17**	**-10,82**	**-9,45%**
ITA	Textiles	C13-15	-423,04	-1,39%	Transport Equipment	C30	-116,44	-1,54%
LUX	Financial Services	K64	-40,32	-0,47%	Transport Equipment	C30	-0,24	-1,59%
NLD	Wholesale Trade	G46	-700,80	-1,06%	Textiles	C13-15	-43,08	-2,92%
PRT	Textiles	C13-15	-64,81	-1,34%	Transport Equipment	C30	-4,25	-2,36%
ROEU	Wholesale Trade	G46	-559,78	-0,48%	Transport Equipment	C30	-111,42	-1,44%
ROEuro	Real Estate	L68	-151,77	-0,74%	Transport Equipment	C30	-7,39	-1,85%
USA	Administrative Service	N	-398,07	-0,06%	Waste Collection Activities	E37-39	-67,65	-0,16%
CHN	Electronics and Computers	C26	-204,89	-0,08%	Electronics and Computers	C26	-204,89	-0,08%
ROW	Mining and Quarrying	B	-2657,53	-0,12%	Mining and Quarrying	B	-2657,53	-0,12%
GBR	**Administrative Service**	**N**	**-3231,54**	**-2,55%**	**Electronics and Computers**	**C26**	**-1267,43**	**-6,77%**
EU27	**Wholesale Trade**	**G46**	**-4125,17**	**-0,55%**	**Transport Equipment**	**C30**	**-1129,90**	**-1,8%**
World	Wholesale Trade	G46	-8485,84	-0,18%	Pharmaceutical	C21	-2744,99	-0,60%

Table 2.1. *Most affected sectors in each country in absolute (millions $) and relative (%) LiVA terms. Soft Brexit scenario.*

Summing up the losses incurred by each sector in each country we find that the sector most affected in the world is the Wholesale Trade sector. The same result is obtained by limiting the sum of sectoral losses to EU27 member states.

Moving from the soft to the hard Brexit scenario, results are similar, though different in the magnitude of losses and with some relevant distinctions. Indeed, if we introduce the tariffs in our model the ranking of the most affected sectors changes. Table 2.2 shows that, in terms of absolute LiVA, the German Motor Vehicles sector will be the worst affected industry in the case of a no-deal scenario. Furthermore, the same industry placed in Ireland will be also the most influenced in relative LiVA terms. These results are confirmed by the fact that the automotive sector is generally the most sensitive to tariffs in EU27 in both absolute and relative terms. In this scenario, as expected, the UK sectors also suffer large losses, in particular, the Wholesale Trade sector, which is in absolute the most affected in the world, and the textile sector, the most affected in relative terms.

Summarising, our results for the trade shock model suggest that in both scenarios Brexit could be risky and costly not only for the UK but also for EU countries. There will be no Brexit winners, although some trade policies could mitigate the losses. These are further discussed in the following section.

Trade Shock Model Hard Brexit

	Most affected sectors in absolute terms				Most affected sectors in relative terms			
	Sector	**WIOD Code**	**Absolute LiVA**	**Relative LiVA**	**Sector**	**WIOD Code**	**Absolute LiVA**	**Relative LiVA**
AUT	Wholesale Trade	G46	-360,75	-1,57%	Transport Equipment	C30	-82,47	-7,04%
BEL	Legal and Accounting	M69_70	-846,15	-2,47%	Motor Vehicles	C29	-725,35	-19,19%
DEU	**Motor Vehicles**	**C29**	**-12301,40**	**-8,77%**	Motor Vehicles	C29	-12301,40	-8,77%
ESP	Motor Vehicles	C29	-1228,32	-10,69%	Motor Vehicles	C29	-1228,32	-10,69%
FIN	Paper products	C17	-184,06	-4,88%	Petroleum products	C19	-24,02	-5,07%
FRA	Administrative Service	N	-4601,25	-3,35%	Textiles	C13-15	-777,90	-11,32%
GRC	Water Transport	H50	-165,42	-2,20%	Basic Metals	C24	-70,43	-3,60%
IRL	Food, Beverage and Tobacco	C10-12	-3719,35	-32,44%	**Motor Vehicles**	**C29**	**-101,82**	**-39,73%**
ITA	Textiles	C13-15	-2284,16	-7,50%	Textiles	C13-15	-2284,16	-7,50%
LUX	Financial Services	K64	-134,07	-1,56%	Transport Equipment	C30	-0,90	-5,93%
NLD	Wholesale Trade	G46	-2545,24	-3,85%	Textiles	C13-15	-235,76	-15,99%
PRT	Textiles	C13-15	-360,27	-7,44%	Motor Vehicles	C29	-149,42	-9,48%
ROEU	Wholesale Trade	G46	-2194,32	-1,89%	Motor Vehicles	C29	-2013,99	-5,97%
ROEuro	Real Estate	L68	-473,74	-2,30%	Transport Equipment	C30	-28,64	-7,19%
USA	Administrative Service	N	-1598,78	-0,24%	Waste Collection Activities	E37-39	-261,72	-0,61%
CHN	Electronics and Computers	C26	-778,49	-0,30%	Electronics and Computers	C26	-778,49	-0,30%
ROW	Mining and Quarrying	B	-10268,79	-0,47%	Mining and Quarrying	B	-10268,79	-0,47%
GBR	**Wholesale Trade**	**G46**	**-11668,13**	**-13,62%**	**Textiles**	**C13-15**	**-3111,09**	**-30,96%**
EU27	**Motor Vehicles**	**C29**	**-19230,37**	**-8,33%**	**Motor Vehicles**	**C29**	**-19230,37**	**-8,33%**
World	Wholesale Trade	G46	-32689,78	-0,69%	Motor Vehicles	C29	-25302,17	-2,53%

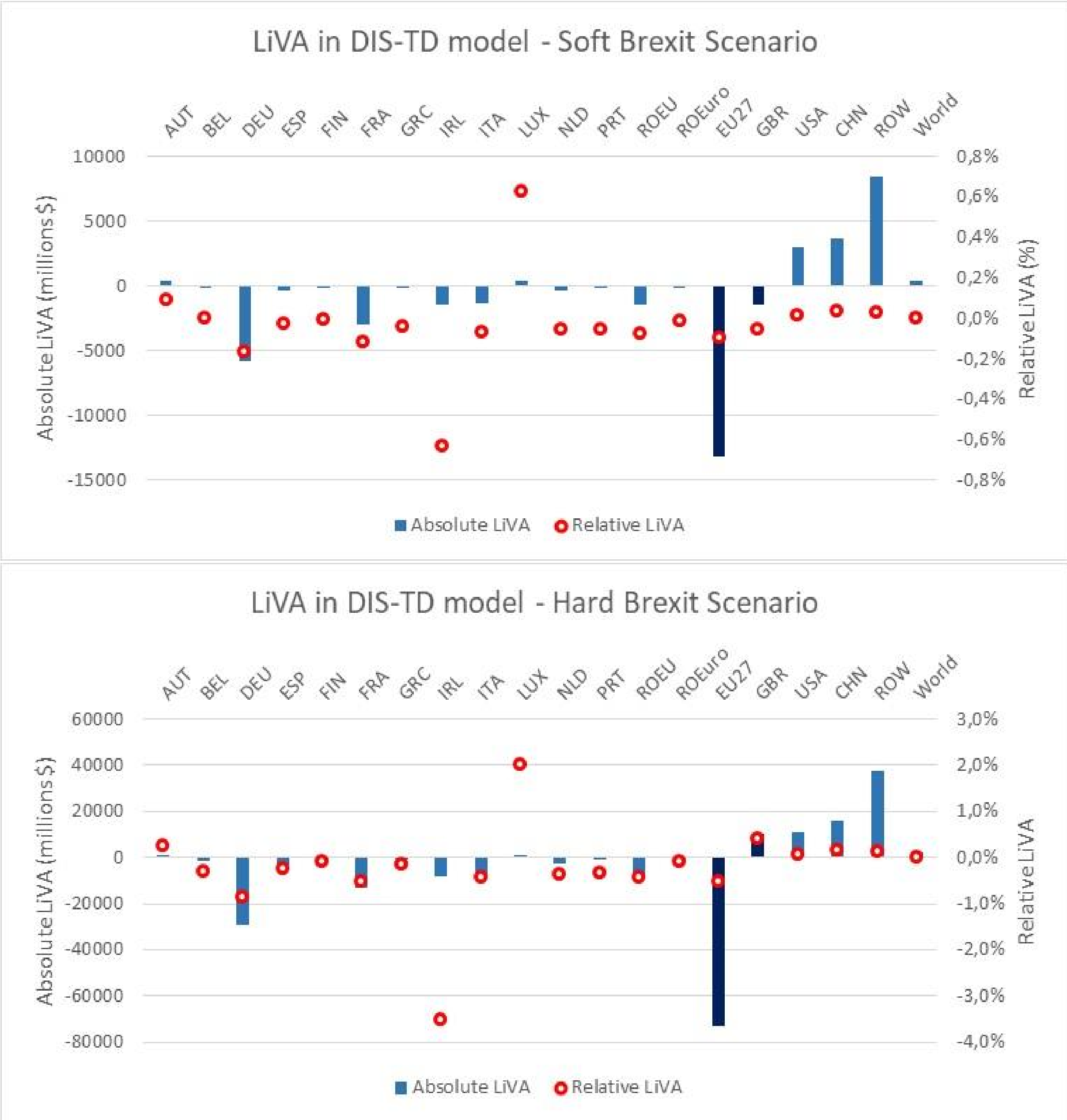
Table 2.2. *Most affected sectors in each country in absolute (millions $) and relative (%) LiVA terms. Hard Brexit scenario.*

2.6.2 Domestic Import Substitution-Trade Diversion Model Results

In this sub-section, we show the results obtained introducing the hypotheses that in response to Brexit, UK trade will be partly diverted to extra-EU countries and EU imported products will be partly substituted by domestic purchases. Conversely, on the other side of the Channel we assume that EU countries will partly substitute UK imported products by intra-EU purchases.

Figures 2.16 and 2.17 summarise the results for the domestic import substitution and trade diversion (DIS-TD) model showing the absolute and relative LiVA for all 18 countries in the dataset.

The first remark we can draw is that in both scenarios the losses are significantly lower for the United Kingdom and for each EU27 member state. In particular, here the UK is no longer the most affected country. Rather, estimated losses in the UK ranging from a LiVA of $1.4 billion in the soft Brexit scenario to a surprisingly negative LiVA, i.e. a gain of $10.6 billion in the hard Brexit scenario.



Figures 2.16 & 2.17. *Per Country value added losses in the soft and hard Brexit scenarios. Note: blue charts correspond to absolute losses in value added, as given on the left-hand axis. Red dots correspond to percentage losses to value added, as given on the right-hand axis. For country codes see Table A.1.1 Appendix 1.*

This corresponds to a drop in value added production as a percentage of GDP of 0.05 percent under a soft Brexit and to a rise of 0.4 percent under a hard Brexit scenario. Hence, introducing the hypothesis of DIS-TD the UK would even benefit from a no-deal scenario. Clearly, this conclusion relies on the assumption that UK would be actually able to substitute EU imported products with domestics and to partly divert its trade to extra-EU countries. Thus, the UK should be able to

implement a trade policy to achieve a trade agreement with extra-EU countries, and at the same time, it should invest in domestic sectors and implement a strategic industrial plan to make domestic production competitive with EU goods. This may prove too ambitious.
Outside the UK, losses are larger, although the absolute and relative LiVA are heterogeneously distributed among sectors and countries. The most affected EU27 countries in terms of absolute and relative losses are Germany, France, Ireland, Italy, the Netherlands and the region we labelled Rest of Europe, for both the soft and hard Brexit scenarios. In the latter case also Spain and Belgium face a large LiVA. However, compared to the previous trade shock model, results suggest that if EU countries would be able to divert some of their trade substituting part of UK imported products by intra-EU purchases, losses will be more modest.

2.7 Discussion

In this section, we discuss our main findings for both models developed, and relating them back to some of the relevant studies that investigated the potential impact of Brexit.
The trade shock model employed in this paper, delivers estimates about the losses the UK will face that are broadly similar to the results in the literature which has focused on the trade effects of Brexit (Dhingra et al., 2017; Aichele and Felbermayr, 2015; Kierzenkowski et al., 2016; Rojas-Romagosa, 2016; and Booth et al., 2016). Our results suggest that under the soft and hard Brexit scenarios, the UK faces relative losses which are three times larger than EU27 expected losses, and range from 1.35 to 5.07 percent of GDP. However, when we compare our results to the predictions outlined in earlier studies that also consider the impact of Brexit on the EU27, our estimated value added losses for the EU27 are much higher. Actually, our findings indicate that the absolute losses in value added production for the EU27 are significantly larger than those of the UK. Besides the fact that EU27 is a much larger economy than the UK, this result is partly due to the EU27 being directly exposed to increasing UK tariff costs, with the UK running an increasingly large trade deficit with the EU27, especially in trade in goods, which are usually dutiable. The inclusion of indirect trade effects in our model represents a potential alternative explanation for the larger absolute losses we found for the EU27. Indeed, EU production network is closely integrated, which implies that tariff changes with the UK do not affect only direct trade flows, but also indirect trade flows via other EU countries. Therefore, the inclusion of indirect trade effects would lead to larger absolute losses for all the EU27 member states and the EU27 as a whole. This highlights the importance of including indirect trade in economic analysis of trade shocks. Nevertheless, the study by Vandenbussche et al. (2017) which also include in their analysis complex supply chain linkages gives similar results for the EU27 as those derived from the econometric model shown in J. Chen et al. (2018).

Our analysis found that, outside the UK, the most affected individual countries were Germany, France, Ireland, Belgium, and the Netherlands. All within the EU, these countries also correspond to some of the UK's top source and destination countries and thus are highly reliant on UK consumers and businesses for trade. These results are supported by the findings showed by Vandenbussche et al. (2017). Supporting the work of W. Chen et al. (2018) who find that some regions in Ireland are just as exposed to Brexit as some UK regions, the results show that Ireland faces similar relative value added losses to the UK in both scenarios. Overall, this suggests that Brexit would be risky and costly also for EU27, hence, the negotiation of a Brexit deal is crucial for countries across the EU27 not just for the UK.

In motivating their methodology W. Chen et al. (2018) list a number of shortcomings in the studies aiming at quantifying the actual changes in the UK and EU countries GDP due to Brexit. One of these, concerns the lack of models that allow contemplating a post-Brexit world in which the UK trade could be largely diverted to extra-EU countries and the UK and EU countries could substitute imported products by domestic purchases. Our DIS-TD model simulates this world, though not immune to all the criticisms made by W. Chen et al. (2018). As shown in the previous section, introducing the hypothesis of domestic import substitution and trade diversion leads to different estimates about the potential impact of Brexit on both macro-regions. In particular, we find the absolute and relative losses in value added production for the UK and for each EU27 member state to be significantly lower compared to the results shown in the Brexit literature and in our trade shock model. A potential explanation for the lower estimates delivered by our DIS-TD model is that we move away from the usual claim underlying standard trade models according to which trade liberalisation always tend to increase welfare. In our second model, trade barriers would not necessarily mean negative economic shocks, because we allow sectors and countries to partly substitute foreign products, which are rendered less competitive due to tariffs. This change to the model leads to results in line with Rodrik (2018b, c) and Skidelsky (2016) remarks, according to which, under circumstances of weak domestic growth and growing trade deficit, trade protectionism and domestic import substitution policies would be preferable to unconditional free trade.

2.8 Conclusion

This paper has two main purposes. First, provide a detailed and holistic discussion of the UK's decision to leave the EU and how it will affect international trade networks and value-added, globally. Second, explore if there are options available to policy-makers so that Brexit does not result in huge economic losses.

The first aim required the construction of a model that would allow us to identify all the channels through which the economic effects of Brexit would propagate within and among sectors and countries. Thus, we employed the World Input-Output Database (WIOD) to develop a multi-sector inter-country model that includes trade in intermediate and final goods and services, in order to track, at the industry level, the direct and indirect effect of Brexit along global value chains. The inclusion of indirect effects makes our predictions different with respect to the results in the main literature, or at least regarding the losses expected for Europe. Indeed, our model simulation suggests that EU27 would face larger absolute losses than what emerges in the literature. Absolute losses for the EU27 are even bigger than those the UK suffers, and range from \$54 billion under a free trade agreement scenario to \$218 billion under a no-deal scenario. However, in line with the literature, we find the UK be the most affected country, facing value-added losses of \$36 billion and \$135 billion for the soft and hard Brexit scenarios, respectively.

