Which Manufacturing Sectors Are Most Vulnerable to Brexit?

Briefing Paper 16 – February 2018

Online Appendix

Country groups

The analysis in the briefing paper focusses on trade relationships between the UK and three groups of countries: the remaining 27 members of the EU, the 67 countries with which the EU has signed Free Trade Agreements (FTA67) and the remaining countries in the rest of the world (ROW).

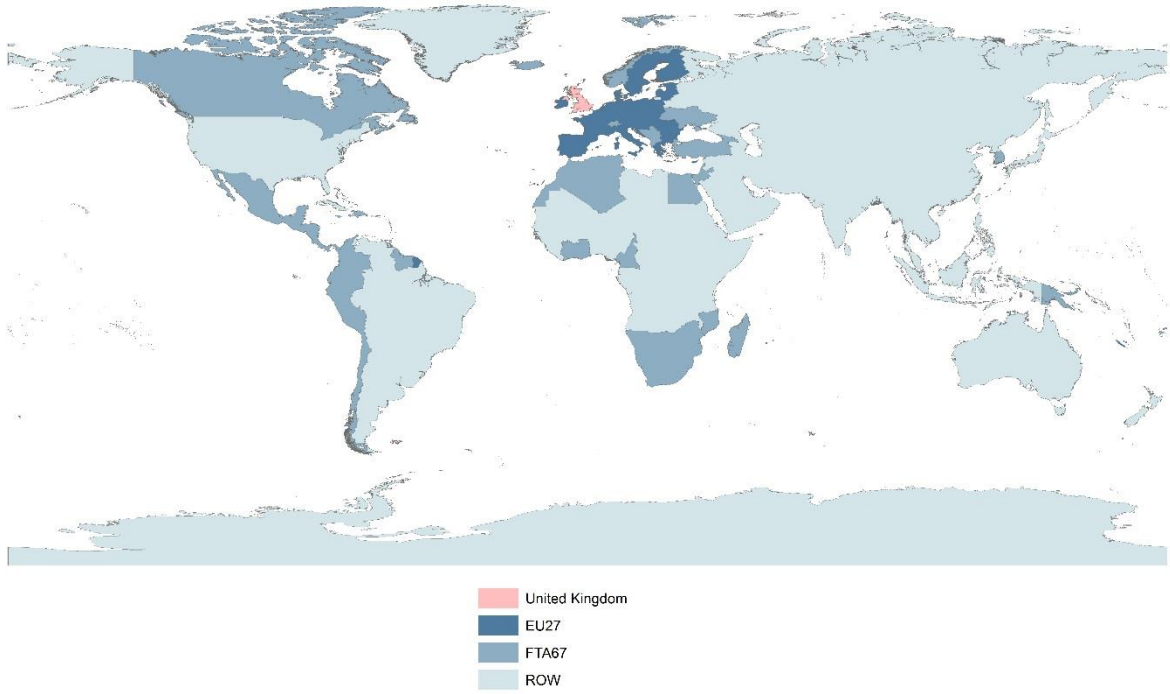
Table 1, below, lists all 67 countries with which the EU has trade agreements. These differ, and range from the membership of the EEA (for example, Norway), Customs Union (Turkey), Deep and Comprehensive Free Trade Agreement (Ukraine), Economic Partnership Agreement (Mauritius) to Association Agreement (Moldova). In addition, Figure 1 shows four markets of the partial equilibrium model on a geopolitical map.

Table 1: Countries with which the EU has trade agreements (as of end of 2016)

	Country	Agreement
1.	Albania	Stabilisation and Association Agreement
2.	Algeria	Association Agreement
3.	Andorra	Customs Union
4.	Antigua and Barbuda	Economic Partnership Agreement
5.	Bahamas	Economic Partnership Agreement
6.	Barbados	Economic Partnership Agreement
7.	Belize	Economic Partnership Agreement
8.	Bosnia Herzegovina	Stabilisation and Association Agreement
9.	Botswana	Economic Partnership Agreement
10.	Cameroon	Interim Economic Partnership Agreement
11.	Canada	Comprehensive Economic and Trade Agreement (CETA)
12.	Chile	Association Agreement and Additional Protocol
13.	Colombia	Trade Agreement
14.	Costa Rica	Association Agreement with a strong trade component
15.	Dominica	Economic Partnership Agreement
16.	Dominican Republic	Economic Partnership Agreement
17.	Ecuador	Trade Agreement
18.	Egypt	Association Agreement
19.	El Salvador	Association Agreement with a strong trade component
20.	Faroe Islands	Agreement
21.	Fiji	Interim Partnership Agreement
22.	Georgia	Association Agreement
23.	Ghana	Stepping stone Economic Partnership Agreement provisionally applied
24.	Grenada	Economic Partnership Agreement
25.	Guatemala	Association Agreement with a strong trade component
26.	Guyana	Economic Partnership Agreement
27.	Haiti	Economic Partnership Agreement
28.	Honduras	Association Agreement with a strong trade component
29.	Iceland	Economic Area Agreement

