



The network of production and supply links between British industries, the EU and Germany

Author:

Berthold Busch
Telefon: 0049-221 4981-762
E-Mail: busch@iwkoeln.de

June 2017

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JEL Classification:

F13: trade policy; international trade organizations

F14: empirical studies of trade

O52: Europe

Abstract¹

If the British government has its way, when the United Kingdom (UK) withdraws from the European Union (EU), it will also leave the internal market and the customs union. This means that trade between the two economic areas will in future be hobbled by non-tariff trade barriers and, if the worst comes to the worst, by actual tariffs. This may not only mean additional costs for end consumers, but would also affect those companies in the UK and the EU that are linked by value chains. In order to find out which industries will be particularly affected, this study examines data from the World Input-Output Database (WIOD) on the exchange of inputs between 56 industries in the UK and the EU on the one hand, and between the United Kingdom and Germany on the other. The majority of inputs exported from the UK to the EU are provided by service industries. In the other direction, the picture looks very different. Eight of the ten EU industries with the largest volume of intermediate products and services exported to the UK are in manufacturing. The inverse coefficients for the exchange of inputs between Germany and the UK are calculated for each sector. This shows how dense the network of links between these industries is. The value regarding German inputs sourced from Britain is the highest for other transport equipment, followed by coke and refined petroleum products and the basic metal industry. In terms of British inputs sourced from Germany, the inverse coefficients suggest that the industries most affected are automobile and chemicals.

¹ This article is a translated version of Busch (2017).

1. Potential adjustment burden

The British government has made it clear that the United Kingdom (UK) does not want to be part of the EU's internal market and customs union after it leaves the European Union (EU) (May, 2017; HM Government, 2017). This does not mean that there will necessarily be tariffs between the UK and the EU, because the British are striving for a free trade agreement with the EU as well as a customs agreement. However, bureaucratic burdens on trade flows or non-tariff trade barriers between the two economic areas are to be expected when both sides conclude a free trade agreement, due to customs clearance procedures on the one hand and rules of origin on the other.

If both negotiating parties do not agree on a free trade agreement, the trade relations between the two economic areas would in future be subject to the rules of the World Trade Organisation (WTO). The EU's average external tariff was only 5.1 per cent in 2015. However, this average value masks the sometimes high tariffs on agricultural products: milk products – 33.5 per cent, confectionery – 20.2 per cent, beverages and tobacco – 19.4 per cent (WTO, 2017). The EU also has an above-average import tariff for certain industrial products: trucks – 22 per cent, passenger cars – 10 per cent (European Commission, 2017). According to a study by Open Europe (Booth et al., 2015), 35 per cent of British exports go to industries where the EU charges significant tariffs: cars, chemicals, clothing, food, beverages and tobacco. The German chemical industry can expect to pay an annual tariff bill of EUR 200 million if the British impose duties at the current EU external tariff rate (VCI, 2017). There would be a disruptive effect on trade flows for different key areas due to WTO tariffs (Carl, 2017, 12).

In addition, it is not yet known whether there will be any regulatory differences. This would mean that products manufactured for the respective domestic market would have to be technically modified before they could be placed on other markets. This would be the case if the regulations in both economic areas, which are very similar today, were further developed in different ways. The British plan to first transform existing Community legislation into British law with the Great Repeal Bill after its exit, but then allow the British Parliament and Government to amend these rules (Caird, 2017), could result in this outcome.

Modern free trade agreements are an instrument to reduce these so-called non-tariff barriers whereby regulations and standards are harmonised or are mutually recognised as equivalent. However, this is not always feasible and is difficult, as shown by the negotiations on the transatlantic free trade agreement (TTIP) or the EU's economic and trade agreement with Canada (CETA). Moreover, the

bureaucratic hurdles associated with rules of origin still remain. In a customs union, goods that are imported from third countries and have legally crossed the common external customs border can freely circulate between the member states of the customs union; but when it comes to the cross-border movement of goods between the member states of a free trade zone, it must always be shown that the products originate wholly or to a significant extent from the free-trade area and not from non-member countries (rules of origin). Otherwise, third countries could use the member state of a free trade area with the lowest level of external tariffs as a means of moving their goods to countries in the free trade zone that apply higher tariff rates. According to recent studies, rules of origin generate costs in the region of 4 to 8 per cent of the value of the goods (CEPR, 2013, 57). These costs can lead to changes in demand. In the CETA agreement, more than 100 pages are devoted to the subject of rules of origin, with special attention being paid to the sectors that are likely to cause problems: motor vehicles, agriculture and fisheries (Carl, 2017, 16).