The second purpose of the paper required the study of the main features of UK trade patterns, the detection of geographical composition of UK trade in goods and services, and the analysis of the UK balance of payments, in order to find if there is room to boost domestic growth by implementing industrial and trade policies in the UK. In the third and fourth section, UK trading relationships were analysed, taking both a long-term and a static view, concluding that the UK economy has experienced de-industrialisation and 'servification' in the past 15 years. This trend has returned a significant and growing deterioration in the UK trade balance with Europe, especially in manufacturing, that has led to widespread calls for rebalancing the economy (Coutts and Rowthorn, 2013) culminated in the vote for Brexit (Los et al., 2017). Hence, we modify the first model interpreting Brexit as a special case in which a country implements a protectionist trade policy in order to rebalance the external accounts and boost domestic growth. This second model builds on Rodrick (2018a, 2018b, 2018c) remarks, according to which under circumstances of weak domestic growth and growing trade deficit, trade protectionism would be preferable to unconditional free trade. The inclusion of the hypotheses that in response to Brexit, (1) UK trade will be partly diverted to extra-EU countries, (2) EU imported products will be partly substituted by domestic purchases, (3) EU countries will partly substitute UK imported products by intra-EU purchases, returns absolute and relative losses for the UK and EU27 significantly lower. In particular, estimated losses in the UK ranging from $1.4 billion in the soft Brexit scenario to a surprisingly gain of $10.6 billion in the hard Brexit scenario. Outside the UK, losses are larger, although significantly below to the first model estimates.

The results achieved in the second model should not be used to claim that Brexit would bring benefits to the UK. However, since the UK decision to leave Europe has been taken, the main economic literature produced a large body of material explaining why that decision has been wrong. In contrast, there has been no post-vote material emerging helping understand how to deal with the implications of this decision to curb welfare losses. In this sense, the present paper fills this gap exploring some available policy options to address the economic impact of Brexit. The main conclusion is that a passive attitude towards the Brexit by the UK government could lead to huge losses for the UK as well as for EU27. On the other hand, a trade and industrial plan in the UK could have positive implications globally. Ultimately, both macro-regions should wish to conclude a trade agreement that does not result in significant losses for the UK and in turn for EU27 countries.

The study conducted provides some novelty. First, the multi-sector inter-country model developed in the paper complements traditional trade models, offering a comprehensive view of the direct and indirect effects involved in Brexit. More generally, our model allows verifying how the economic impact of tariffs would propagate within an IO production network. Second, we challenge the traditional assumption underlying standard trade models, according to which trade liberalisation always increases welfare. The second model we develop includes domestic import substitution and trade diversion policies, i.e. we allow sectors and countries to partly substitute foreign products turned less competitive due to tariffs. Considering that new trade wars are on the horizon at a global level, for example between the US and China, our models could prove to be a useful tool in future researches. Finally, the models we developed enrich the multi-regional IO literature adopting in an inter-country framework, an extension of the well-known hypothetical extraction technique, namely the partial hypothetical extraction method introduced by Dietzenbacher and Lahr (2013). Furthermore, for the first time the partial hypothetical expansion, described in Dietzenbacher and Lahr (2013) to consider the import substitution cases, has been applied to an empirical analysis.

Along with these novelties, our study includes some limits. For example, we do not include the potential effects of Brexit due to immigration paths and foreign direct investment. Although, several studies suggest that trade effects account for the main part of the Brexit impact (Vandenbussche et al., 2017). Furthermore, the models developed are static and hence fail in consider all the possible interactions among the variables involved. In this sense, the emerging literature on dynamic non-linear IO models (see the view of Dietzenbacher in Dietzenbacher et al., 2013) with endogenous growth (Gualdi and Mandel, 2018) and financial networks (Bigio and La'O, 2016; Battiston et al., 2007; Delli Gatti et al., 2010a), seems fruitful for future investigations.

Chapter 3

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

3.1 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. 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 material 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 European production network (EPN) and to identify the 'systemically important' sectors from a Brexit perspective. 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 connected, 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 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 provide 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 identifying key import sectors and key 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 present and discuss the results and lastly, the paper offers some concluding remarks.

3.2 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 sectors or firm sizes in an economy is typically fat-tailed. Under these circumstances, the central limit theorem break 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. 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.

Most of the empirical works in this field have 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 and Tukker and Dietzenbacher, 2013; Garbellini and Wirkierman, 2014). 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), find 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 chapter 2 for a complete review). Just a few have emphasised the relevance of input-output linkages (e.g. Vandenbussche et al., 2017; 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 Garcia-Muniz et al., 2008; Alatriste-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.

3.3 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.

3.3.1 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 3.1 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	$\mathbf{Z}^{11}$	$\mathbf{Z}^{1.}$	$\mathbf{Z}^{1N}$	$\mathbf{F}^{11}$	$\mathbf{F}^{1.}$	$\mathbf{F}^{1N}$	$\mathbf{x}^{1}$
…	$\mathbf{Z}^{.1}$	$\mathbf{Z}^{..}$	$\mathbf{Z}^{.N}$	$\mathbf{F}^{.1}$	$\mathbf{F}^{..}$	$\mathbf{F}^{.N}$	$\mathbf{x}^{.}$
S Industries, country N	$\mathbf{Z}^{N1}$	$\mathbf{Z}^{N.}$	$\mathbf{Z}^{NN}$	$\mathbf{F}^{N1}$	$\mathbf{F}^{N.}$	$\mathbf{F}^{NN}$	$\mathbf{x}^{N}$
Value added	$(\mathbf{v}^{1})'$	$(\mathbf{v}^{2})'$	$(\mathbf{v}^{N})'$				
Output	$(\mathbf{x}^{1})'$	$(\mathbf{x}^{2})'$	$(\mathbf{x}^{N})'$				

Figure 3.1. *A world input-output table with N countries and S sectors (source: Los et al. 2013).*

The stylised WIOT depicted in Figure 3.1 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 **Z**), or to final user (block matrices labelled **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 (**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 **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 contains 1568 nodes (56 sectors in each of the 28 countries) and 2241747 directed weighted edges.

3.3.2 The Structure of the EPN

The aim of this section is to summarise the main topological properties of the EPN, from a Brexit perspective. In particular, our primary interest is in illustrating the degree of industries connection, the density of sectoral interactions, the distance between country-sectors, the presence of hub sectors or potential shock propagators in the network etc. 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 **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 **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})[3] respectively defined as the sum of all elements in the column i^{th} of the adjacency (**D**) and weighted (**Z**) matrices:

$$d_i^{in} = \sum_{j \neq i} d_{ji} \tag{3.1}$$

$$s_i^{in} = \sum_{j \neq i} s_{ji} \tag{3.2}$$

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

$$d_i^{out} = \sum_{j \neq i} d_{ij} \tag{3.3}$$

$$s_i^{out} = \sum_{j \neq i} s_{ij} \tag{3.4}$$

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

[3] 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 **A**.

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 3.2, 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 (Alatriste-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.

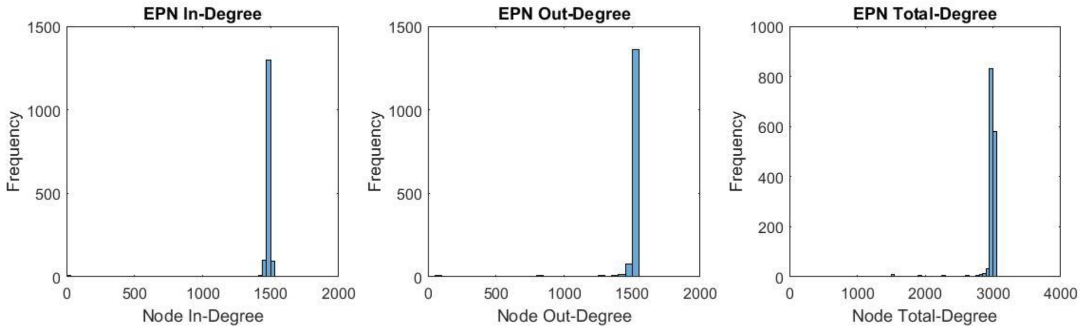


Figure 3.2. *Histogram of in-degree, out-degree and total-degree distribution for the European Production Network 2014.*

Moving from the unweighted EPN to the weighted one, Figure 3.3 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 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. Our findings are coherent with Alatriste-Contreras and Fagiolo (2014), Alatriste-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.

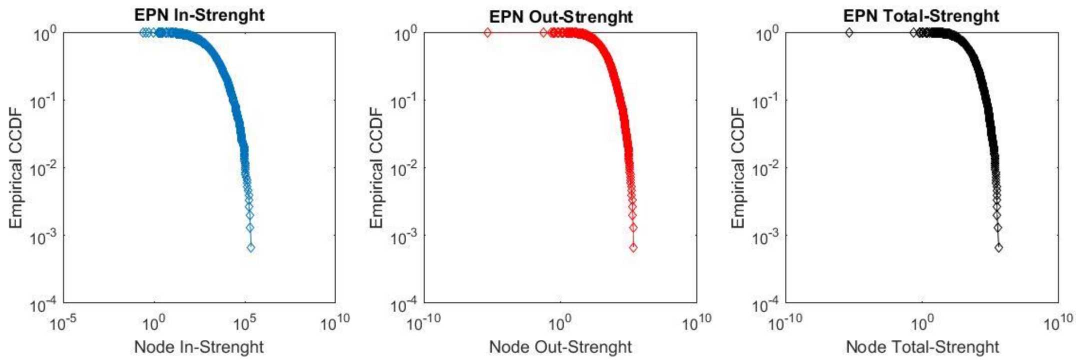


Figure 3.3. *Empirical Counter-Cumulative Distribution Function of in-strength, out-strength and total-strength for the European Production Network 2014.*

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

The unequal distribution of in, out and total strength suggests the presence of hub-like country-sectors. In fact, as shown in Table 3.1, 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 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).

Summarising, 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).

3.3.3 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 sector is involved in global value chains. 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 $\mathbf{x} = \mathbf{Zi} + \mathbf{f}$, 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:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} = \mathbf{Lf} \tag{3.5}$$

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^{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:

$$\mathbf{w} = \mathbf{i}'\mathbf{L} \circ \frac{\boldsymbol{f}'}{\boldsymbol{i}'\boldsymbol{f}} \tag{3.6}$$

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 **e**, that coincides to the left-hand eigenvector corresponding to the dominant eigenvalue of the technical coefficients matrix **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 contains a damping factor that penalise the distant connections. It is computed iteratively for each node i as follows:

$$PR(i; t+1) = \frac{1-d}{N} + d \sum_{j \in M(i)} \frac{PR(j; t) w_{ij}}{S(j)} \tag{3.7}$$

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 start at time step $t = 0$, assuming a probability distribution such that $PR(i; 0) = 1/N$.
As in the strength distributions, Figure 3.4 shows that the network centrality of different nodes is distributed in the form of 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 3.2. Again, as in Table 3.1 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). 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 tend 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’, the PageRank centrality (PR), addresses also this problem.

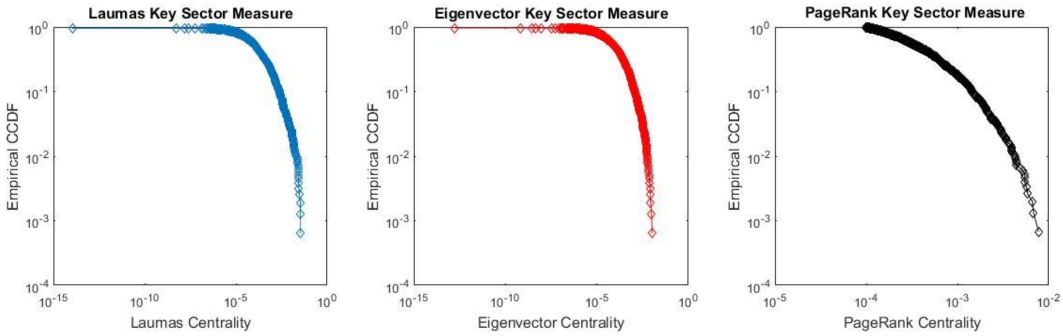


Figure 3.4. *The distribution of different country-sector centrality measures.*

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

According to the PR Germany still plays a central role in the EPN, hosting the first two sectors, which are respectively motor vehicles (C29), and machinery and equipment (C28). 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.

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 but do not provide any effective quantitative measure of the possible economic implication of Brexit. This will be the object of the next section.

3.4 The Hypothetically Extraction method to unveil Key Industries from a Brexit perspective

The Brexit debate has been enriched by numerous studies by 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 chapter 2 for a review). 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 yet known, 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 show 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, help 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 a technique called "hypothetical extraction" 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:

$$\mathbf{x}^* = (\mathbf{I} - \mathbf{A}^*)^{-1}\mathbf{f}^* \tag{3.8}$$

The change before and after extraction is equal to the difference $\mathbf{s}' = (\mathbf{x} - \mathbf{x}^*)$. This method can be easily extended in 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. Figure 3.5 shows a simplified version of the global WIOT presented in Figure 3.1, with one sector and three countries, namely the UK, an EU country (EU) and a country from the rest of the world (ROW).

		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	$\mathbf{x}_{\mathrm{UK}}$
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	$\mathbf{x}_{\mathrm{EU}}$
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	$\mathbf{x}_{\mathrm{ROW}}$
Value Added		$\mathbf{v}_{\mathrm{UK}}$	$\mathbf{v}_{\mathrm{EU}}$	$\mathbf{v}_{\mathrm{ROW}}$				
Gross Input		$\mathbf{x}_{\mathrm{UK}}$	$\mathbf{x}_{\mathrm{EU}}$	$\mathbf{x}_{\mathrm{ROW}}$				

Figure 3.5. *A three-country one-sector representation of the WIOT.*

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 3.5, with three countries and *n* sectors, can be formally represented using partitioned matrices. The coefficients matrix **A** and the final demand matrix **F** are constructed as:

$$\mathbf{A} = \begin{bmatrix} \mathbf{A}^{\mathrm{UU}} & \mathbf{A}^{\mathrm{UE}} & \mathbf{A}^{\mathrm{UR}} \\ \mathbf{A}^{\mathrm{EU}} & \mathbf{A}^{\mathrm{EE}} & \mathbf{A}^{\mathrm{ER}} \\ \mathbf{A}^{\mathrm{RU}} & \mathbf{A}^{\mathrm{RE}} & \mathbf{A}^{\mathrm{RR}} \end{bmatrix} \qquad \mathbf{F} = \begin{bmatrix} \mathbf{F}^{\mathrm{UU}} & \mathbf{F}^{\mathrm{UE}} & \mathbf{F}^{\mathrm{UR}} \\ \mathbf{F}^{\mathrm{EU}} & \mathbf{F}^{\mathrm{EE}} & \mathbf{F}^{\mathrm{ER}} \\ \mathbf{F}^{\mathrm{RU}} & \mathbf{F}^{\mathrm{RE}} & \mathbf{F}^{\mathrm{RR}} \end{bmatrix} \tag{3.9}$$

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

$$\mathbf{A}^* = \begin{bmatrix} \mathbf{A}^{\mathrm{UU}} & 0 & \mathbf{A}^{\mathrm{UR}} \\ 0 & \mathbf{A}^{\mathrm{EE}} & \mathbf{A}^{\mathrm{ER}} \\ \mathbf{A}^{\mathrm{RU}} & \mathbf{A}^{\mathrm{RE}} & \mathbf{A}^{\mathrm{RR}} \end{bmatrix} \qquad \mathbf{F}^* = \begin{bmatrix} \mathbf{F}^{\mathrm{UU}} & 0 & \mathbf{F}^{\mathrm{UR}} \\ 0 & \mathbf{F}^{\mathrm{EE}} & \mathbf{F}^{\mathrm{ER}} \\ \mathbf{F}^{\mathrm{RU}} & \mathbf{F}^{\mathrm{RE}} & \mathbf{F}^{\mathrm{RR}} \end{bmatrix} \tag{3.10}$$

Again, the estimated new vector of sector gross outputs is given by equation (3.8), 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 (3.8) 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:

$$\mathbf{v}^* = \widehat{\mathbf{V}}(\mathbf{I} - \mathbf{A}^*)^{-1}\mathbf{f}^* \tag{3.11}$$

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

This is briefly 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. Indeed, assuming that trade barriers, in general, can reduce bilateral trade between two countries, applying country-sector hypothetical extractions allow us to identify those sectors for which a reduction in trade flows implies a higher loss for the economies involved. Furthermore, our indicator provide 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.