Further problems arise from the exchange of services. Even within the internal market, the trade in services is considered to be less liberalised than the cross-border movement of goods (Dunne, 2015). Brexit has two consequences in this regard: Firstly, even modern free trade agreements (e.g. CETA) do not contain provisions for a comprehensive liberalisation of the mutual exchange of services. CETA does not include banking services, for example (Cremades/Novak, 2017, 33). The UK would therefore definitely be worse off than the status quo because there would be regulatory differences. Secondly, there are efforts within the internal market to further liberalise cross-border trade in services. This would exacerbate the regulatory differences between the EU and the UK.

2. Investigative steps

External trade between the EU member states is currently not limited to products that meet final demand (Matthes et al., 2017). Trade also often takes place at the level of intermediate inputs within value chains. If production parts in such value chains cross the border between the British economy and the other EU member states several times, they will be particularly affected by these non-tariff trade barriers, but also by tariffs that cannot be entirely excluded. According to European automobile associations, a single car part may be composed of more than 30 components, pass through 100 processing steps until completion and cross the borders of 15 countries. A single vehicle consists of around 30,000 parts (ACEA / CLEPA, 2017). It would therefore make sense to look at the flow of intermediate inputs between the EU and the UK. The tables of the World Input-Output Database, updated for 2014, are used

as the data source (Timmer et al., 2015; WIOD, 2016). The data is based on US dollars.

The first part deals with the relations between the UK and the EU. Firstly, the intermediate input links between the EU and the UK are presented in selected sectors: on the one hand, from the UK's perspective and on the other hand, from the EU's perspective. It then examines which British industries are most closely linked to the EU, in other words what portion of their exported intermediate inputs is exported to other member states and what share these economic sectors have in the overall value added in the UK.

The second part focuses on the relations between the British and German economies. This involves three aspects:

- Which German industries are most closely linked to the UK, especially in terms of intermediate inputs?
- Of all the German industries, which ones are most dependent on intermediate inputs from the UK?
- Of all the British industries, which ones are most dependent on intermediate inputs from Germany?

Of the 56 industries reviewed in the WIOD, the British industry that delivered most to the EU-27 was administrative and support service activities (Table 1a). This includes the rental of vehicles and machinery, the activities of travel agencies and tour operators, trade fair services and the provision of labour. The UK had a surplus of over USD 2 billion here. In second place was wholesale trade, ahead of activities related to financial and insurance services. In the case of the latter, the British registered the largest surplus with USD 14 billion. Industrial products ranked fourth (chemicals) and only three industrial sectors were among the top ten. The strength of the British service sector is already apparent compared to the manufacturing sector. The sectors included in the table accounted for 58 per cent of all intermediate inputs exported by Britain to the EU in 2014.

In 2014, 27 member states supplied intermediate inputs worth some USD 230 billion to the UK, which in turn exported intermediate inputs to the value of USD 202 billion to these 27 member states. Thus, the British had an intermediate input trade deficit of USD 28 billion vis-à-vis the EU. The largest supplier of intermediate products and services to the UK was Germany, followed by France, the Netherlands, Italy and Ireland. The third place for the Netherlands is likely to be over-estimated by the so-called Rotterdam effect: goods that reach the EU from third countries via the Rotterdam port do not necessarily stay in the Netherlands, but are also sent from

there to other EU countries. Fifth place for Ireland signalled the traditionally close economic ties between the two islands.

Table 1: The supply of intermediate inputs between the EU and the UK

Figures for 2014 in USD millions

a. Supply of intermediate inputs from selected industries in the UK to the EU-27

WZ number	Industry	UK to EU	Balance for UK
N	Administrative and support service activities	22,442	2,154
G46	Wholesale trade	21,066	8,866
K66	Activities auxiliary to financial services and insurance activities	14,352	14,059
C20	Manufacture of chemicals and chemical products	11,659	-7,219
M74-M75	Other professional, scientific and technical activities	11,236	8,146
B	Mining and quarrying	9,639	6,290
C24	Manufacture of basic metals	7,974	828
M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities	7,803	2,666
K64	Financial services	5,728	-12
C28	Manufacture of machinery and equipment	5,663	-4,757

b. Supply of intermediate inputs from selected industries in the EU-27 to the UK

WZ number	Industry	EU to UK	Balance for EU
N	Administrative and support service activities	20,288	-2,154
C20	Manufacture of chemicals and chemical products	18,878	7,219
C29	Manufacture of motor vehicles and parts	16,305	11,506
C21	Manufacture of pharmaceutical products	13,963	10,338
G46	Wholesale trade	12,200	-8,866
C26	Manufacture of computers	11,843	7,091
C28	Manufacture of machinery and equipment	10,419	4,757
C19	Manufacture of coke and refined petroleum products	9,848	4,469
C22	Rubber and plastics	7,706	3,291
C27	Manufacture of electrical equipment	7,238	3,766

WZ number: Classification of economic sectors.
Sources: WIOD, 2016; Cologne Institute for Economic Research

Table 1: http://www.iwkoeln.de/_storage/asset/346493/storage/master/download/tab1.xlsx

While other economic services dominate the intermediate input trade between EU and Britain (Table 1b), industrial products occupy the next three places. Eight of the ten sectors with the largest volume of intermediate products and services exported to the UK are in manufacturing. In the other direction, it is only three of the ten sectors. According to statistics from the British Parliament, in 2016 the UK imported

intermediate products and services for automobile production to the value of GBP 10.8 billion, 80 per cent of which came from the EU (Mor/Brown, 2017, 10).

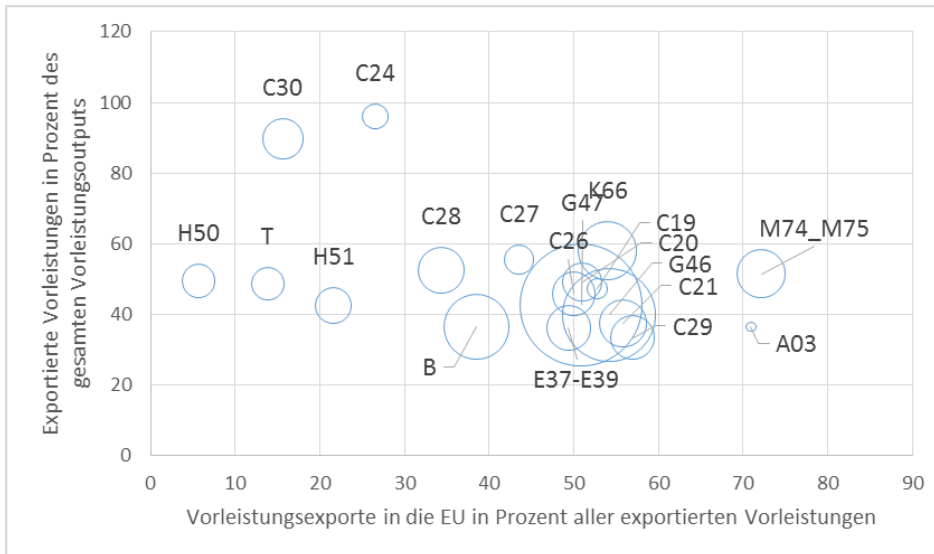
3. Link to value added

The links between the UK and the EU described above do neither indicate the extent to which industries are export-oriented regarding their production of intermediates, nor do they indicate the overall economic importance of the individual economic sectors. Therefore, the following questions have been explored: Which British industries are most closely linked to the EU? What portion of their exports of intermediate inputs is exported to other member states and what share do these industries have in the overall value added in the UK? Only the industries with an export rate of more than one third for intermediate products and services are taken into account.

What is initially apparent is that the industry that supplies the most intermediate inputs to the EU of all the sectors (administrative and support service activities) is generally not very export-oriented. In this industry, the rate of intermediate inputs exported is 17.2 per cent of the total intermediate output and therefore does not appear in Figure 1. Also the legal and tax consultancy, auditing, business consultancy and financial services sectors are concentrated mainly on the UK market with export rates for intermediate inputs of 10.1 and 21.2 per cent.

The other sectors included in Table 1a show an export rate for intermediate inputs of more than one third of the total intermediate output, which means they appear in Figure 1. These industries account for 19.5 per cent or almost one fifth of the UK's value added. Ten British industries export 50 per cent or more of their intermediate input exports to other EU member states. Other professional, scientific and technical activities are at the top of the list (M74-M75). They include designer activities, translation and interpreting, and veterinary activities with over 72 per cent, followed by fisheries and aquaculture. The automobile and pharmaceutical industries belong to the manufacturing sector. However, they contribute only 1.5 per cent to the value added in the UK. This is different for wholesale trade (G46) and activities related to financial services (K66); their contribution to value added in the UK amounts to 3.2 per cent and 1.3 per cent. This is the same for retail trade (G47), which also has close ties with the EU and its share of value added in the UK is 5.6 per cent. These results demonstrate the low overall economic importance of the manufacturing sector in the UK. In 2016, its share of value added amounted to 9.7 per cent, while the EU average was 16 per cent.