3.4.1 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 **A** and the final demand matrix **F** of the WIOT are presented in summary form as:

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

$$\mathbf{F} = \begin{bmatrix} \mathbf{F}^{\mathrm{UU}} & \mathbf{F}^{\mathrm{UE_1}} & \cdots & \mathbf{F}^{\mathrm{UE_{27}}} & \mathbf{F}^{\mathrm{UR}} \\ \mathbf{F}^{\mathrm{E_1U}} & \mathbf{F}^{\mathrm{E_1E_1}} & \cdots & \mathbf{F}^{\mathrm{E_1E_{27}}} & \mathbf{F}^{\mathrm{E_1R}} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \mathbf{F}^{\mathrm{E_{27}U}} & \mathbf{F}^{\mathrm{E_{27}E_1}} & \cdots & \mathbf{F}^{\mathrm{E_{27}E_{27}}} & \mathbf{F}^{\mathrm{E_{27}R}} \\ \mathbf{F}^{\mathrm{RU}} & \mathbf{F}^{\mathrm{RE_1}} & \cdots & \mathbf{F}^{\mathrm{RE_{27}}} & \mathbf{F}^{\mathrm{RR}} \end{bmatrix} \tag{3.12}$$

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.

Let us 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 $\mathbf{A}^{\mathrm{E_1U}}$ to $\mathbf{A}^{\mathrm{E_{27}U}}$ are set equal to zero. Thus the pre and post extraction coefficients matrix of the EU country s will be:

$$\mathbf{A}^{\mathrm{E_sU}} = \begin{bmatrix} a_{ij}^{\mathrm{E_sU}} & \cdots & a_{ij}^{\mathrm{E_sU}} \\ \vdots & \ddots & \vdots \\ a_{nj}^{\mathrm{E_sU}} & \cdots & a_{nn}^{\mathrm{E_sU}} \end{bmatrix} \qquad \mathbf{A}^{\mathrm{E_sU}*} = \begin{bmatrix} 0 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ a_{nj}^{\mathrm{E_sU}} & \cdots & a_{nn}^{\mathrm{E_sU}} \end{bmatrix} \tag{3.13}$$

The same holds for the final demand:

$$\mathbf{F}^{\mathrm{E_sU}} = \begin{bmatrix} f_{ij}^{\mathrm{E_sU}} & \cdots & f_{ij}^{\mathrm{E_sU}} \\ \vdots & \ddots & \vdots \\ f_{nj}^{\mathrm{E_sU}} & \cdots & f_{nn}^{\mathrm{E_sU}} \end{bmatrix} \qquad \mathbf{F}^{\mathrm{E_sU*}} = \begin{bmatrix} 0 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ f_{nj}^{\mathrm{E_sU}} & \cdots & f_{nn}^{\mathrm{E_sU}} \end{bmatrix} \tag{3.14}$$

Hence, the post extraction global **A** and **F** matrices are constructed as:

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

$$\mathbf{F}^{*} = \begin{bmatrix} \mathbf{F}^{\mathrm{UU}} & \mathbf{F}^{\mathrm{UE_1}} & \cdots & \mathbf{F}^{\mathrm{UE_{27}}} & \mathbf{F}^{\mathrm{UR}} \\ \mathbf{F}^{\mathrm{E_1U*}} & \mathbf{F}^{\mathrm{E_1E_1}} & \cdots & \mathbf{F}^{\mathrm{E_1E_{27}}} & \mathbf{F}^{\mathrm{E_1R}} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \mathbf{F}^{\mathrm{E_{27}U*}} & \mathbf{F}^{\mathrm{E_{27}E_1}} & \cdots & \mathbf{F}^{\mathrm{E_{27}E_{27}}} & \mathbf{F}^{\mathrm{E_{27}R}} \\ \mathbf{F}^{\mathrm{RU}} & \mathbf{F}^{\mathrm{RE_1}} & \cdots & \mathbf{F}^{\mathrm{RE_{27}}} & \mathbf{F}^{\mathrm{RR}} \end{bmatrix} \tag{3.15}$$

Finally, as in W. Chen et al. (2018) we estimate the new vector of sector value added using equation (3.11), 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 $\mathbf{A}^{\mathrm{UE_1}}$ to $\mathbf{A}^{\mathrm{UE_{27}}}$ 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.

3.5 Results and Discussion

3.5.1 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 3.3, 3.4 and 3.5, more detailed information can be found in tables from A.2.3 to A.2.8 in the Appendix 2.

The Table 3.3 summarises the results in tables A.2.3 to A.2.6, 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. These evidence suggest 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 3.2, the Table A.2.3 suggests that this finding depend 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.

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 3.3. *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.*

As revealed by Tables A.2.3 and A.2.4, 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 quite obvious, given that our technique involves 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 of Europe, Tables A.2.5 and A.2.6 show that the USA is the most exposed country along with the region labeled 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. The goods sector could face both, whereas only non-tariff barriers can be applied to the service sectors. Table 3.3 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.

	EU 27		UK		extra-EU	
GOODS	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 3.4. *Most affected country-sectors in terms of LiVA as a result of goods sectors hypothetical extraction.*

Tables 3.4 and 3.5 summarise the results reported in tables A.2.7 and A.2.8 and show the most affected industries in terms of sectoral LiVA in EU27, the UK and extra-EU countries, as a result of sectors hypothetical extraction. As expected, with the exception of the sector petroleum products (C19), the most exposed sectors in the UK and in EU, are the ones directly involved in the hypothetical extraction. For example, if we exclude bilateral trade flows of live animals (A1) between the UK and EU, the most affected industry will be the Irish live animals' sector followed by the same sector placed in the UK. Instead, second round effects by means of the global value chains will hit industries outside Europe, especially mining and quarrying sector (B) from ROW. As in the previous tables, the UK has the largest number of industries ranked as the most exposed, although, again the most vulnerable goods sector is the German automotive industry. On the other hand, the UK wholesale trade industry (G46) is the most exposed services sector.

In this sub-section, consistently with W. Chen et al. (2018) and the main Brexit studies, we showed that in terms of LiVA, the UK is the country most exposed to the economic risk deriving from Brexit. However, using a hypothetical extraction technique at a more granular level than W. Chen et al. (2018), 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. Hence, the UK would be less exposed than EU countries to trade barriers. 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.

	EU 27		UK		extra-EU	
SERVICES	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 3.5. *Most affected country-sectors in terms of LiVA as a result of services sectors hypothetical extraction.*

3.5.2 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 3.6 and 3.7, more detailed information can be found in tables from A.2.9 to A.2.20 in the Appendix 2.

Tables 3.6 and 3.7 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 3.6 and 3.7 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 3.6 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 3.7 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.

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 3.6. *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 3.7. *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.*

This last remark could strengthen the position of the UK in the negotiation of a Brexit deal with EU.

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 a foremost importance in the negotiations between the UK and EU.

3.6 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.

Summarising, 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, 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., 2010a; Delli Gatti et al., 2012), real and financial interactions (Sornette and Woodard, 2010; Riccetti et al., 2013; Bargigli et al., 2014), and non-linear dynamics (Dietzenbacher, 1993).

Conclusions

The present research aimed to provide a detailed and holistic discussion of some important global economic phenomena.

Firstly, using network analysis techniques we show the first study on the historical evolution of the global ownership and control network. Our findings suggest that the network control is highly concentrated in the world: the fraction of top holders holding cumulatively the 80% of the global economic value of the firms considered in the sample is always under the fraction of 2%. Furthermore, by inspecting the temporal dynamics of the phenomenon we observe an increase in the global centralization of capital: this trend assumes a more regular and general character from the 2007 financial crisis, with a growth of more than 20%.

Secondly, we study the role played by global value chains in propagating the trade shock that Brexit may generate, and we suggest policy alternatives to face the potential losses. The inclusion of direct and indirect trade leads to estimates that diverge with the results of the main literature, according to which the UK will face losses far higher than the whole EU27. Differently, we show that Brexit could be risky and costly not only for the UK but also for EU countries, especially Ireland, Germany, Belgium, and the Netherlands, with Ireland facing losses similar or even greater than those of the UK. However, the losses for both macro-regions, the UK and EU27 could be mitigated by implementing domestic import substitution and trade diversion policies.

Finally, we enrich our investigation on the economic impact of Brexit, providing a description of the European production network (EPN), and identifying the key sectors in the complex structure of the UK-EU trade relationships. In line with the second chapter results, losses due to Brexit would be heterogeneous among sectors and countries. Indeed, the exposure of sector i to Brexit depends on its location within the EPN, and relies on the connection the sector i has with 'systemically important' sectors. Again as in the previous chapter, we find 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 would be less exposed than EU countries to trade barriers, as 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. Clearly, this 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.

The common factor in the three chapters concerns the asymmetric distribution of the studied variables, whether they are the percentage of corporate control held by an agent, or the losses suffered by a sector, or the quantity of input-output goods and services flowing through a sector, etc. This feature of real economic phenomena should not be surprising since the economic system is composed of millions of interacting agents, whose distribution is far from being normally distributed (Gallegati, 2018). In this sense, heterogeneous interacting agent-based-models (ABMs) seem particularly suitable to expand from a different perspective the topics covered in the present research. For example, in all three chapters, we analysed the empirical features of three exogenous networks, namely the global ownership and control network, and the global and European production networks. Basically, we made three pictures. Future research should be dedicated to producing three movies. Future works should be conducted adopting a ABMs framework, to study the dynamic evolution and the endogenous formation of these networks in order to investigate the roots of the empirical distributions we find in this research. Particularly interesting and promising is the emerging literature on the interplay between input-output production networks and agent-based frameworks (Baqaee and Farhi, 2018), where it is considered both the role of the network as a shock propagator (Otto et al., 2017), and the role played by the network in the process of technological innovation (Gualdi and Mandel, 2018) and in the creation of new products (Cristelli et al., 2017).

Appendix 1

Country/Region Number	WIOD Country/Region Code	Country Name/ Countries included in Region
1	AUT	Austria
2	BEL	Belgium
3	DEU	Germany
4	ESP	Spain
5	FIN	Finland
6	FRA	France
7	GRC	Greece
8	IRL	Ireland
9	ITA	Italy
10	LUX	Luxembourg
11	NLD	Netherlands
12	PRT	Portugal
13	GBR	United Kingdom
14	ROEU	**Rest of EU**
		Denmark
		Bulgaria
		Croatia
		Hungary
		Romania
		Sweden
		Czech Republic
		Poland
15	ROEuro	**Rest of Eurozone**
		Latvia
		Lithuania
		Slovenia
		Estonia
		Malta
		Cyprus
		Slovakia
16	USA	United States of America
17	CHN	China
18	ROW	**Rest of World**
		ROW plus the following countries:
		Brasil
		Canada
		India
		Indonesia
		Japan
		South Korea
		Mexico
		Norway
		Russia
		Switzerland
		Turkey
		Taiwan

Table A.1.1. Summary of 18 countries in database.

	Trade Shock				Domestic Import Substitution and Trade Diversion			
	Soft Brexit		**Hard Brexit**		**Soft Brexit**		**Hard Brexit**	
	Absolute LiVA	Relative LiVA	Absolute LiVA	Relative LiVA	Absolute LiVA	Relative LiVA	Absolute LiVA	Relative LiVA
AUT	-1021,6	-0,26%	-4045,8	-1,04%	370,6	0,095%	1036,6	0,27%
BEL	-2724,9	-0,57%	-10797,0	-2,27%	-2,7	-0,001%	-1433,0	-0,30%
DEU	-16306,2	-0,47%	-66883,7	-1,92%	-5754,9	-0,165%	-29485,2	-0,85%
ESP	-2986,3	-0,24%	-12600,6	-1,00%	-365,1	-0,029%	-3082,8	-0,25%
FIN	-545,1	-0,23%	-2021,5	-0,86%	-21,1	-0,009%	-198,5	-0,09%
FRA	-8185,9	-0,32%	-31538,5	-1,24%	-2949,6	-0,116%	-13203,5	-0,52%
GRC	-228,6	-0,11%	-804,4	-0,39%	-82,8	-0,040%	-291,3	-0,14%
IRL	-2788,7	-1,22%	-12292,9	-5,40%	-1431,9	-0,629%	-8002,0	-3,52%
ITA	-5556,3	-0,29%	-22999,4	-1,20%	-1304,9	-0,068%	-7957,2	-0,41%
LUX	-236,3	-0,41%	-828,4	-1,42%	366,0	0,628%	1167,0	2,00%
NLD	-5030,7	-0,63%	-18855,6	-2,38%	-410,6	-0,052%	-2980,1	-0,38%
PRT	-515,7	-0,26%	-2171,4	-1,08%	-109,0	-0,054%	-686,7	-0,34%
ROEU	-7208,2	-0,39%	-28486,5	-1,53%	-1418,5	-0,076%	-7809,0	-0,42%
ROEuro	-1283,0	-0,49%	-4629,0	-1,79%	-31,0	-0,012%	-233,4	-0,09%
USA	-3464,0	-0,02%	-14236,3	-0,08%	2965,6	0,017%	11041,2	0,06%
CHN	-1939,9	-0,02%	-7830,7	-0,08%	3676,0	0,036%	16123,2	0,16%
ROW	-10427,9	-0,04%	-42003,2	-0,14%	8385,5	0,028%	37369,6	0,13%
GBR	**-36043,7**	**-1,35%**	**-135127,0**	**-5,07%**	**-1438,4**	**-0,054%**	**10576,6**	**0,40%**
EU27	**-54617,4**	**-0,39%**	**-218955,0**	**-1,57%**	**-13145,4**	**-0,094%**	**-73158,9**	**-0,53%**
World	-106493,0	-0,14%	-418152,0	-0,57%	443,3	0,001%	1951,7	0,00%

Table A.1.2. Absolute and relative LiVA in trade shock and DIS-TD models, soft and hard Brexit scenarios.

Appendix 2

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.2.1. Countries in WIOD.

Goods		Services	
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.2.2. Sectors in WIOD.

	AUT	BEL	BGR	CYP	CZE	DEU	DNK	ESP	EST	FIN	FRA	GRC	HRV	HUN	IRL	ITA	LTU	LUX	LVA	MLT	NLD	NOR	POL	PRT	ROU	SVK	SVN	SWE	EU27	GBR
A01	-31	-159	-21	-11	-17	-594	-159	-869	-2	-37	-708	-43	-5	-30	-2279	-294	-10	-31	-5	-1	-851	-94	-128	-42	-35	-17	-5	-53	-6438	-1970
A02	-1	-1	0	0	-2	-10	-2	-2	-1	-1	-2	0	0	-1	-104	-1	0	0	-2	0	-3	-2	-4	0	-1	-2	0	-12	-153	-57
A03	-1	-4	0	0	-1	-18	-9	-13	0	-1	-14	-3	0	-1	-22	-6	0	0	0	0	-26	-13	-3	-1	-1	0	0	-10	-134	-473
B	-14	-35	-2	-2	-10	-165	-638	-37	-2	-23	-114	-8	-6	-8	-104	-49	-2	-7	-2	-1	-2096	-340	-99	-5	-7	-5	-1	-91	-3534	-8353
C10-12	-313	-1769	-48	-16	-280	-5198	-952	-1711	-12	-145	-4250	-70	-35	-241	-5197	-2670	-99	-70	-25	-6	-2876	-299	-1216	-197	-118	-76	-24	-462	-28075	-10891
C13-15	-83	-435	-36	-1	-111	-1184	-73	-661	-8	-23	-1009	-8	-8	-33	-73	-2746	-38	-15	-5	-2	-346	-44	-171	-343	-179	-20	-12	-121	-7742	-2987
C16	-53	-79	-2	-1	-33	-341	-48	-103	-73	-229	-124	-2	-5	-13	-218	-154	-36	-5	-186	0	-73	-30	-233	-66	-16	-14	-6	-450	-2561	-293
C17	-184	-225	-4	-1	-74	-1388	-74	-173	-13	-705	-507	-9	-5	-29	-94	-375	-10	-11	-7	-1	-275	-83	-176	-82	-15	-29	-15	-785	-5266	-1175
C18	-4	-20	0	0	-2	-37	-7	-21	0	-12	-13	-1	-3	-3	-56	-46	-1	-2	0	-2	-27	-5	-12	-2	-1	-1	-1	-9	-287	-470
C19	-40	-418	-9	-2	-27	-743	-388	-138	-9	-243	-429	-34	-4	-19	-71	-131	-105	-16	-7	-2	-2091	-2050	-225	-21	-16	-11	-4	-909	-6112	-3216
C20	-263	-1324	-31	-5	-147	-5579	-243	-882	-9	-171	-2943	-41	-18	-90	-444	-1002	-66	-37	-10	-3	-2382	-461	-475	-80	-68	-43	-25	-398	-16779	-8980
C21	-170	-1379	-19	-15	-86	-5226	-757	-739	-6	-91	-2529	-81	-30	-127	-1435	-1647	-13	-35	-10	-9	-1420	-91	-207	-81	-44	-21	-55	-488	-16720	-7985
C22	-156	-379	-17	-2	-174	-2716	-115	-429	-4	-82	-996	-25	-9	-105	-270	-732	-29	-23	-4	-3	-576	-98	-388	-110	-58	-74	-33	-166	-7676	-3800
C23	-68	-167	-18	-1	-80	-804	-50	-306	-2	-22	-348	-10	-7	-42	-159	-362	-4	-9	-6	-1	-203	-87	-202	-48	-12	-21	-8	-53	-3010	-1138
C24	-161	-312	-19	-2	-107	-1971	-72	-577	-5	-109	-686	-81	-8	-41	-86	-618	-7	-23	-5	-2	-649	-373	-251	-48	-40	-30	-18	-297	-6226	-4417
C25	-285	-282	-17	-2	-217	-2359	-130	-363	-16	-57	-599	-20	-32	-66	-216	-947	-16	-16	-10	-5	-382	-65	-380	-118	-39	-119	-42	-166	-6899	-1933
C26	-232	-316	-22	-4	-451	-5249	-249	-316	-15	-182	-1927	-12	-11	-205	-687	-715	-14	-48	-9	-4	-1094	-101	-571	-108	-104	-117	-24	-385	-13069	-6490
C27	-302	-280	-21	-3	-255	-3481	-126	-448	-8	-112	-997	-42	-14	-104	-135	-1124	-12	-15	-7	-3	-442	-88	-592	-75	-129	-71	-41	-226	-9066	-3461
C28	-535	-554	-33	-3	-421	-7723	-467	-602	-9	-235	-2128	-31	-22	-243	-263	-2782	-16	-35	-9	-9	-1397	-186	-583	-83	-131	-114	-45	-650	-19124	-8052
C29	-933	-1394	-50	-7	-1218	-20143	-202	-2863	-14	-130	-3683	-42	-31	-526	-248	-3003	-26	-58	-14	-7	-1189	-312	-1673	-320	-362	-505	-89	-958	-39690	-9521
C30	-216	-364	-17	-2	-155	-2875	-58	-1154	-6	-53	-2681	-11	-10	-49	-39	-1444	-14	-15	-4	-2	-479	-88	-347	-54	-126	-43	-15	-200	-10433	-4357
C31-32	-179	-210	-13	-2	-143	-2362	-166	-304	-14	-68	-1156	-26	-13	-69	-269	-1352	-100	-12	-20	-3	-571	-65	-370	-57	-73	-36	-22	-165	-7774	-3607
C33	-69	-72	-7	-1	-38	-245	-21	-53	-4	-15	-436	-7	-7	-21	-20	-153	-7	-3	-2	-6	-97	-7	-95	-19	-14	-22	-7	-19	-1462	-167

Table A.2.3. Aggregate LiVA (expressed in millions of US dollars) in all EU27 countries and the UK as a result of bilateral trade flows extraction. Goods.

	AUT	BEL	BGR	CYP	CZE	DEU	DNK	ESP	EST	FIN	FRA	GRC	HRV	HUN	IRL	ITA	LTU	LUX	LVA	MLT	NLD	NOR	POL	PRT	ROU	SVK	SVN	SWE	EU27	GBR
D35	-14	-82	-4	0	-25	-169	-155	-16	-3	-4	-50	-2	-8	-17	-3	-41	-1	-2	-4	0	-147	-68	-19	-3	-5	-41	-3	-16	-834	-341
E36	-1	-8	-3	0	-11	-52	0	-2	0	0	-1	0	-5	-6	0	-9	0	0	-1	0	-5	0	-9	-2	-3	-8	-1	-1	-129	-11
E37-39	-40	-149	-30	-2	-57	-1072	-45	-33	-9	-34	-371	-22	-7	-32	-16	-242	-4	-19	-8	-2	-470	-27	-99	-24	-75	-16	-5	-55	-2938	-3773
F	-33	-331	-7	-1	-23	-272	-275	-36	-6	-12	-60	-10	-11	-13	-12	-83	-5	-32	-7	-4	-1036	-22	-237	-21	-22	-24	-13	-49	-2637	-508
G45	-29	-323	-6	-1	-14	-507	-32	-172	-2	-8	-262	-2	-1	-20	-35	-116	-1	-10	-1	-6	-158	-16	-452	-6	-8	-9	-2	-141	-2323	-3013
G46	-320	-1380	-33	-9	-99	-5270	-675	-1004	-10	-75	-5272	-24	-9	-187	-231	-1026	-15	-115	-20	-26	-3946	-215	-881	-95	-77	-91	-14	-562	-21468	-30532
G47	-27	-668	-8	-9	-25	-258	-15	-323	-2	-7	-511	-2	-2	-27	-382	-481	-2	-39	-4	-4	-217	-25	-696	-29	-17	-111	-4	-289	-4158	-4028
H49	-77	-123	-14	-2	-85	-185	-44	-204	-7	-35	-803	-8	-14	-61	-35	-172	-19	-16	-54	-2	-869	-24	-118	-31	-89	-12	-10	-38	-3127	-621
H50	-15	-82	-6	-29	-7	-660	-282	-59	-9	-24	-427	-635	-7	-7	-50	-114	-8	-6	-15	-17	-349	-56	-27	-12	-26	-3	-2	-105	-2983	-497
H51	-56	-182	-25	-11	-50	-467	-78	-588	-7	-50	-1056	-57	-11	-70	-1354	-193	-9	-14	-48	-22	-859	-101	-94	-258	-33	-9	-5	-120	-5726	-1631
H52	-29	-230	-10	-10	-36	-227	-36	-117	-14	-14	-225	-30	-7	-38	-32	-159	-9	-14	-27	-18	-388	-18	-38	-31	-26	-18	-4	-158	-1947	-2342
H53	-28	-63	-1	-1	-5	-140	-16	-7	-1	-5	-198	-1	0	-9	-113	-30	-1	-16	-1	-6	-481	-8	-11	-3	-3	-2	-1	-6	-1148	-1009
I	-119	-89	-4	-1	-16	-371	-23	-930	-2	-11	-37	-2	-2	-10	-284	-29	-18	-4	-1	-13	-37	-10	-15	-90	-123	-14	-1	-9	-2254	-1170
J58	-15	-36	-1	0	-30	-113	-25	-11	-1	-10	-43	-2	-7	-3	-317	-21	-1	-6	-1	-1	-32	-11	-22	-2	-3	-5	-1	-76	-785	-1831
J59-60	-6	-21	-1	0	-5	-116	-28	-9	-1	-3	-70	-2	-1	-6	-12	-33	-1	-3	-1	-1	-31	-9	-26	-5	-2	-3	-1	-21	-409	-2938
J61	-114	-853	-18	-2	-66	-894	-123	-58	-9	-18	-1454	-5	-8	-51	-208	-802	-3	-118	-7	-7	-810	-38	-121	-72	-71	-97	-39	-224	-6253	-5463
J62-63	-35	-119	-15	-10	-42	-547	-47	-55	-3	-50	-243	-4	-2	-62	-488	-111	-1	-53	-2	-2	-288	-18	-123	-8	-39	-16	-2	-109	-2474	-4150
K64	-77	-374	-6	-205	-13	-1762	-55	-34	-11	-20	-421	-15	-4	-11	-1604	-216	-1	-557	-12	-195	-426	-36	-77	-9	-14	-12	-5	-97	-6234	-7067
K65	-10	-36	-3	-4	-12	-180	-20	-10	0	-11	-41	-14	-1	-2	-238	-28	0	-7	-1	-9	-63	-10	-9	-3	-2	-4	-2	-11	-722	-2808
K66	-12	-104	-2	-49	-8	-115	-23	-19	-4	-9	-106	-4	-2	-6	-116	-96	-1	-16	-1	-13	-73	-41	-27	-7	-5	-5	-1	-22	-845	-13522
L68	-56	-25	-5	-4	-36	-1121	-6	-6	-20	-2	-13	0	-2	-6	-2	-1245	-8	-18	-1	-10	-37	-3	-450	-6	-5	-1252	-1	-14	-4350	-422
M69-70	-31	-477	-10	-2	-30	-448	-55	-29	-5	-45	-441	-12	-8	-47	-128	-110	-1	-76	-2	-23	-2590	-25	-66	-18	-19	-76	-3	-125	-4878	-7935
M71	-31	-128	-11	-1	-25	-444	-86	-24	-2	-21	-329	-3	-9	-17	-178	-106	-1	-40	-1	-2	-135	-14	-43	-8	-22	-9	-3	-80	-1758	-3275
M72	-13	-50	-22	0	-19	-273	-46	-8	-1	-34	-396	-6	-12	-19	-56	-139	0	-11	-1	0	-52	-8	-24	-3	-12	-3	-1	-102	-1307	-1606
M73	-38	-241	-19	-1	-29	-375	-33	-18	-4	-8	-426	-8	-12	-22	-72	-86	-1	-11	-9	-4	-73	-10	-94	-12	-35	-13	-4	-75	-1722	-2025
M74-75	-29	-84	-4	-3	-22	-945	-46	-26	-8	-20	-208	-40	-8	-188	-640	-771	-2	-19	-4	-2	-150	-44	-236	-113	-10	-32	-20	-131	-3762	-10307
N	-144	-977	-59	-7	-154	-2899	-959	-330	-31	-178	-9953	-47	-7	-69	-437	-2252	-6	-110	-28	-33	-941	-120	-247	-155	-35	-99	-7	-247	-20412	-22665
O84	-5	-89	0	-3	-8	-33	-8	-32	-1	-4	-239	-1	0	-3	-3	-25	0	-6	-1	-1	-771	-3	-5	-15	-1	-9	0	-11	-1276	-510
P85	-13	-66	-5	0	-4	-102	-93	-12	0	-22	-60	-3	0	-1	-29	-7	-1	-7	0	0	-54	-3	-13	-2	-1	-7	-1	-12	-516	-1024
Q	-4	-5	-2	0	-1	-44	-16	-9	0	-1	-119	0	0	-1	-47	-87	0	-12	0	0	-22	-1	-39	-3	-2	-11	-1	-12	-441	-173
R-S	-88	-220	-14	-84	-124	-471	-92	-233	-18	-8	-575	-68	-145	-58	-34	-385	-3	-42	-8	-786	-292	-21	-168	-31	-39	-71	-8	-85	-4149	-4194

Table A.2.4. Aggregate LiVA (expressed in millions of US dollars) in all EU27 countries and the UK as a result of bilateral trade flows extraction. Services.

	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.2.5. 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	-5	-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	-2	-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.2.6. 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_N	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	-350,85	-340,48	-279,83	-262,25	-254,19	-190,70	-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	-345,72	-321,62	-320,41	-310,22	-307,53	-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	NOR_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.2.7. Top 15 most affected country-sectors in terms of LiVA (expressed in millions of US dollars) as a result of goods sectors hypothetical extraction.