Figure 1: Intermediate Inputs exported by British industries
 Figures in per cent¹⁾



Vertical axis = Exported inputs as a percentage of total output.

Horizontal axis = Inputs exported to the EU as a percentage of all exported inputs.

WZ number: Classification of economic sectors (see annex).

1) Share of total value added in the UK as bubble size.

Sources: WIOD, 2016; Cologne Institute for Economic Research

Figure 1: http://www.iwkoeln.de/_storage/asset/346490/storage/master/download/abb1.xlsx

By linking the supply of intermediate inputs from British industries to the EU with the share of industries in the overall value added in the UK, this connects the industries to the British economy. In this way, the results show that in the case of a (hard) Brexit, the British economy would be less affected by tariff and non-tariff trade barriers in individual industries, but primarily by restrictions on the access of British services exports to the internal market. It is questionable whether a possible free trade or association agreement in the service sector can offer similarly good market access as for industrial goods.

4. The input relationships between Germany and the UK

In this section, the focus will be on the relationship between the British and the German economy. The aim is to find out which German industries supply the most to the UK, which British intermediate inputs are imported by German industries, and what share of German intermediate inputs are exported to the UK.

Of the 56 German industries, 15 supply intermediate products and services worth more than USD 1 billion to the UK, including 11 industrial sectors (Table 2). The

automobile sector is at the top of the list, followed by chemical and pharmaceutical products. These are particularly vulnerable sectors as far as Britain's exit from the EU is concerned. According to a study by Open Europe (Booth et al., 2017, 19, 38), there are strict requirements for compliance with product standards for highly regulated industries such as the automobile and chemical industries. An authorised conformity assessment body carries out the necessary checks and issues certifications. A hearing in the British Parliament also showed that there are major concerns about non-tariff trade barriers in the automobile and aerospace industries (House of Commons, 2017, Q7).

Table 2: Supply of intermediate inputs from German industries to the UK
Supply and German-UK balance in 2014 in USD millions

WZ number	Industry	Supply	Balance D-UK
C29	Manufacture of motor vehicles and parts	6,266	4,525
C20	Manufacture of chemicals and chemical products	6,109	2,737
C21	Manufacture of pharmaceutical products	4,853	4,486
C26	Manufacture of computers	4,259	3,121
C28	Manufacture of machinery and equipment	4,158	3,045
G46	Wholesale trade	3,078	-800
C22	Rubber and plastics	2,753	1,872
C24	Manufacture of basic metals	2,674	-167
C27	Manufacture of electrical equipment	2,630	1,963
N	Administrative and support service activities	2,475	980
C25	Manufacture of fabricated metal products	1,955	1,609
C17	Paper and paper products	1,465	1,245
K64	Financial services	1,224	-311
C19	Manufacture of coke and refined petroleum products	1,131	416
E37-E39	Sewerage; waste collection, treatment and disposal activities	1,126	-109

WZ number: Classification of economic sectors.

Sources: WIOD, 2016; Cologne Institute for Economic Research

Table 2: http://www.iwkoeln.de/_storage/asset/346494/storage/master/download/tab2.xlsx

If there was a regulatory difference following Brexit, these industries in particular would have to pay adjustment costs if they wanted to market their products in the UK. This would also be the case in the reverse situation. Five of the industrial sectors included in Table 2 also received intermediate inputs of more than USD 1 billion from the UK in 2014: the chemical industry – USD 3.4 billion, metal production and processing – USD 2.8 billion, the automobile industry – USD 1.7 billion, computer manufacturing – USD 1.1 billion, and machinery and equipment manufacturing – USD 1.1 billion. Financial services accounted for USD 1.5 billion. In absolute figures,

wholesale trade imported the most intermediate inputs in 2014, at a value of USD 3.9 billion.

5. Overall economic importance

Not only is there a focus on the absolute values, but the importance of the supply of intermediate products and services from German industries to the UK is also taken into account. To this end, the exported intermediate output is initially compared with the total intermediate output of the industry. The percentage of intermediates exported to the UK is then determined (Table 3). The criterion for selecting the industry is based on an export rate of more than one third of the output.

This analysis shows that eight sectors in Germany - six of which are industrial sectors – export 5 per cent or more of their intermediate inputs to the UK. This share is particularly high in the pharmaceutical industry at over 22 per cent. In second place is computer manufacturing, followed by car manufacturing. The industries listed here account for a total of almost 22 per cent of the total value added in Germany. Of the above-mentioned sectors, the automobile industry has the largest proportion with 4 per cent. The vulnerability of the automobile, chemical and pharmaceutical industries with regard to Brexit is also apparent from this analysis.

6. Effects of interdependencies in Germany

It was further examined which German industries are likely to be most impacted by the changed economic framework conditions as a result of Britain's exit from the internal market and the customs union together with inputs from the UK. The bureaucratic burdens of supply and value chains will, in the case of industrial products, lead to changes in the demand and supply behaviour of the companies concerned. This in turn would have an effect on other sectors because of the general economic interdependencies. Similar effects would also arise in the case of services if mutual market access is restricted.

The intensity of the intermediate input ties between German and British industries can initially be calculated based on the input coefficients from the WIOD for the supply of intermediate inputs from British industries to 56 German economic sectors. The quotient is calculated from the field value and the column total. The input coefficients indicate how much of an industry's output was sourced from another production area. The input coefficients thus indicate the extent to which the output of a German industry is dependent on British inputs. However, they only take into account the direct effects of a change in demand. But it should be noted that the

inverse coefficients not only measure the direct changes in final demand in an industry but also the indirect changes. They therefore show all the changes that impact other industries if one industry experiences a change in final demand.

Table 3: Supply of intermediate inputs from German industries in relation to total intermediate output

WZ number	Industry	Intermediates exported to the UK as a percentage of all exported intermediates	Exported intermediates as a percentage of total output of intermediates	Share of value added in Germany in per cent
C21	Manufacture of pharmaceutical products	22.3	63.9	0.9
C26	Manufacture of computers	9.4	87.6	1.3
C29	Manufacture of motor vehicles and parts	6.7	53.3	4.0
E37-E39	Sewerage; waste collection, treatment and disposal activities	6.7	33.6	0.8
C17	Paper and paper products	6.5	50.2	0.4
C22	Rubber and plastics	5.9	54.4	1.0
H51	Air transport	5.0	43.6	0.2
C20	Manufacture of chemicals and chemical products	5.0	79.0	1.6
C23	Glass, ceramics	4.9	34.3	0.6
C30	Other transport equipment	4.9	57.9	0.5
C28	Manufacture of machinery and equipment	4.6	61.5	3.5
C31-C32	Manufacture of furniture; other manufacturing	4.5	72.1	0.9
C27	Manufacture of electrical equipment	4.4	62.4	1.7
C24	Manufacture of basic metals	4.4	48.6	0.8
I	Hotels and restaurants	4.2	49.4	1.5
C19	Manufacture of coke and refined petroleum products	4.2	46.8	0.2
C16	Manufacture of wooden products	4.0	34.0	0.2
C13-C15	Textiles, clothing, leather products	3.0	92.9	0.3
A03	Fishing and aquaculture	3.0	58.8	0.0
H50	Water Transport	2.6	79.3	0.3
M72	Research and development	2.5	42.9	0.8
B	Mining and quarrying	0.5	77.4	0.2

WZ number: Classification of economic sectors.

Sources: WIOD, 2016; Cologne Institute for Economic Research

Table 3: http://www.iwkoeln.de/_storage/asset/346495/storage/master/download/tab3.xlsx

Table 4: Inverse coefficients for German inputs sourced from the UK

German industry that receives intermediate inputs from the UK				British industry that supplies intermediate inputs with the greatest impact on the German industry		
WZ number	Industry	Cumulative coefficient	Share of value added in D in per cent	WZ number	Industry	Coefficient
C30	Other transport equipment	0.079	0.5	C30	Other transport equipment	0.032
C19	Manufacture of coke and refined petroleum products	0.058	0.2	B	Mining and quarrying	0.019
C24	Manufacture of basic metals	0.054	0.8	C24	Manufacture of basic metals	0.011
C20	Manufacture of chemicals and chemical products	0.047	1.6	C20	Manufacture of chemicals and chemical products	0.011
C22	Rubber and plastics	0.041	1.0	C20	Manufacture of chemical products	0.010
H51	Air transport	0.040	0.2	C19	Manufacture of coke and refined petroleum products	0.005
C33	Repair and installation of machinery	0.038	0.6	C30	Other transport equipment	0.008
C13-C15	Textiles, clothing, leather products	0.037	0.3	G46	Wholesale trade	0.006
C29	Manufacture of motor vehicles and parts	0.032	4.0	C29	Manufacture of motor vehicles and parts	0.005
C17	Paper and paper products	0.030	0.4	C20	Manufacture of chemical products	0.003
C25	Manufacture of fabricated metal products	0.027	2.0	C24	Manufacture of basic metals Metal production and processing	0.005
C28	Manufacture of machinery and equipment	0.027	3.5	C24	Manufacture of basic metals Metal production and processing	0.003