Extracted Sector		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D35	Country-Sector	GBR_D35	DNK_D35	DEU_D35	NLD_D35	GBR_B	NOR_B	BEL_D35	ROW_B	DNK_B	SVK_D35	FRA_D35	ITA_D35	RUS_B	CZE_D35	NLD_M69_70
	Loss	-192,20	-89,96	-86,16	-69,83	-63,87	-58,59	-53,31	-48,65	-35,69	-30,17	-28,56	-19,87	-15,86	-15,74	-11,38
E36	Country-Sector	DEU_E36	GBR_E36	POL_E36	CZE_E36	BEL_E36	SVK_E36	ITA_E36	HRV_E36	HUN_E36	NLD_E36	ROU_E36	BGR_E36	PRT_E36	DEU_N	DEU_D35
	Loss	-34,20	-7,48	-6,56	-6,41	-5,26	-5,04	-4,34	-4,19	-4,09	-2,60	-2,11	-1,97	-1,74	-1,59	-1,55
E37-39	Country-Sector	GBR_E37-39	DEU_E37-39	GBR_N	NLD_E37-39	FRA_E37-39	GBR_H49	GBR_K64	GBR_M69_70	ITA_E37-39	BEL_E37-39	GBR_F	USA_E37-39	DEU_N	POL_E37-39	GBR_J62-63
	Loss	-2385,04	-586,42	-272,02	-219,76	-175,44	-155,14	-96,18	-93,30	-90,20	-84,41	-80,42	-76,97	-71,33	-51,85	-51,59
F	Country-Sector	NLD_F	GBR_F	BEL_F	DNK_F	POL_F	DEU_F	NLD_G46	NLD_C25	ROW_B	NLD_K64	GBR_N	NLD_N	ITA_F	DNK_G46	NLD_M71
	Loss	-657,49	-299,81	-199,50	-153,98	-129,77	-64,24	-59,25	-39,86	-36,92	-35,21	-30,31	-28,93	-25,68	-25,54	-22,37
G45	Country-Sector	GBR_G45	POL_G45	DEU_G45	BEL_G45	FRA_G45	GBR_N	ESP_G45	NLD_G45	SWE_G45	GBR_M69_70	GBR_J62-63	GBR_H49	GBR_K64	ITA_G45	GBR_H52
	Loss	-2135,31	-370,19	-303,87	-222,53	-142,40	-133,03	-100,71	-95,36	-91,88	-83,95	-75,69	-58,33	-49,66	-44,77	-44,70
G46	Country-Sector	GBR_G46	DEU_G46	NLD_G46	FRA_G46	GBR_H52	GBR_H49	GBR_N	GBR_M69_70	GBR_F	BEL_G46	GBR_J62-63	GBR_L68	GBR_K64	GBR_G45	ESP_G46
	Loss	-16708,12	-3099,89	-2776,49	-2691,14	-1843,80	-1665,72	-1458,92	-1001,66	-792,85	-781,23	-742,99	-638,90	-626,87	-609,37	-536,39
G47	Country-Sector	GBR_G47	POL_G47	BEL_G47	FRA_G47	ITA_G47	IRL_G47	ESP_G47	GBR_F	SWE_G47	GBR_M69_70	NLD_G47	GBR_L68	GBR_N	DEU_G47	SVK_G47
	Loss	-2649,44	-513,30	-478,48	-304,22	-290,39	-288,94	-216,86	-203,85	-203,31	-173,25	-128,01	-125,69	-120,25	-95,94	-73,58
H49	Country-Sector	NLD_H49	FRA_H49	GBR_H49	ESP_H49	ITA_H49	BEL_H49	DEU_H49	ROW_B	POL_H49	FRA_H52	GBR_N	ROU_H49	AUT_H49	CZE_H49	FRA_N
	Loss	-599,11	-538,76	-349,55	-114,98	-102,02	-69,92	-69,73	-69,60	-64,54	-59,35	-52,48	-48,60	-48,55	-47,50	-42,15
H50	Country-Sector	GRC_H50	DEU_H50	GBR_H50	DEU_H52	NLD_H50	DNK_H50	ROW_H52	ROW_B	FRA_H52	GRC_L68	FRA_H50	FRA_N	DNK_H52	DEU_N	GBR_H52
	Loss	-391,01	-246,34	-229,15	-160,78	-158,08	-135,63	-99,40	-95,48	-95,12	-91,86	-67,21	-60,76	-56,64	-49,52	-46,64
H51	Country-Sector	IRL_H51	GBR_H51	FRA_H51	NLD_H51	ROW_B	ESP_H51	GBR_N	DEU_H51	PRT_H51	NLD_H52	USA_N	IRL_H52	ESP_H52	GBR_H52	FRA_N
	Loss	-911,64	-745,36	-597,45	-341,70	-305,43	-237,10	-124,35	-115,46	-109,98	-93,14	-82,26	-81,27	-79,61	-78,17	-77,43
H52	Country-Sector	GBR_H52	NLD_H52	GBR_N	BEL_H52	FRA_H52	DEU_H52	GBR_M69_70	SWE_H52	ITA_H52	ESP_H52	GBR_F	GBR_K64	GBR_M71	GBR_J62-63	GBR_H49
	Loss	-1482,15	-251,32	-152,32	-139,78	-136,47	-106,21	-98,88	-92,62	-86,93	-68,29	-61,55	-59,01	-46,57	-44,60	-36,31
H53	Country-Sector	GBR_H53	NLD_H53	FRA_H53	IRL_H53	DEU_H53	GBR_N	BEL_H53	GBR_J62-63	GBR_M69_70	GBR_K64	AUT_H53	GBR_H49	GBR_G45	GBR_J61	GBR_F
	Loss	-593,57	-364,03	-144,63	-91,90	-62,78	-55,29	-40,44	-36,81	-35,14	-22,72	-20,87	-19,58	-19,14	-18,51	-18,11
I	Country-Sector	GBR_I	ESP_I	IRL_I	DEU_I	GBR_C10-12	AUT_I	ROU_I	PRT_I	ESP_L68	ESP_C10-12	BEL_I	GBR_N	ESP_G46	DEU_L68	GBR_M69_70
	Loss	-705,29	-610,17	-222,39	-182,58	-104,98	-83,61	-71,61	-61,96	-51,58	-50,93	-49,08	-41,83	-38,96	-33,08	-30,64
J58	Country-Sector	GBR_J58	IRL_J58	GBR_N	GBR_C18	GBR_G45	GBR_M69_70	GBR_G46	DEU_J58	SWE_J58	GBR_R-S	GBR_M73	GBR_J62-63	GBR_H49	GBR_M71	CZE_J58
	Loss	-1188,19	-279,48	-69,72	-59,35	-53,66	-43,18	-41,47	-41,33	-40,99	-38,31	-32,60	-30,13	-26,87	-19,28	-18,69
J59-60	Country-Sector	GBR_J59-60	GBR_R-S	GBR_N	GBR_M69_70	GBR_J61	GBR_J62-63	DEU_J59-60	GBR_M71	GBR_K64	GBR_M73	USA_J59-60	GBR_P85	GBR_F	GBR_C10-12	GBR_H52
	Loss	-1901,01	-186,34	-140,11	-107,68	-99,97	-74,76	-59,78	-43,52	-35,56	-27,82	-25,08	-22,41	-20,77	-19,41	-19,05
J61	Country-Sector	GBR_J61	FRA_J61	NLD_J61	BEL_J61	ITA_J61	DEU_J61	GBR_J62-63	IRL_J61	GBR_N	GBR_M69_70	SWE_J61	GBR_F	LUX_J61	FRA_N	GBR_K64
	Loss	-3830,47	-824,77	-597,54	-584,96	-445,61	-396,64	-181,51	-163,21	-157,27	-123,59	-109,91	-109,84	-101,92	-96,90	-85,45
J62-63	Country-Sector	GBR_J62-63	DEU_J62-63	IRL_J62-63	USA_N	GBR_N	GBR_M69_70	ROW_N	NLD_J62-63	FRA_J62-63	GBR_M71	POL_J62-63	USA_G46	NLD_N	BEL_J62-63	GBR_M74-75
	Loss	-2982,57	-383,16	-354,46	-287,77	-246,46	-197,44	-177,83	-127,87	-112,23	-93,12	-82,93	-78,49	-71,33	-68,92	-63,19
K64	Country-Sector	GBR_K64	IRL_K64	DEU_K64	GBR_M69_70	GBR_K66	GBR_N	LUX_K64	USA_K66	NLD_K64	BEL_K64	GBR_J62-63	FRA_K64	LUX_K66	DEU_M69_70	GBR_H53
	Loss	-4084,30	-1317,46	-1027,31	-628,61	-359,29	-324,58	-291,20	-274,66	-251,05	-240,59	-213,57	-204,37	-152,02	-134,43	-133,58
K65	Country-Sector	GBR_K65	IRL_K65	GBR_M69_70	ROW_K65	GBR_N	GBR_J62-63	GBR_K66	GBR_F	GBR_L68	GBR_K64	DEU_K65	GBR_H53	GBR_J61	GBR_M71	GBR_M73
	Loss	-1589,07	-162,86	-156,17	-110,32	-109,79	-100,26	-79,97	-73,96	-71,87	-66,44	-62,94	-58,25	-55,40	-48,28	-35,20
K66	Country-Sector	GBR_K66	GBR_J62-63	GBR_N	GBR_J61	GBR_H53	GBR_M69_70	GBR_K64	GBR_M71	GBR_R-S	GBR_H52	GBR_P85	GBR_D35	GBR_F	GBR_G45	IRL_K66
	Loss	-9641,82	-677,40	-414,75	-405,24	-398,70	-341,09	-237,08	-107,02	-105,01	-91,41	-80,32	-78,24	-74,07	-70,42	-66,84
L68	Country-Sector	ITA_L68	DEU_L68	SVK_L68	GBR_L68	POL_L68	SVK_R-S	SVK_F	DEU_F	AUT_L68	ITA_K64	DEU_M69_70	GBR_K64	DEU_K64	POL_D35	POL_F
	Loss	-1138,93	-921,52	-914,44	-319,18	-309,91	-122,07	-53,93	-43,24	-39,07	-33,45	-30,78	-29,20	-28,50	-27,67	-27,00
M69-70	Country-Sector	GBR_M69_70	NLD_M69_70	GBR_N	BEL_M69_70	DEU_M69_70	FRA_M69_70	GBR_J62-63	GBR_K64	GBR_M71	GBR_P85	NLD_N	GBR_J61	NLD_K64	IRL_M69_70	FRA_N
	Loss	-6175,10	-1840,84	-391,72	-354,97	-268,02	-220,08	-182,63	-120,29	-118,76	-114,95	-112,46	-91,74	-90,62	-84,52	-80,52
M71	Country-Sector	GBR_M71	DEU_M71	GBR_M69_70	GBR_O84	FRA_M71	IRL_M71	GBR_N	NLD_M71	GBR_J62-63	BEL_M71	ITA_M71	GBR_K64	DNK_M71	SWE_M71	GBR_P85
	Loss	-2146,94	-270,55	-221,43	-202,03	-198,52	-151,72	-121,19	-83,90	-82,02	-79,66	-64,60	-55,50	-51,03	-49,66	-48,50
M72	Country-Sector	GBR_M72	FRA_M72	DEU_M72	ITA_M72	GBR_N	GBR_P85	SWE_M72	IRL_M72	FRA_N	GBR_M69_70	NLD_M72	BEL_M72	FIN_M72	DNK_M72	GBR_J62-63
	Loss	-1121,99	-242,80	-170,22	-93,82	-79,85	-71,46	-69,07	-45,59	-37,07	-29,49	-27,77	-26,97	-25,62	-23,33	-23,29
M73	Country-Sector	GBR_M73	FRA_M73	GBR_M69_70	DEU_M73	BEL_M73	GBR_J62-63	GBR_N	POL_M73	IRL_M73	GBR_J61	FRA_N	BEL_M69_70	GBR_M71	GBR_K64	DEU_J59-60
	Loss	-1242,72	-240,37	-207,19	-204,25	-96,30	-68,21	-65,40	-63,97	-55,87	-55,20	-48,89	-47,00	-46,99	-36,67	-36,26
M74-75	Country-Sector	GBR_M74-75	GBR_N	DEU_M74-75	ITA_M74-75	IRL_M74-75	GBR_M69_70	GBR_M71	GBR_J62-63	GBR_K64	POL_M74-75	HUN_M74-75	GBR_Q	FRA_N	GBR_R-S	GBR_J61
	Loss	-7205,46	-653,08	-497,71	-489,64	-475,37	-456,55	-255,16	-247,18	-176,14	-158,00	-142,63	-135,29	-104,88	-85,96	-73,17
N	Country-Sector	GBR_N	FRA_N	DEU_N	GBR_M69_70	ITA_N	BEL_N	DNK_N	NLD_N	GBR_M71	GBR_J62-63	FRA_L68	GBR_K64	FRA_M69_70	IRL_N	GBR_G45
	Loss	-16548,50	-7257,87	-1934,86	-1259,00	-1202,43	-651,63	-615,64	-612,04	-519,69	-479,82	-463,16	-418,74	-411,32	-308,77	-287,02
O84	Country-Sector	NLD_O84	GBR_O84	FRA_O84	BEL_O84	NLD_N	ESP_O84	NLD_K64	NLD_F	GBR_M69_70	GBR_P85	ITA_O84	GBR_N	NLD_G46	GBR_F	PRT_O84
	Loss	-568,93	-338,35	-187,85	-69,63	-42,17	-23,42	-23,41	-18,72	-18,56	-16,92	-15,22	-14,01	-12,52	-12,48	-11,74
P85	Country-Sector	GBR_P85	DEU_P85	DNK_P85	BEL_P85	FRA_P85	NLD_P85	IRL_P85	GBR_N	FIN_P85	POL_P85	AUT_P85	ESP_P85	GBR_M69_70	SWE_P85	GBR_H49
	Loss	-894,75	-80,73	-78,41	-61,06	-47,54	-43,95	-25,14	-24,18	-17,46	-10,46	-10,41	-9,40	-8,08	-7,57	-7,19
Q	Country-Sector	GBR_Q	FRA_Q	ITA_Q	IRL_Q	POL_Q	DEU_Q	NLD_Q	DNK_Q	LUX_Q	SWE_Q	SVK_Q	ESP_Q	GBR_N	GBR_M69_70	GBR_C21
	Loss	-124,59	-98,93	-64,85	-41,94	-29,56	-26,25	-16,23	-13,42	-11,06	-9,30	-7,89	-5,77	-5,53	-3,40	-3,34
R-S	Country-Sector	GBR_R-S	MLT_R-S	FRA_R-S	DEU_R-S	ITA_R-S	GBR_N	GBR_M69_70	ESP_R-S	NLD_R-S	BEL_R-S	GBR_J62-63	HRV_R-S	POL_R-S	GBR_M73	CZE_R-S
	Loss	-2996,94	-536,21	-370,08	-297,25	-193,90	-173,52	-172,28	-161,34	-158,42	-124,68	-113,60	-97,90	-91,01	-80,88	-78,17

Table A.2.8. Top 15 most affected country-sectors in terms of LiVA (expressed in millions of US dollars) as a result of services sectors hypothetical extraction.

	AUT	BEL	BGR	CYP	CZE	DEU	DNK	ESP	EST	FIN	FRA	GRC	HRV	HUN	IRL	ITA	LTU	LUX	LVA	MLT	NLD	POL	PRT	ROU	SVK	SVN	SWE	EU27	GBR
A01	-3	-10	0	0	-2	-40	-4	-7	0	-3	-24	-1	0	-1	-19	-12	-1	-1	0	0	-22	-5	-1	-1	-1	0	-7	-166	-1514
A02	0	0	0	0	0	-2	0	0	0	0	-1	0	0	0	-3	-1	0	0	0	0	-1	0	0	0	0	0	0	-10	-52
A03	-1	-3	0	0	-1	-11	-2	-2	0	-1	-8	-1	0	0	-3	-4	0	0	0	0	-9	-2	0	0	0	0	-3	-53	-470
B	-7	-20	-1	-1	-5	-92	-24	-16	-1	-5	-56	-6	-1	-4	-16	-29	-1	-3	-1	-1	-153	-14	-3	-3	-3	-1	-18	-484	-8334
C10-12	-21	-65	-4	-1	-15	-287	-30	-48	-2	-28	-179	-5	-2	-11	-145	-84	-4	-7	-2	-1	-153	-40	-10	-8	-7	-2	-49	-1208	-9834
C13-15	-5	-20	-1	0	-4	-69	-6	-14	0	-4	-40	-1	0	-2	-9	-48	-1	-1	-1	0	-29	-10	-4	-2	-2	-1	-10	-283	-2855
C16	-1	-2	0	0	-1	-9	-1	-2	-1	-3	-5	0	0	0	-4	-3	0	0	-2	0	-3	-3	-1	0	0	0	-5	-47	-237
C17	-5	-9	0	0	-2	-50	-4	-7	0	-13	-24	-1	0	-1	-6	-14	-1	-1	0	0	-22	-6	-2	-1	-1	0	-17	-190	-1083
C18	-1	-3	0	0	-1	-16	-1	-2	0	-3	-8	0	0	0	-2	-5	0	0	0	0	-5	-2	-1	0	0	0	-4	-57	-463
C19	-6	-26	-1	-1	-4	-83	-54	-14	-1	-9	-52	-3	-1	-3	-13	-22	-3	-3	-1	-1	-421	-14	-3	-2	-2	-1	-36	-780	-2803
C20	-41	-190	-4	-2	-24	-719	-41	-105	-2	-30	-414	-8	-3	-16	-98	-148	-9	-9	-3	-2	-333	-64	-14	-10	-8	-4	-70	-2369	-8633
C21	-13	-60	-1	-1	-6	-288	-23	-41	-1	-7	-138	-2	-1	-5	-51	-69	-1	-4	-1	-1	-90	-13	-5	-3	-3	-1	-15	-843	-7718
C22	-12	-47	-1	0	-8	-201	-11	-30	-1	-10	-109	-2	-1	-5	-26	-48	-2	-3	-1	0	-78	-22	-5	-3	-3	-1	-21	-655	-3635
C23	-3	-9	0	0	-2	-41	-5	-8	0	-3	-23	-1	0	-1	-7	-12	0	-1	0	0	-31	-6	-1	-1	-1	0	-6	-165	-1077
C24	-23	-53	-4	-1	-18	-324	-28	-67	-1	-14	-142	-10	-2	-9	-27	-91	-2	-5	-2	-1	-179	-48	-9	-8	-6	-3	-49	-1126	-4284
C25	-5	-10	-1	0	-3	-62	-4	-12	0	-3	-26	-2	0	-2	-7	-18	0	-1	-1	0	-20	-9	-2	-1	-2	-1	-8	-200	-1810
C26	-20	-35	-2	-1	-21	-332	-20	-40	-1	-10	-138	-4	-1	-12	-37	-73	-2	-4	-1	-1	-101	-38	-7	-8	-5	-2	-29	-945	-6236
C27	-15	-32	-2	0	-13	-220	-14	-33	-1	-8	-96	-3	-1	-8	-19	-63	-1	-3	-1	-1	-63	-30	-5	-5	-4	-2	-22	-667	-3320
C28	-33	-58	-3	-1	-28	-463	-34	-66	-2	-15	-185	-6	-3	-16	-33	-150	-3	-5	-2	-1	-129	-62	-12	-10	-10	-4	-51	-1384	-7786
C29	-71	-125	-6	-2	-64	-1020	-44	-183	-3	-24	-405	-10	-4	-34	-63	-284	-5	-9	-4	-2	-204	-154	-26	-27	-20	-8	-97	-2897	-8913
C30	-17	-33	-2	-1	-12	-188	-13	-39	-1	-7	-116	-3	-2	-6	-18	-82	-1	-3	-1	-1	-54	-28	-6	-5	-4	-2	-29	-674	-4186
C31-32	-8	-18	-1	0	-6	-109	-8	-17	-2	-8	-52	-2	-1	-4	-15	-37	-1	-2	-3	0	-39	-18	-4	-3	-2	-1	-20	-383	-3489
C33	0	-1	0	0	0	-5	0	-1	0	0	-3	0	0	0	0	-2	0	0	0	0	-1	-1	0	0	0	0	-1	-16	-144

Table A.2.9. Aggregate LiVA (expressed in millions of US dollars) in all EU27 countries and the UK as a result of UK outflows to EU extraction. Goods.