Inverse coefficient: If the final demand for other transport equipment in Germany changes by 1,000 units, the intermediate inputs from the other transport equipment industry in Britain changes by 32 units.

Cumulative coefficient: Addition of the inverse coefficients of all the exporting British industries compared to the individual industries in Germany. WZ number: Classification of economic sectors.

Sources: WIOD, 2016; Cologne Institute for Economic Research

Table 4: http://www.iwkoeln.de/_storage/asset/346496/storage/master/download/tab4.xlsx

An inverse coefficient of 0.032 (other transport equipment in Table 4, right column) indicates that a change of 1,000 units in the final demand for products in this industry in Germany means a change of 32 units for intermediate inputs from the corresponding British industry (other transport equipment). The higher the coefficient, the greater the multiplier effect in the case of a change in the final demand for products from the respective industry, but also the more intense the economic relationship in terms of intermediate inputs. Therefore, the higher the inverse coefficient is, the more the industry concerned is affected by non-tariff barriers or market access restrictions in the case of services once Britain leaves the EU.

For each of the 56 receiving industries in Germany, the inverse coefficients were first determined compared to the supplying industries in Britain, and then the individual coefficients of the 56 supplying British industries were added.

On this basis, the coefficient of 0.079 for other transport equipment can be interpreted to mean that a change in demand of 1,000 units in this industry in Germany will lead to a change in inputs from all British industries of almost 80 units.

The industries in Table 4 are arranged in order of the sum of the inverse coefficients. The highest value is for other transport equipment. This essentially includes the production of ships, rail vehicles and, in particular, air and spacecraft equipment (such as Airbus).

Next on the list is the manufacture of coke and refined petroleum products as well as metal production and processing. The fourth column shows the share of each industry in the total value added in Germany. The fifth and sixth columns include all those British industries that have the greatest impact on the German industries, calculated by the bilateral inverse coefficients. The corresponding inverse coefficient is shown in column 7. Often, but not consistently, this is the same British industry as with other transport equipment or metal production and processing. However, the British chemical industry not only has the greatest single influence on German chemical manufacturing, but also on rubber and plastics as well as paper and cardboard manufacturing in Germany. The British metal production and processing industry also has the largest single influence on three German industries.

The 12 German industries that are most affected by the British economy, as measured by the sum of the respective inverse coefficients compared to the other German sectors, contribute 15.1 per cent to the total value added in Germany.

Table 5: Inverse coefficients for British intermediate inputs sourced from Germany

British industry that receives intermediate inputs from Germany				German industry that supplies intermediate inputs with the greatest impact on the British industry		
WZ number	Industry	Cumulative coefficient	Share of value added in the UK in per cent	WZ number	Industry	Coefficient
C29	Manufacture of motor vehicles and parts	0.173	0.7	C29	Manufacture of motor vehicles and parts	0.053
C20	Manufacture of chemicals and chemical products	0.132	0.6	C20	Manufacture of chemicals and chemical products	0.056
C24	Manufacture of basic metals	0.110	0.2	C24	Manufacture of basic metals	0.034
C27	Manufacture of electrical equipment	0.107	0.3	C27	Manufacture of electrical equipment	0.015
C28	Manufacture of machinery and equipment	0.103	0.8	C28	Manufacture of machinery and equipment	0.021
C22	Rubber and plastics	0.102	0.6	C20	Manufacture of chemicals and chemical products	0.034
C17	Paper and paper products	0.087	0.3	C17	Paper and paper products	0.021
C26	Manufacture of computers	0.082	0.7	C26	Manufacture of computers	0.022
C16	Manufacture of wooden products	0.070	0.1	C16	Manufacture of wooden products	0.010
C25	Manufacture of fabricated metal products	0.069	1.0	C24	Manufacture of basic metals	0.018
C30	Other transport equipment	0.069	0.6	C30	Other transport equipment	0.008
C18	Printing	0.068	0.3	C17	Paper and paper products	0.013

Inverse coefficients: If the final demand in the production of motor vehicles and parts in the UK changes by 1,000 units, the intermediate inputs obtained from the German motor vehicles and parts industry will change by 53 units. Cumulative coefficient: Addition of the inverse coefficients of all the exporting German industries compared to the individual industries in the UK. WZ number: Classification of economic sectors.