	AUT	BEL	BGR	CYP	CZE	DEU	DNK	ESP	EST	FIN	FRA	GRC	HRV	HUN	IRL	ITA	LTU	LUX	LVA	MLT	NLD	POL	PRT	ROU	SVK	SVN	SWE	EU27	GBR
D35	-1	-1	0	0	0	-7	-3	-1	0	0	-4	0	0	0	-1	-2	0	0	0	0	-20	-1	0	0	0	0	-2	-45	-331
E36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-9
E37-39	-6	-19	-3	0	-6	-102	-9	-9	-1	-4	-64	-2	-1	-4	-11	-27	-1	-3	-1	-1	-48	-12	-3	-6	-3	-1	-10	-358	-3742
F	-1	-2	0	0	-1	-10	-1	-2	0	-1	-6	0	0	0	-2	-3	0	0	0	0	-4	-2	0	0	0	0	-2	-37	-461
G45	-5	-11	-1	0	-4	-68	-5	-12	0	-2	-38	-1	0	-3	-8	-23	0	-1	0	0	-18	-11	-2	-2	-2	-1	-8	-226	-2992
G46	-33	-109	-6	-4	-28	-422	-55	-78	-4	-28	-360	-16	-4	-21	-92	-177	-5	-14	-7	-4	-209	-70	-21	-15	-33	-4	-73	-1891	-30319
G47	-3	-9	0	0	-2	-39	-5	-7	0	-2	-28	-1	0	-2	-9	-16	0	-1	0	0	-18	-7	-2	-1	-6	0	-6	-167	-3962
H49	-1	-2	0	0	-1	-9	-1	-2	0	-1	-7	0	0	0	-2	-3	0	0	0	0	-5	-1	0	0	0	0	-2	-38	-586
H50	0	-2	0	0	0	-9	-3	-1	0	0	-7	-5	0	0	-1	-3	0	0	0	0	-5	-1	0	0	0	0	-2	-41	-427
H51	-2	-7	0	0	-1	-21	-4	-6	0	-2	-21	-1	0	-1	-8	-9	-1	-1	0	0	-17	-4	-2	-1	-1	0	-6	-115	-1369
H52	-2	-8	0	0	-2	-29	-4	-6	0	-2	-29	-3	0	-2	-9	-12	0	-1	-1	-1	-15	-4	-2	-1	-1	0	-5	-141	-2321
H53	-1	-4	0	0	-1	-15	-2	-3	0	-1	-14	-1	0	-1	-6	-6	0	-1	0	0	-9	-2	-1	-1	-1	0	-2	-71	-994
I	-1	-4	0	0	-1	-15	-2	-3	0	-1	-13	0	0	-1	-7	-5	0	0	0	0	-9	-2	-1	0	-1	0	-2	-70	-1144
J58	-2	-6	0	0	-2	-23	-2	-4	0	-3	-15	-1	0	-1	-6	-7	0	-1	0	0	-9	-3	-1	-1	-1	0	-5	-93	-1803
J59-60	-3	-10	-1	0	-2	-35	-5	-6	0	-2	-39	-1	-1	-2	-8	-15	0	-1	0	0	-15	-6	-2	-1	-2	0	-5	-162	-2935
J61	-8	-26	-1	0	-8	-123	-10	-14	-1	-5	-75	-2	-1	-5	-18	-38	-1	-3	-1	-1	-48	-16	-4	-4	-5	-1	-14	-430	-5379
J62-63	-3	-10	-1	0	-2	-39	-6	-5	0	-2	-49	-1	0	-2	-10	-19	0	-2	0	0	-15	-6	-2	-1	-1	0	-5	-183	-4044
K64	-4	-19	-1	-1	-4	-59	-8	-10	-1	-4	-68	-2	-1	-3	-21	-27	-1	-4	-1	-1	-30	-9	-4	-2	-5	-1	-9	-299	-6398
K65	-3	-9	0	-1	-2	-31	-4	-6	0	-2	-28	-1	0	-2	-11	-14	0	-2	0	-1	-13	-5	-2	-1	-3	0	-5	-146	-2759
K66	-9	-38	-2	-3	-7	-107	-13	-17	-1	-8	-102	-3	-1	-5	-33	-47	-1	-6	-1	-2	-61	-15	-6	-4	-4	-1	-19	-516	-13506
L68	0	0	0	0	0	-2	0	0	0	0	-1	0	0	0	-1	-1	0	0	0	0	-1	0	0	0	0	0	0	-8	-410
M69-70	-4	-19	-1	-1	-3	-57	-10	-8	-1	-4	-86	-1	0	-3	-17	-30	0	-3	-1	-1	-25	-9	-4	-2	-2	-1	-9	-302	-7884
M71	-2	-7	0	0	-2	-29	-4	-4	0	-2	-29	-1	0	-2	-7	-12	0	-1	0	0	-12	-4	-1	-1	-1	0	-5	-129	-3257
M72	-1	-5	0	0	-1	-22	-2	-2	0	-2	-19	0	0	-1	-6	-9	0	-1	0	0	-7	-3	-1	0	-1	0	-3	-89	-1592
M73	-2	-6	0	0	-1	-20	-2	-3	0	-2	-18	0	0	-1	-5	-8	0	-1	0	0	-10	-3	-1	-1	-1	0	-4	-89	-1988
M74-75	-8	-33	-2	-1	-7	-135	-22	-17	-1	-6	-181	-3	-1	-12	-53	-78	-1	-7	-1	-1	-46	-21	-8	-3	-4	-1	-17	-673	-10274
N	-21	-80	-5	-2	-19	-319	-49	-51	-2	-16	-419	-7	-3	-15	-65	-151	-2	-12	-3	-3	-111	-47	-16	-9	-10	-2	-41	-1481	-22507
O84	-1	-1	0	0	-1	-8	-1	-1	0	0	-5	0	0	0	-1	-3	0	0	0	0	-3	-1	0	0	0	0	-1	-29	-498
P85	0	-1	0	0	0	-6	-1	-1	0	0	-5	0	0	0	-1	-2	0	0	0	0	-3	-1	0	0	0	0	-1	-25	-1022
Q	0	-1	0	0	0	-5	0	-1	0	0	-3	0	0	0	-1	-1	0	0	0	0	-2	0	0	0	0	0	0	-16	-169
R-S	-2	-9	0	0	-2	-34	-5	-5	0	-2	-37	-1	0	-2	-8	-15	0	-1	0	0	-14	-5	-2	-1	-1	0	-5	-151	-3909

Table A.2.10. Aggregate LiVA (expressed in millions of US dollars) in all EU27 countries and the UK as a result of UK outflows to EU extraction. Services.

	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.2.11. 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	-7,74	-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	-5,04	-7,70	-0,49	-1,43	-4,41	-3,70	-0,62	-5,22	-3,58	-1,12	-0,98	-22,67	-24,07	-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	-0,36	-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.2.12. 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_G46	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	-6,82	-5,92	-5,41	-5,35	-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	-27,40	-25,33	-25,17	-20,22	-18,12	-16,02	-14,48	-14,43	-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	NOR_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	-2,42	-2,07	-1,78	-1,61	-1,44	-1,35	-1,30	-1,16

Table A.2.13. 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.

Extracted Sector		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D35	Country-Sector	GBR_D35	GBR_B	NOR_B	ROW_B	GBR_K64	GBR_N	GBR_M69_70	GBR_F	GBR_J62-63	NLD_B	NLD_M69_70	RUS_B	GBR_G46	GBR_M71	GBR_C25
	Loss	-192,09	-62,32	-41,27	-16,40	-8,95	-8,18	-7,21	-6,40	-4,64	-4,40	-4,38	-4,23	-3,87	-3,60	-2,93
E36	Country-Sector	GBR_E36	GBR_F	GBR_D35	GBR_N	GBR_K64	GBR_J62-63	GBR_M69_70	GBR_B	GBR_M71	NOR_B	GBR_G46	GBR_L68	ROW_B	GBR_C28	GBR_G45
	Loss	-7,48	-0,30	-0,24	-0,15	-0,14	-0,12	-0,11	-0,09	-0,08	-0,06	-0,06	-0,05	-0,05	-0,05	-0,04
E37-39	Country-Sector	GBR_E37-39	GBR_N	GBR_H49	GBR_K64	GBR_M69_70	GBR_F	GBR_J62-63	GBR_M71	GBR_L68	GBR_G45	GBR_H52	GBR_K65	USA_E37-39	GBR_P85	GBR_J61
	Loss	-2384,80	-266,72	-154,53	-95,06	-90,47	-79,94	-50,30	-46,47	-45,53	-43,53	-36,91	-32,81	-32,12	-31,13	-31,13
F	Country-Sector	GBR_F	GBR_N	GBR_M69_70	GBR_M71	GBR_C25	GBR_K64	GBR_C23	GBR_G45	GBR_G46	GBR_J62-63	GBR_C22	GBR_H49	GBR_B	GBR_L68	GBR_C33
	Loss	-299,14	-25,34	-12,07	-11,55	-8,67	-8,54	-7,64	-7,44	-6,71	-6,59	-5,84	-4,92	-4,37	-4,04	-3,94
G45	Country-Sector	GBR_G45	GBR_N	GBR_M69_70	GBR_J62-63	GBR_H49	GBR_K64	GBR_H52	GBR_M71	GBR_F	GBR_J61	GBR_G46	GBR_C29	GBR_M73	GBR_C22	GBR_D35
	Loss	-2134,92	-130,47	-81,84	-74,85	-57,97	-48,87	-44,22	-41,75	-32,68	-24,55	-22,55	-21,67	-19,70	-17,85	-17,36
G46	Country-Sector	GBR_G46	GBR_H52	GBR_H49	GBR_N	GBR_M69_70	GBR_F	GBR_J62-63	GBR_L68	GBR_K64	GBR_G45	GBR_J61	GBR_M71	GBR_H53	GBR_C10-12	GBR_D35
	Loss	-16705,48	-1838,70	-1662,73	-1411,38	-974,09	-790,22	-733,57	-637,00	-618,74	-605,69	-462,96	-385,85	-319,43	-261,44	-216,62
G47	Country-Sector	GBR_G47	GBR_F	GBR_M69_70	GBR_L68	GBR_N	GBR_K64	GBR_C10-12	GBR_J62-63	GBR_H49	GBR_M71	GBR_G45	GBR_H52	GBR_D35	GBR_I	GBR_J61
	Loss	-2649,32	-203,09	-168,02	-125,06	-110,44	-70,64	-58,16	-52,28	-44,03	-41,48	-36,38	-31,19	-30,55	-27,83	-26,61
H49	Country-Sector	GBR_H49	GBR_N	GBR_H52	GBR_G45	GBR_M69_70	GBR_O84	GBR_J62-63	GBR_K64	GBR_F	ROW_B	GBR_M71	GBR_J61	GBR_L68	GBR_D35	GBR_M73
	Loss	-348,93	-47,96	-32,68	-17,89	-17,19	-15,23	-12,67	-9,67	-7,32	-7,32	-6,61	-4,98	-4,87	-4,45	-4,19
H50	Country-Sector	GBR_H50	GBR_H52	GBR_N	GBR_M69_70	GBR_J62-63	GBR_F	GBR_K64	GBR_M71	GBR_C33	GBR_G45	GBR_L68	GBR_J61	GBR_R-S	ROW_B	GBR_M73
	Loss	-228,68	-39,19	-35,54	-16,69	-16,44	-10,90	-7,26	-6,54	-5,12	-5,07	-4,93	-3,96	-3,92	-3,49	-3,35
H51	Country-Sector	GBR_H51	GBR_N	GBR_H52	GBR_J62-63	GBR_M69_70	ROW_B	GBR_K64	GBR_F	GBR_L68	GBR_R-S	GBR_G45	USA_C30	GBR_K65	GBR_M71	GBR_J61
	Loss	-744,73	-106,18	-71,92	-62,57	-49,19	-32,04	-26,92	-26,65	-22,63	-20,70	-17,32	-16,95	-15,69	-14,85	-13,92
H52	Country-Sector	GBR_H52	GBR_N	GBR_M69_70	GBR_F	GBR_K64	GBR_M71	GBR_J62-63	GBR_H49	GBR_J61	GBR_G45	GBR_L68	GBR_P85	GBR_R-S	GBR_M73	GBR_H50
	Loss	-1481,80	-148,68	-96,34	-61,22	-58,10	-45,88	-43,65	-35,92	-31,26	-27,27	-22,99	-22,24	-19,76	-17,82	-13,72
H53	Country-Sector	GBR_H53	GBR_N	GBR_J62-63	GBR_M69_70	GBR_K64	GBR_H49	GBR_G45	GBR_F	GBR_J61	GBR_R-S	GBR_P85	GBR_M71	GBR_H52	GBR_H51	GBR_M73
	Loss	-593,45	-53,53	-36,14	-32,65	-22,13	-19,35	-18,85	-17,90	-17,68	-17,64	-15,13	-14,71	-14,07	-10,66	-10,41
I	Country-Sector	GBR_I	GBR_C10-12	GBR_N	GBR_M69_70	GBR_A01	GBR_K64	GBR_G46	GBR_J62-63	GBR_F	GBR_H49	GBR_G45	GBR_M71	GBR_D35	GBR_R-S	GBR_J61
	Loss	-705,19	-102,83	-40,01	-28,83	-22,02	-21,71	-21,42	-18,27	-15,02	-13,12	-10,95	-10,86	-10,83	-10,68	-9,74
J58	Country-Sector	GBR_J58	GBR_N	GBR_C18	GBR_G45	GBR_M69_70	GBR_G46	GBR_R-S	GBR_M73	GBR_J62-63	GBR_H49	GBR_M71	GBR_Q	GBR_K64	GBR_F	GBR_C17
	Loss	-1188,10	-67,98	-59,24	-52,97	-41,93	-38,95	-38,07	-32,26	-29,38	-26,32	-18,60	-17,80	-17,27	-16,30	-15,99
J59-60	Country-Sector	GBR_J59-60	GBR_R-S	GBR_N	GBR_M69_70	GBR_J61	GBR_J62-63	GBR_M71	GBR_K64	GBR_M73	USA_J59-60	GBR_P85	GBR_F	GBR_C10-12	GBR_H52	GBR_G45
	Loss	-1901,01	-186,30	-139,53	-107,45	-99,87	-74,59	-43,44	-35,46	-27,76	-23,49	-22,38	-20,74	-19,36	-19,00	-17,22
J61	Country-Sector	GBR_J61	GBR_J62-63	GBR_N	GBR_M69_70	GBR_F	GBR_K64	GBR_G46	GBR_H52	GBR_G45	GBR_C26	GBR_P85	GBR_L68	GBR_M71	GBR_C22	GBR_R-S
	Loss	-3829,57	-176,05	-142,30	-116,48	-108,79	-82,48	-59,91	-58,76	-56,23	-54,69	-52,08	-51,71	-50,86	-48,77	-44,31
J62-63	Country-Sector	GBR_J62-63	GBR_N	GBR_M69_70	GBR_M71	GBR_K64	GBR_G45	GBR_M73	GBR_M74-75	GBR_P85	GBR_J61	GBR_R-S	GBR_H52	FRA_N	GBR_F	GBR_K66
	Loss	-2979,85	-230,78	-190,60	-87,94	-51,35	-39,74	-38,85	-31,14	-30,74	-28,91	-27,14	-26,57	-25,44	-25,11	-19,18
K64	Country-Sector	GBR_K64	GBR_M69_70	GBR_N	GBR_J62-63	GBR_H53	GBR_J61	GBR_K66	GBR_M71	GBR_L68	GBR_P85	GBR_R-S	GBR_F	GBR_H52	GBR_M73	GBR_G45
	Loss	-4071,71	-522,77	-278,56	-182,61	-118,12	-109,57	-106,48	-97,19	-89,97	-81,11	-80,12	-75,04	-67,29	-64,63	-43,74
K65	Country-Sector	GBR_K65	GBR_M69_70	GBR_N	GBR_J62-63	GBR_F	GBR_L68	GBR_K66	GBR_K64	GBR_H53	GBR_J61	GBR_M71	GBR_M73	GBR_G45	GBR_I	GBR_P85
	Loss	-1587,87	-153,35	-107,20	-98,17	-73,47	-71,50	-66,80	-63,77	-56,94	-52,57	-46,68	-34,65	-29,19	-28,64	-26,98
K66	Country-Sector	GBR_K66	GBR_J62-63	GBR_N	GBR_J61	GBR_H53	GBR_M69_70	GBR_K64	GBR_M71	GBR_R-S	GBR_H52	GBR_P85	GBR_D35	GBR_F	GBR_G45	GBR_M73
	Loss	-9641,68	-676,72	-413,51	-402,98	-397,66	-339,62	-235,67	-106,46	-104,78	-91,17	-80,15	-78,12	-73,83	-70,13	-62,04
L68	Country-Sector	GBR_L68	GBR_K64	GBR_F	GBR_M69_70	GBR_N	GBR_O84	GBR_M71	GBR_J62-63	GBR_K65	GBR_J61	GBR_D35	GBR_P85	GBR_G45	GBR_H53	GBR_H52
	Loss	-319,09	-28,23	-18,32	-6,65	-5,10	-4,41	-3,33	-2,81	-2,58	-1,97	-1,24	-1,17	-1,15	-1,12	-1,07
M69-70	Country-Sector	GBR_M69_70	GBR_N	GBR_J62-63	GBR_K64	GBR_M71	GBR_P85	GBR_J61	GBR_F	GBR_M73	GBR_H53	FRA_N	GBR_M74-75	GBR_R-S	GBR_G45	GBR_H49
	Loss	-6172,70	-383,14	-178,94	-117,93	-116,91	-114,39	-88,67	-62,08	-53,59	-50,87	-46,17	-45,27	-44,34	-37,87	-34,68
M71	Country-Sector	GBR_M71	GBR_M69_70	GBR_O84	GBR_N	GBR_J62-63	GBR_K64	GBR_P85	GBR_F	GBR_R-S	GBR_M73	GBR_J61	GBR_K66	GBR_H52	GBR_H53	GBR_M74-75
	Loss	-2146,62	-219,33	-201,94	-117,80	-81,13	-54,82	-48,31	-31,78	-27,01	-26,45	-25,02	-21,50	-20,24	-19,83	-18,90
M72	Country-Sector	GBR_M72	GBR_N	GBR_P85	GBR_M69_70	GBR_J62-63	GBR_M71	GBR_O84	GBR_M74-75	GBR_K64	GBR_J61	GBR_Q	GBR_L68	GBR_G46	GBR_C25	GBR_G45
	Loss	-1121,97	-75,96	-71,16	-28,35	-22,64	-22,48	-21,94	-20,08	-19,39	-11,86	-11,66	-11,53	-10,66	-9,51	-8,80
M73	Country-Sector	GBR_M73	GBR_M69_70	GBR_J62-63	GBR_N	GBR_J61	GBR_M71	GBR_K64	GBR_R-S	GBR_P85	GBR_F	GBR_H49	GBR_H53	GBR_G45	GBR_J59-60	GBR_G46
	Loss	-1242,45	-202,82	-66,65	-57,83	-54,20	-45,74	-35,66	-31,81	-30,17	-17,25	-14,35	-13,99	-12,97	-12,17	-10,70
M74-75	Country-Sector	GBR_M74-75	GBR_N	GBR_M69_70	GBR_M71	GBR_J62-63	GBR_K64	GBR_Q	FRA_N	GBR_R-S	GBR_P85	GBR_H49	GBR_J61	GBR_F	GBR_M73	GBR_G45
	Loss	-7205,31	-649,85	-453,28	-253,65	-245,66	-173,65	-135,25	-101,21	-85,46	-71,74	-71,35	-70,83	-62,81	-56,70	-51,58
N	Country-Sector	GBR_N	GBR_M69_70	GBR_M71	GBR_J62-63	GBR_K64	GBR_G45	GBR_R-S	FRA_N	GBR_J61	GBR_H52	GBR_M74-75	GBR_H49	GBR_P85	GBR_F	GBR_M73
	Loss	-16541,33	-1243,07	-513,31	-471,12	-411,75	-283,84	-224,62	-223,70	-187,49	-183,26	-173,34	-165,87	-165,64	-158,09	-152,59
O84	Country-Sector	GBR_O84	GBR_M69_70	GBR_P85	GBR_F	GBR_N	GBR_K64	GBR_L68	GBR_R-S	GBR_J62-63	GBR_J61	GBR_H49	GBR_M71	GBR_H53	GBR_C25	GBR_G45
	Loss	-338,29	-16,92	-16,79	-12,26	-12,01	-10,31	-9,12	-8,33	-6,78	-5,54	-4,98	-4,65	-3,87	-3,87	-3,01
P85	Country-Sector	GBR_P85	GBR_N	GBR_M69_70	GBR_H49	GBR_J62-63	GBR_R-S	GBR_F	GBR_D35	GBR_G46	GBR_C18	GBR_C10-12	GBR_M71	GBR_G45	GBR_L68	GBR_M74-75
	Loss	-894,73	-23,68	-7,89	-7,16	-6,62	-5,26	-4,94	-4,47	-4,08	-4,02	-3,86	-3,56	-3,55	-3,32	-3,29
Q	Country-Sector	GBR_Q	GBR_N	GBR_M69_70	GBR_C21	GBR_I	GBR_G46	GBR_J62-63	GBR_R-S	GBR_M71	GBR_H49	GBR_C10-12	GBR_L68	DEU_C21	GBR_K64	ROW_I
	Loss	-124,58	-4,99	-3,19	-3,00	-2,61	-2,22	-1,92	-1,88	-1,79	-1,77	-1,60	-1,58	-1,56	-1,41	-1,20
R-S	Country-Sector	GBR_R-S	GBR_N	GBR_M69_70	GBR_J62-63	GBR_K64	GBR_M71	GBR_F	GBR_J61	GBR_M73	GBR_J59-60	GBR_C10-12	GBR_P85	GBR_G45	GBR_L68	GBR_G46
	Loss	-2993,41	-155,38	-126,35	-101,61	-46,60	-41,42	-33,13	-24,47	-23,52	-22,18	-21,82	-21,58	-21,41	-18,68	-18,00