Sources: WIOD, 2016; Cologne Institute for Economic Research

Table 5: http://www.iwkoeln.de/_storage/asset/346497/storage/master/download/tab5.xlsx

7. Effects of interdependencies in the UK

This analysis can also be seen from the UK's perspective (Table 5). Of all the 56 British industries, which are most dependent on intermediate products and services from Germany for their production? Here again, the intermediate inverse coefficients are used and the British industries are arranged according to the sum of the coefficients in descending order. In top place is the British automobile industry, followed by the British chemical industry. These are all industrial sectors.

It is interesting to note that the twelve British industries most closely linked to Germany account for only 6.2 per cent of the total value added. Here again, the overall lower industrial share in the UK compared to Germany is noticeable. In addition, services are integrated into the international division of labour to a lesser extent than the manufacturing sector.

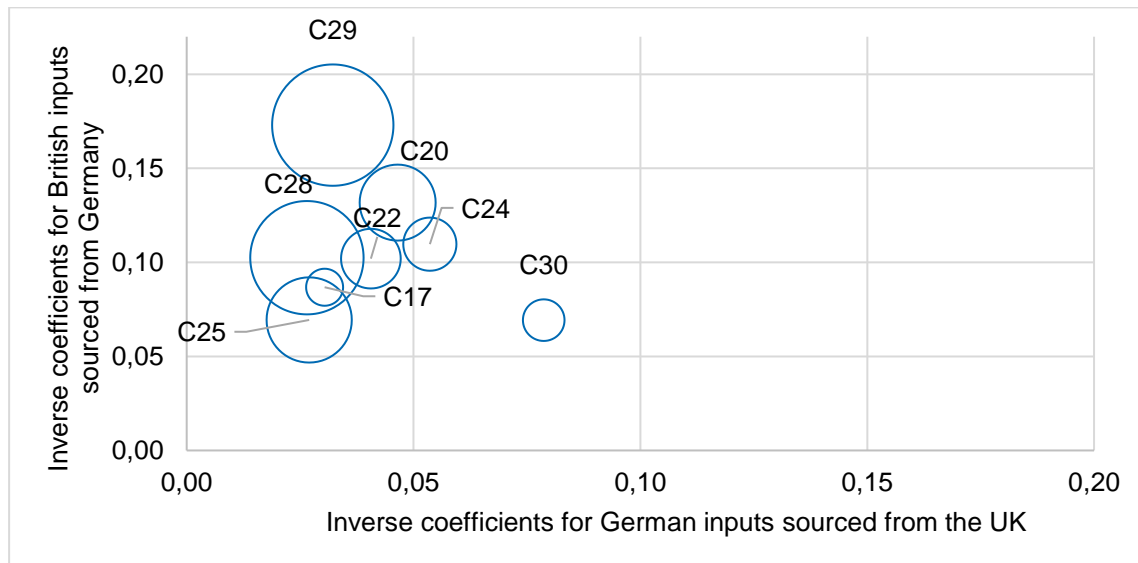
Eight of the sectors listed in Table 4, which have some of the highest inverse coefficients for German intermediate inputs from the UK, are also included in Table 5 (highlighted in grey). They therefore have the highest inverse coefficients for British intermediate inputs from Germany. Since barriers to market access resulting from Brexit affect both procurement and supply, the integration of these industries into supply chains is particularly susceptible to problems.

This relationship is shown in Figure 2. The higher the share of the industry in the overall economic value added, the bigger the bubble. The manufacture of motor vehicles is top of the list in terms of the share of value added in the German economy, followed by machine construction and the manufacture of metal products.

What is noteworthy is that the (totalled) inverse coefficients in the British industries that receive intermediate products and services from Germany are significantly higher than vice versa. This suggests that demand for intermediate input links in the British industries is much higher than that in the German industries. The British industries are therefore more dependent on supplies from Germany than vice versa. This does not mean that everything is fine for German industries supplying inputs to the UK.