Table A.2.14. Top 15 most affected country-sectors in terms of LiVA (expressed in millions of US dollars) as a result of UK services exports to EU hypothetical extraction.

	AUT	BEL	BGR	CYP	CZE	DEU	DNK	ESP	EST	FIN	FRA	GRC	HRV	HUN	IRL	ITA	LTU	LUX	LVA	MLT	NLD	POL	PRT	ROU	SVK	SVN	SWE	EU27	GBR
A01	-29	-150	-20	-11	-16	-557	-155	-863	-2	-34	-687	-43	-5	-29	-2271	-284	-9	-30	-5	-1	-832	-123	-41	-34	-17	-5	-46	-6298	-518
A02	-1	-1	0	0	-2	-8	-2	-2	-1	0	-1	0	0	-1	-103	-1	0	0	-2	0	-2	-4	0	-1	-2	0	-11	-145	-5
A03	0	-1	0	0	0	-7	-7	-11	0	0	-6	-2	0	0	-20	-2	0	0	0	0	-17	-1	0	0	0	0	-7	-83	-3
B	-7	-16	-1	-1	-5	-74	-624	-21	-1	-18	-59	-2	-5	-4	-89	-20	-1	-4	-1	0	-1976	-86	-2	-4	-2	-1	-74	-3098	-25
C10-12	-295	-1717	-45	-14	-267	-4950	-926	-1671	-10	-119	-4104	-66	-33	-233	-5078	-2596	-96	-64	-23	-5	-2753	-1182	-188	-111	-71	-22	-417	-27054	-1560
C13-15	-79	-421	-35	-1	-108	-1132	-69	-652	-8	-19	-978	-7	-8	-31	-65	-2729	-37	-14	-5	-2	-321	-164	-341	-178	-18	-12	-113	-7546	-158
C16	-52	-78	-2	-1	-32	-334	-47	-102	-73	-229	-120	-2	-5	-13	-215	-152	-36	-5	-186	0	-70	-231	-66	-16	-14	-6	-449	-2535	-63
C17	-182	-218	-4	-1	-73	-1357	-71	-169	-13	-703	-490	-8	-5	-28	-89	-366	-10	-10	-7	-1	-257	-172	-81	-14	-28	-15	-780	-5152	-106
C18	-3	-17	0	0	-2	-22	-6	-19	0	-9	-5	0	-2	-3	-54	-41	0	-2	0	-2	-22	-10	-2	-1	-1	-1	-5	-231	-7
C19	-35	-398	-8	-2	-23	-669	-339	-125	-9	-237	-383	-31	-3	-17	-59	-110	-104	-13	-6	-2	-1697	-213	-19	-14	-9	-4	-885	-5413	-459
C20	-246	-1245	-28	-4	-135	-5323	-217	-841	-7	-155	-2752	-36	-16	-80	-372	-925	-63	-30	-8	-2	-2205	-438	-72	-62	-38	-23	-355	-15678	-532
C21	-162	-1357	-18	-14	-82	-5097	-748	-717	-5	-86	-2455	-79	-29	-124	-1410	-1615	-13	-31	-9	-8	-1369	-197	-78	-41	-19	-54	-477	-16295	-339
C22	-145	-336	-16	-1	-168	-2548	-105	-404	-3	-73	-899	-23	-8	-101	-248	-693	-27	-21	-3	-3	-504	-371	-106	-56	-71	-32	-146	-7112	-194
C23	-65	-158	-18	-1	-79	-767	-46	-300	-2	-20	-327	-9	-7	-41	-153	-352	-3	-8	-5	0	-173	-197	-47	-11	-20	-8	-47	-2863	-66
C24	-147	-276	-16	-2	-95	-1770	-47	-548	-3	-100	-587	-76	-7	-34	-63	-559	-5	-20	-4	-1	-502	-217	-42	-34	-26	-17	-267	-5463	-177
C25	-282	-273	-16	-2	-214	-2310	-126	-352	-16	-55	-577	-18	-31	-64	-210	-933	-16	-15	-10	-5	-364	-372	-116	-38	-118	-42	-159	-6735	-129
C26	-218	-288	-20	-3	-441	-5067	-236	-283	-14	-174	-1846	-9	-10	-197	-664	-658	-13	-44	-8	-3	-1018	-542	-102	-98	-113	-23	-366	-12459	-338
C27	-291	-253	-20	-2	-245	-3311	-114	-422	-7	-106	-918	-39	-14	-98	-118	-1077	-11	-12	-6	-3	-386	-568	-71	-126	-68	-39	-207	-8532	-165
C28	-510	-506	-30	-2	-403	-7410	-440	-548	-8	-224	-1988	-25	-20	-231	-234	-2685	-13	-31	-7	-8	-1300	-533	-74	-123	-107	-42	-611	-18112	-324
C29	-895	-1299	-46	-6	-1189	-19608	-166	-2772	-12	-111	-3436	-33	-28	-509	-194	-2836	-22	-50	-11	-5	-1025	-1583	-305	-350	-495	-84	-898	-37967	-775
C30	-203	-340	-16	-1	-146	-2727	-46	-1130	-5	-47	-2598	-9	-9	-44	-21	-1395	-13	-12	-3	-2	-431	-325	-49	-122	-39	-14	-178	-9922	-304
C31-32	-172	-192	-13	-1	-137	-2259	-158	-288	-12	-60	-1106	-24	-13	-66	-254	-1320	-99	-10	-17	-2	-534	-352	-53	-70	-34	-21	-146	-7410	-128
C33	-69	-72	-7	-1	-37	-240	-20	-53	-4	-15	-434	-7	-7	-21	-19	-151	-7	-3	-2	-6	-96	-95	-19	-14	-22	-7	-19	-1447	-23

Table A.2.15. Aggregate LiVA (expressed in millions of US dollars) in all EU27 countries and the UK as a result of UK inflows from EU extraction. Goods.

	AUT	BEL	BGR	CYP	CZE	DEU	DNK	ESP	EST	FIN	FRA	GRC	HRV	HUN	IRL	ITA	LTU	LUX	LVA	MLT	NLD	POL	PRT	ROU	SVK	SVN	SWE	EU27	GBR
D35	-14	-80	-4	0	-25	-162	-153	-15	-3	-4	-46	-2	-8	-16	-2	-39	-1	-2	-4	0	-127	-18	-3	-4	-41	-3	-14	-790	-10
E36	-1	-8	-3	0	-11	-52	0	-2	0	0	-1	0	-5	-6	0	-8	0	0	-1	0	-5	-9	-2	-3	-8	-1	-1	-129	-1
E37-39	-36	-137	-29	-1	-53	-1020	-38	-25	-9	-32	-323	-21	-7	-28	-5	-221	-3	-17	-7	-2	-426	-91	-22	-73	-13	-5	-47	-2690	-58
F	-32	-330	-7	-1	-23	-262	-274	-34	-6	-11	-54	-10	-11	-13	-10	-79	-5	-32	-6	-4	-1033	-236	-21	-22	-23	-13	-48	-2601	-50
G45	-24	-313	-5	0	-10	-439	-28	-160	-2	-6	-224	-1	-1	-17	-28	-94	-1	-8	0	-6	-140	-442	-4	-6	-7	-1	-133	-2098	-21
G46	-289	-1276	-27	-6	-72	-4864	-623	-928	-6	-47	-4932	-8	-5	-167	-139	-853	-10	-101	-13	-22	-3752	-815	-75	-62	-59	-10	-492	-19654	-231
G47	-24	-659	-7	-9	-23	-219	-10	-316	-1	-5	-483	-1	-1	-25	-373	-465	-1	-38	-3	-3	-199	-689	-27	-16	-106	-3	-283	-3993	-67
H49	-76	-121	-14	-2	-84	-175	-42	-203	-7	-35	-796	-8	-14	-61	-34	-169	-18	-16	-54	-2	-864	-116	-30	-89	-12	-10	-36	-3089	-35
H50	-15	-80	-6	-29	-7	-655	-282	-58	-9	-24	-423	-635	-7	-7	-48	-112	-8	-5	-15	-17	-347	-26	-12	-26	-3	-2	-104	-2962	-74
H51	-54	-176	-24	-11	-48	-448	-75	-584	-7	-49	-1039	-56	-11	-69	-1351	-184	-8	-13	-48	-22	-845	-91	-257	-32	-8	-5	-114	-5630	-271
H52	-27	-223	-9	-10	-35	-200	-32	-112	-14	-13	-197	-28	-7	-37	-23	-148	-9	-13	-26	-17	-374	-34	-29	-25	-16	-4	-154	-1817	-24
H53	-27	-60	-1	0	-4	-125	-14	-3	-1	-4	-185	0	0	-8	-108	-24	0	-15	-1	-5	-473	-8	-2	-2	-2	-1	-3	-1078	-19
I	-118	-85	-4	-1	-15	-356	-21	-927	-2	-10	-24	-1	-2	-9	-278	-24	-18	-4	-1	-13	-27	-13	-90	-122	-13	-1	-6	-2184	-26
J58	-13	-31	-1	0	-29	-91	-23	-8	0	-7	-29	-1	-7	-2	-313	-14	0	-6	-1	0	-23	-19	-1	-2	-4	-1	-72	-697	-29
J59-60	-4	-11	-1	0	-3	-83	-23	-3	-1	-2	-31	-1	-1	-4	-5	-17	0	-2	0	0	-16	-20	-3	-1	-1	0	-17	-249	-3
J61	-107	-836	-17	-2	-59	-780	-115	-44	-9	-13	-1395	-4	-7	-47	-192	-773	-2	-115	-6	-7	-771	-106	-69	-68	-94	-39	-212	-5888	-114
J62-63	-32	-110	-14	-10	-39	-509	-41	-50	-3	-48	-195	-4	-2	-60	-479	-92	-1	-51	-1	-2	-274	-118	-6	-38	-15	-1	-104	-2296	-110
K64	-73	-357	-5	-204	-10	-1708	-46	-24	-10	-17	-355	-14	-4	-8	-1587	-189	-1	-555	-11	-194	-397	-68	-5	-12	-8	-4	-88	-5954	-772
K65	-8	-27	-3	-4	-10	-150	-16	-4	0	-9	-13	-13	0	-1	-229	-14	0	-5	0	-9	-50	-4	-1	-1	-1	-2	-6	-581	-57
K66	-3	-69	-1	-48	-1	-8	-10	-2	-3	-1	-4	0	-1	0	-86	-51	0	-10	0	-12	-13	-12	-1	-1	0	0	-3	-340	-24
L68	-56	-25	-5	-4	-36	-1119	-6	-6	-20	-2	-11	0	-2	-6	-2	-1244	-8	-18	-1	-10	-36	-450	-6	-5	-1252	-1	-13	-4342	-11
M69-70	-27	-461	-9	-2	-27	-394	-45	-20	-4	-42	-358	-10	-8	-44	-112	-80	-1	-73	-2	-23	-2568	-58	-15	-17	-74	-2	-117	-4592	-82
M71	-29	-121	-11	0	-23	-418	-82	-20	-2	-20	-301	-3	-9	-16	-171	-94	0	-39	-1	-2	-123	-39	-6	-21	-8	-3	-75	-1638	-21
M72	-12	-46	-22	0	-18	-253	-44	-6	-1	-33	-380	-5	-12	-17	-51	-131	0	-11	-1	0	-46	-21	-2	-12	-3	-1	-99	-1226	-15
M73	-36	-235	-18	-1	-28	-356	-30	-15	-4	-6	-408	-8	-12	-21	-67	-78	-1	-11	-9	-3	-63	-92	-11	-34	-12	-3	-72	-1635	-39
M74-75	-22	-52	-3	-2	-16	-834	-25	-9	-7	-15	-27	-38	-7	-181	-603	-712	-2	-11	-3	-1	-107	-221	-108	-7	-29	-19	-117	-3176	-45
N	-126	-923	-56	-5	-139	-2656	-937	-287	-29	-166	-9826	-41	-5	-55	-375	-2163	-4	-100	-26	-30	-848	-206	-144	-27	-90	-5	-211	-19482	-274
O84	-5	-88	0	-3	-8	-25	-7	-31	-1	-4	-234	-1	0	-3	-2	-22	0	-6	-1	-1	-768	-4	-15	-1	-8	0	-10	-1248	-12
P85	-12	-65	-5	0	-4	-96	-92	-11	0	-21	-55	-3	0	-1	-28	-5	-1	-6	0	0	-51	-13	-2	0	-7	-1	-11	-491	-2
Q	-3	-4	-2	0	-1	-38	-16	-8	0	-1	-116	0	0	-1	-46	-86	0	-12	0	0	-21	-39	-3	-1	-11	-1	-12	-425	-4
R-S	-86	-211	-14	-84	-122	-437	-87	-228	-18	-7	-539	-67	-144	-57	-26	-370	-2	-40	-7	-786	-278	-163	-29	-38	-70	-8	-80	-4000	-293

Table A.2.16. Aggregate LiVA (expressed in millions of US dollars) in all EU27 countries and the UK 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
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	-80	-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.2.17. 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	-2	-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-S	-3	-5	-30	-20	-44	-3	-7	-8	-8	-2	-11	-20	-15	-4	-113	-184	-4770

Table A.2.18. 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	-160,97	-157,61	-155,73	-138,39	-129,74	-115,69	-106,97	-103,84	-90,29	-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	-250,93	-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	-274,81	-239,26	-226,27	-223,75	-214,02	-201,05	-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	-160,96	-160,11	-145,43	-129,26	-119,78	-108,24	-103,64	-83,62	-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_C28	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	DEU_C31-32	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.2.19. 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.