Figure 2: Comparison of inverse coefficients

Inverse coefficients from German and British perspectives as well as proportion of German value added (bubble size) by industry



WZ number: Classification of economic sectors (see annex).

Sources: WIOD, 2016; Cologne Institute for Economic Research

Figure 2: http://www.iwkoeln.de/_storage/asset/346491/storage/master/download/abb2.xlsx

8. Conclusions

A look at the intermediate inputs exported from 56 British industries to the EU shows that the majority of intermediate inputs are delivered by the service industries: administrative and support service activities, wholesale trade and activities related to financial services. In the other direction, the picture looks very different. Although most of the intermediate inputs exported from the EU to the UK are also from administrative and support services activities, eight out of ten industries that export the highest amount of inputs are from the manufacturing sector. The first impression changes when two other aspects are taken into account: on the one hand, the export orientation of the industries in terms of intermediate products and services and, on the other hand, the share of the overall value added in the British economy. Ten British industries export over 50 per cent of their intermediate input exports to other EU member states. This includes retail trade, which accounts for 5.6 per cent of value added in the UK, followed by wholesale trade with 3.2 per cent of value added and activities related to financial services. They are therefore particularly vulnerable to new barriers following Britain's withdrawal from the EU. The industry that delivers almost three quarters of its exported intermediate output to the EU – other professional services – only contributes less than 1 per cent to added value in the UK. The results show that in the case of a (hard) Brexit, the British economy could be primarily affected by access restrictions on British service exports to the internal

market, and less by non-tariff trade barriers in certain branches of the manufacturing sector.

Furthermore, the input links between 56 British and German industries were taken into account. In 2014, 15 German industries exported more than USD 1 billion worth of intermediate inputs to the UK, mainly the automobile, chemical and pharmaceutical industries. Since a wide range of regulations apply here, these are vulnerable sectors, which are not only susceptible to tariffs, but also non-tariff trade barriers, as a result of Brexit. This is all the more the case since the chemical and automobile industries also source a large amount of intermediate inputs from the UK. It is important to note that the pharmaceutical industry delivers more than one fifth of its exported intermediate inputs to the UK. The automobile industry, which delivers almost seven per cent of its intermediate input exports to the UK, contributes four per cent to the value added in Germany.

In order to find out how tightly linked individual industries in Germany are with those in the UK, the inverse coefficients were calculated to indicate the direct and indirect effects on production in the event of a change in final demand in an industry. The higher the coefficient, the greater not only the multiplier effect, but also the closer the economic relationship in terms of intermediate inputs. The higher the coefficient, the more the industry concerned is affected by non-tariff trade barriers or market access restrictions on services. From the German perspective, this value is highest for other transport equipment, followed by the manufacture of coke and refined petroleum products and metal production and processing. This was also looked at from the British perspective and the inverse coefficients were determined for intermediate inputs exported from Germany. While the 12 German industries with the highest coefficients in terms of exports from the UK represent 15 per cent of the German value added, the 12 British industries identified only account for six per cent. Eight industries appear in the top 12 places in both rankings. From the point of view of these industries, this means that they would be particularly affected both on the procurement as well as the sales side by non-tariff trade barriers following a hard Brexit.

The threat of value chains resulting from a hard Brexit not only has direct consequences for trade relations between the two economic areas, but also indirect effects. At a hearing in the lower house of the British Parliament, it was pointed out that innovations driving productivity in the UK are linked to cross-border value chains. If there are restrictions here, these would also slow down the flow of technology into the UK (House of Commons, 2017, Q.6). These dynamic effects, which go far beyond the multiplier effects shown, have to be taken into account in the case of a hard Brexit.

Annex: Assignment of WZ numbers to the economic sectors

WZ number	Industry
A03	Fishing and aquaculture
B	Mining and quarrying
C17	Manufacture of paper and paper products
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C24	Manufacture of basic metals
C25	Manufacture of fabricated metal products
C26	Manufacture of computers
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment
C29	Manufacture of motor vehicles and parts
C30	Other transport equipment
E37-E39	Sewerage; waste collection, treatment and disposal activities
G46	Wholesale trade
G47	Retail trade
H50	Water transport
H51	Air transport
K66	Activities auxiliary to financial services and insurance activities
M74-M75	Other professional, scientific and technical activities
T	Activities of households as employers

Sources: WIOD, 2016; NACE Rev. 2; Cologne Institute for Economic Research

Annex: http://www.iwkoeln.de/_storage/asset/346492/storage/master/download/anhang.xlsx

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