Extracted Sector		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D35	Country-Sector	DNK_D35	DEU_D35	NLD_D35	BEL_D35	DNK_B	ROW_B	SVK_D35	FRA_D35	ITA_D35	NOR_B	CZE_D35	RUS_B	HUN_D35	DEU_O84	SWE_D35
	Loss	-89,93	-86,05	-69,59	-53,28	-34,14	-32,29	-30,17	-28,50	-19,83	-17,37	-15,73	-11,63	-10,78	-10,16	-8,71
E36	Country-Sector	DEU_E36	POL_E36	CZE_E36	BEL_E36	SVK_E36	ITA_E36	HRV_E36	HUN_E36	NLD_E36	ROU_E36	BGR_E36	PRT_E36	DEU_N	DEU_D35	ROW_B
	Loss	-34,20	-6,56	-6,41	-5,26	-5,04	-4,34	-4,19	-4,09	-2,60	-2,11	-1,97	-1,74	-1,58	-1,55	-1,35
E37-39	Country-Sector	DEU_E37-39	NLD_E37-39	FRA_E37-39	ITA_E37-39	BEL_E37-39	DEU_N	POL_E37-39	USA_E37-39	DEU_M71	DEU_L68	DEU_F	FRA_N	DEU_G46	NLD_G46	ROU_E37-39
	Loss	-585,87	-219,68	-175,15	-89,99	-84,31	-65,14	-51,77	-46,32	-41,10	-34,60	-32,80	-31,35	-29,25	-28,24	-27,23
F	Country-Sector	NLD_F	BEL_F	DNK_F	POL_F	DEU_F	NLD_G46	NLD_C25	NLD_K64	ROW_B	NLD_N	ITA_F	DNK_G46	NLD_M71	LUX_F	NLD_L68
	Loss	-657,43	-199,48	-153,97	-129,73	-64,14	-58,80	-39,78	-35,06	-33,69	-28,64	-25,64	-25,45	-22,33	-21,88	-20,41
G45	Country-Sector	POL_G45	DEU_G45	BEL_G45	FRA_G45	ESP_G45	NLD_G45	SWE_G45	ITA_G45	DEU_L68	IRL_G45	DNK_G45	BEL_M69_70	DEU_C29	AUT_G45	FRA_N
	Loss	-369,62	-302,17	-222,40	-141,83	-100,43	-95,14	-91,80	-44,58	-23,65	-21,63	-17,99	-17,08	-15,26	-13,40	-11,88
G46	Country-Sector	DEU_G46	NLD_G46	FRA_G46	BEL_G46	ESP_G46	POL_G46	ITA_G46	DNK_G46	FRA_N	FRA_L68	DEU_H52	SWE_G46	FRA_M69_70	DEU_L68	DEU_N
	Loss	-3086,78	-2765,73	-2679,59	-777,92	-533,27	-532,64	-436,78	-427,18	-350,98	-345,13	-344,69	-314,47	-285,14	-231,58	-211,25
G47	Country-Sector	POL_G47	BEL_G47	FRA_G47	ITA_G47	IRL_G47	ESP_G47	SWE_G47	NLD_G47	DEU_G47	SVK_G47	BEL_L68	ITA_L68	ESP_L68	FRA_N	BEL_M69_70
	Loss	-513,09	-478,26	-304,11	-290,22	-288,93	-216,77	-203,18	-127,95	-95,58	-73,51	-46,17	-43,82	-32,12	-24,19	-24,07
H49	Country-Sector	NLD_H49	FRA_H49	ESP_H49	ITA_H49	BEL_H49	DEU_H49	POL_H49	ROW_B	FRA_H52	ROU_H49	AUT_H49	CZE_H49	FRA_N	HUN_H49	NLD_N
	Loss	-599,01	-538,66	-114,93	-101,91	-69,88	-69,56	-64,49	-62,30	-59,12	-48,59	-48,54	-47,48	-39,76	-37,92	-35,88
H50	Country-Sector	GRC_H50	DEU_H50	DEU_H52	NLD_H50	DNK_H50	ROW_H52	FRA_H52	ROW_B	GRC_L68	FRA_H50	FRA_N	DNK_H52	DEU_N	DEU_H49	FRA_M69_70
	Loss	-390,99	-246,31	-160,52	-158,07	-135,61	-98,88	-94,94	-92,63	-91,83	-67,20	-59,43	-56,61	-49,00	-38,45	-37,85
H51	Country-Sector	IRL_H51	FRA_H51	NLD_H51	ROW_B	ESP_H51	DEU_H51	PRT_H51	NLD_H52	IRL_H52	ESP_H52	USA_N	FRA_N	NOR_B	ROW_N	RUS_B
	Loss	-911,63	-597,41	-341,67	-274,48	-237,08	-115,44	-109,97	-92,57	-81,24	-79,39	-78,51	-71,91	-63,28	-61,03	-58,01
H52	Country-Sector	NLD_H52	BEL_H52	FRA_H52	DEU_H52	SWE_H52	ITA_H52	ESP_H52	HUN_H52	CZE_H52	NLD_N	PRT_H52	DNK_H52	DEU_H49	LVA_H52	BEL_M69_70
	Loss	-250,87	-139,54	-135,66	-105,18	-92,43	-86,66	-67,99	-25,13	-19,16	-19,13	-18,90	-18,75	-18,34	-18,18	-17,62
H53	Country-Sector	NLD_H53	FRA_H53	IRL_H53	DEU_H53	BEL_H53	AUT_H53	NLD_K64	DEU_H52	NLD_N	USA_H53	ITA_H53	NLD_M69_70	LUX_H53	DNK_H53	NLD_L68
	Loss	-364,01	-144,56	-91,90	-62,71	-40,42	-20,86	-16,74	-14,78	-14,54	-14,51	-13,57	-12,82	-8,99	-8,80	-8,48
I	Country-Sector	ESP_I	IRL_I	DEU_I	AUT_I	ROU_I	PRT_I	ESP_L68	ESP_C10-12	BEL_I	ESP_G46	DEU_L68	ESP_A01	DEU_N	IRL_L68	ESP_K64
	Loss	-610,14	-222,38	-182,55	-83,60	-71,60	-61,95	-51,50	-50,71	-49,05	-38,77	-32,34	-24,83	-16,93	-16,59	-14,59
J58	Country-Sector	IRL_J58	DEU_J58	SWE_J58	CZE_J58	DNK_J58	BEL_J58	FRA_J58	POL_J58	NLD_J58	USA_N	USA_G46	IRL_C31-32	DEU_N	USA_M72	DEU_J62-63
	Loss	-279,31	-41,21	-40,94	-18,69	-15,31	-15,00	-12,78	-10,68	-9,20	-8,49	-7,15	-6,60	-6,11	-5,48	-5,22
J59-60	Country-Sector	DEU_J59-60	FRA_J59-60	DNK_J59-60	POL_J59-60	NLD_J59-60	SWE_J59-60	ITA_J59-60	BEL_J59-60	DEU_N	IRL_J59-60	DEU_R-S	HUN_J59-60	DEU_L68	CZE_J59-60	AUT_J59-60
	Loss	-59,62	-17,33	-15,31	-13,68	-10,11	-8,84	-8,59	-7,47	-3,46	-3,35	-3,20	-2,93	-2,31	-2,04	-1,96
J61	Country-Sector	FRA_J61	NLD_J61	BEL_J61	ITA_J61	DEU_J61	IRL_J61	SWE_J61	LUX_J61	FRA_N	SVK_J61	DEU_L68	DNK_J61	AUT_J61	FRA_M69_70	POL_J61
	Loss	-824,28	-597,30	-584,84	-445,30	-396,10	-163,14	-109,83	-101,87	-83,91	-67,55	-67,45	-63,31	-62,53	-57,19	-53,50
J62-63	Country-Sector	DEU_J62-63	IRL_J62-63	USA_N	ROW_N	NLD_J62-63	FRA_J62-63	POL_J62-63	USA_G46	NLD_N	BEL_J62-63	SWE_J62-63	HUN_J62-63	ITA_J62-63	USA_K64	GBR_M74-75
	Loss	-382,40	-354,30	-284,52	-172,26	-127,63	-111,71	-82,87	-76,79	-69,47	-68,78	-61,57	-46,19	-43,86	-33,61	-32,14
K64	Country-Sector	IRL_K64	DEU_K64	LUX_K64	USA_K66	GBR_K66	NLD_K64	BEL_K64	FRA_K64	LUX_K66	DEU_M69_70	MLT_K64	DEU_L68	GBR_M69_70	USA_K64	CHE_K64
	Loss	-1317,18	-1026,54	-291,10	-266,05	-255,09	-249,98	-240,08	-202,96	-151,92	-131,03	-121,71	-120,44	-114,37	-107,30	-98,95
K65	Country-Sector	IRL_K65	ROW_K65	DEU_K65	ROW_K64	DEU_K66	NLD_K65	IRL_K66	USA_K66	BEL_K65	GBR_K66	DNK_K65	DEU_M69_70	GBR_M74-75	DEU_L68	ROW_J61
	Loss	-162,80	-103,04	-62,80	-28,11	-26,76	-23,11	-18,44	-17,34	-13,85	-13,45	-11,64	-10,35	-9,65	-8,86	-8,82
K66	Country-Sector	IRL_K66	BEL_K66	ITA_K66	CYP_M69_70	MLT_K66	CYP_K64	DNK_K66	BEL_M69_70	LUX_K66	CYP_K66	POL_K66	NLD_K66	GBR_K66	USA_K66	BEL_L68
	Loss	-66,57	-39,51	-34,22	-26,87	-9,16	-7,59	-7,20	-6,95	-6,89	-6,31	-6,26	-5,69	-5,17	-5,10	-3,48
L68	Country-Sector	ITA_L68	DEU_L68	SVK_L68	POL_L68	SVK_R-S	SVK_F	DEU_F	AUT_L68	ITA_K64	DEU_M69_70	DEU_K64	POL_D35	POL_F	SVK_K64	EST_L68
	Loss	-1138,91	-921,43	-914,44	-309,91	-122,07	-53,93	-43,22	-39,06	-33,40	-30,67	-28,18	-27,66	-26,98	-17,65	-17,17
M69-70	Country-Sector	NLD_M69_70	BEL_M69_70	DEU_M69_70	FRA_M69_70	NLD_N	NLD_K64	IRL_M69_70	SWE_M69_70	NLD_L68	NLD_G46	ROW_N	USA_M69_70	LUX_M69_70	SVK_M69_70	USA_N
	Loss	-1839,93	-353,79	-265,79	-216,60	-109,11	-89,44	-84,17	-77,20	-69,68	-69,15	-59,38	-57,54	-56,06	-52,69	-50,64
M71	Country-Sector	DEU_M71	FRA_M71	IRL_M71	NLD_M71	BEL_M71	ITA_M71	DNK_M71	SWE_M71	DEU_M69_70	LUX_M71	DEU_L68	POL_M71	AUT_M71	FRA_N	FRA_L68
	Loss	-270,24	-198,24	-151,66	-83,81	-79,61	-64,35	-50,98	-49,59	-39,93	-33,86	-24,77	-24,16	-21,01	-15,81	-14,70
M72	Country-Sector	FRA_M72	DEU_M72	ITA_M72	SWE_M72	IRL_M72	FRA_N	NLD_M72	BEL_M72	FIN_M72	DNK_M72	FRA_M69_70	BGR_M72	FRA_L68	POL_M72	HUN_M72
	Loss	-242,78	-170,20	-93,79	-69,06	-45,59	-29,06	-27,76	-26,96	-25,60	-23,33	-18,10	-17,98	-16,37	-14,49	-13,49
M73	Country-Sector	FRA_M73	DEU_M73	BEL_M73	POL_M73	IRL_M73	BEL_M69_70	FRA_N	DEU_J59-60	SWE_M73	NLD_M73	BEL_J59-60	ITA_M73	FRA_M69_70	ROU_M73	DEU_L68
	Loss	-240,27	-204,13	-96,29	-63,93	-55,87	-45,99	-43,00	-36,17	-30,44	-27,44	-24,01	-18,96	-16,74	-15,61	-14,92
M74-75	Country-Sector	DEU_M74-75	ITA_M74-75	IRL_M74-75	POL_M74-75	HUN_M74-75	NLD_M74-75	SWE_M74-75	DEU_M69_70	PRT_M74-75	ITA_M69_70	IRL_L68	DEU_L68	DEU_N	BEL_M74-75	ITA_N
	Loss	-497,21	-488,87	-475,17	-157,91	-142,59	-66,20	-62,80	-61,82	-61,68	-36,27	-35,23	-34,83	-34,61	-27,18	-23,15
N	Country-Sector	FRA_N	DEU_N	ITA_N	BEL_N	DNK_N	NLD_N	FRA_L68	FRA_M69_70	IRL_N	FRA_K64	ESP_N	FRA_I	FRA_H52	FRA_G46	DEU_M69_70
	Loss	-7248,99	-1923,30	-1199,37	-649,56	-615,09	-607,37	-458,74	-402,93	-307,62	-176,59	-156,70	-123,25	-119,05	-117,49	-115,41
O84	Country-Sector	NLD_O84	FRA_O84	BEL_O84	NLD_N	ESP_O84	NLD_K64	NLD_F	ITA_O84	NLD_G46	PRT_O84	NLD_M69_70	NLD_J62-63	NLD_L68	FRA_N	NLD_Q
	Loss	-568,90	-187,80	-69,62	-41,97	-23,41	-23,28	-18,64	-15,21	-12,00	-11,74	-9,53	-8,90	-8,72	-8,27	-7,87
P85	Country-Sector	DEU_P85	DNK_P85	BEL_P85	FRA_P85	NLD_P85	IRL_P85	FIN_P85	POL_P85	AUT_P85	ESP_P85	SWE_P85	LUX_P85	SVK_P85	BGR_P85	ITA_P85
	Loss	-80,72	-78,40	-61,05	-47,50	-43,94	-25,13	-17,46	-10,46	-10,41	-9,40	-7,57	-6,14	-5,81	-4,38	-3,75
Q	Country-Sector	FRA_Q	ITA_Q	IRL_Q	POL_Q	DEU_Q	NLD_Q	DNK_Q	LUX_Q	SWE_Q	SVK_Q	ESP_Q	ITA_M69_70	FRA_N	BEL_Q	AUT_Q
	Loss	-98,93	-64,85	-41,94	-29,56	-26,25	-16,22	-13,42	-11,06	-9,30	-7,89	-5,76	-2,68	-2,47	-2,43	-2,31
R-S	Country-Sector	MLT_R-S	FRA_R-S	DEU_R-S	ITA_R-S	ESP_R-S	NLD_R-S	BEL_R-S	HRV_R-S	POL_R-S	CZE_R-S	DNK_R-S	GBR_M73	SVK_R-S	GBR_M69_70	GRC_R-S
	Loss	-536,21	-369,81	-297,00	-193,78	-161,29	-158,33	-124,62	-97,90	-90,98	-78,16	-59,33	-57,40	-52,63	-46,19	-45,28

Table A.2.20. Top 15 most affected country-sectors in terms of LiVA (expressed in millions of US dollars) as a result of UK services imports from EU hypothetical extraction.

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