30.	Israel	Association Agreement
31.	Ivory Coast	Stepping stone Economic Partnership Agreement provisionally applied
32.	Jamaica	Economic Partnership Agreement
33.	Jordan	Association Agreement
34.	Kosovo	Stabilisation and Association Agreement
35.	Lebanon	Association Agreement
36.	Lesotho	Economic Partnership Agreement
37.	Macedonia	Stabilisation and Association Agreement
38.	Madagascar	Economic Partnership Agreement
39.	Mauritius	Economic Partnership Agreement
40.	Mexico	Global Agreement
41.	Moldova	Association Agreement
42.	Montenegro	Stabilisation and Association Agreement
43.	Morocco	Association Agreement
44.	Mozambique	Economic Partnership Agreement
45.	Namibia	Economic Partnership Agreement
46.	Nicaragua	Association Agreement with a strong trade component
47.	Norway	Economic Area Agreement
48.	Palestinian Authority	Interim Association Agreement
49.	Panama	Association Agreement with a strong trade component
50.	Papua New Guinea	Interim Partnership Agreement
51.	Peru	Trade Agreement
52.	San Marino	Customs Union
53.	Serbia	Stabilisation and Association Agreement
54.	Seychelles	Economic Partnership Agreement
55.	South Africa	Interim Trade, Development and Co-operation Agreement; Economic Partnership Agreement
56.	South Korea	Free Trade Agreement
57.	St Kitts and Nevis	Economic Partnership Agreement
58.	St Lucia	Economic Partnership Agreement
59.	St Vincent and the Grenadines	Economic Partnership Agreement
60.	Suriname	Economic Partnership Agreement
61.	Swaziland	Economic Partnership Agreement
62.	Switzerland	Agreement
63.	Trinidad and Tobago	Economic Partnership Agreement
64.	Tunisia	Association Agreement
65.	Turkey	Customs Union
66.	Ukraine	Deep and Comprehensive Free Trade Agreement
67.	Zimbabwe	Economic Partnership Agreement

Figure 1: Markets of the partial equilibrium model



The simulation model and data

The analysis is based on a partial equilibrium model (see: Annex to Briefing Paper 16) which requires data on production, bilateral trade flows and trade costs, where production data are adjusted to capture the domestic absorption (i.e. domestic consumption of domestic production). The model requires these data to be broken down by industry and by country (i.e. market). It also requires a set of parameters including elasticity of demand, elasticity of substitution and elasticity of supply.

Production data

Data on gross output have been collected at the level of 4-digit classes of the International Standard Industrial Classification (ISIC) Revision 4 from two different sources.

First, the source of production data for the OECD countries was the OECD Structural and Demographic Business Statistics (SDBS) database, which covers the business economy corresponding to divisions 05-82 of the ISIC Revision 4, but excludes divisions 64-66 (i.e. financial and insurance activities). It also excludes agriculture, forestry and fishing, activities of the public sector, and other service activities. The OECD SDBS gross output data are reported in national currency units and we converted these data to US dollars using the period-average bilateral exchange rates from the OECD.

For other non-OECD countries, we obtained production data from the UNIDO INDSTAT4 database, which contains time series production data (reported in both national currency units and US dollars) for 79 countries, both OECD and non-OECD countries, but the coverage

differs from country to country. Production data reported in the UNIDO INDSTAT4 database are of narrower sectoral coverage compared to those in the OECD SDBS – data pertain to 137 ISIC Revision 4 classes of the manufacturing sector.

At the time of collecting data (end of 2017), the latest production data in the OECD SDBS referred to 2015 and those in the UNIDO INDSTAT referred to 2013. As we sought production data for 2016, and neither source contained data as recent as this, we grossed up the most recent production data by the growth in the respective countries' exports. This essentially amounts to assuming a constant openness ratio, defined as a ratio of exports to production.

The model requires the size of domestic sales (i.e. home consumption of domestic production). In principle, this can be obtained by taking production minus exports. However, this can lead to anomalous outcomes because production data is calculated on an activity basis while trade data on a commodity basis. We therefore interpolated the UK production numbers based on the exports to production ratio from the UK input-output tables. A similar procedure was adopted for the remaining countries on the basis of the information in the World Input-Output Database (WIOD).

Bilateral trade data

The source of bilateral goods trade data used in this paper is the UN Comtrade database, which is accessed through the World Bank's World Integrated Trade Solutions (WITS) website. Data for trade in goods are collected at the 6-digit level of the Harmonised Standard (HS) 2012, the most detailed level at which trade flows can be classified while maintaining international comparability. At the 6-digit level, the HS comprises of approximately 5,200 commodities, and these are grouped in 21 HS sections. The UN Comtrade trade data are reported in value terms (US dollars) at current prices.

To reduce the number of missing observations at the HS 6-digit subheading level and improve the accuracy of trade flows data, we averaged imports data and mirror flows based on partners' exports data. In theory, country A reported imports from country B should match country B reported exports to country A, but in practice discrepancies exist. By averaging the value of imports and mirror flows, we hope to minimise data reporting errors.

Trade costs data

To account for the size of trade costs between different pairs of countries, we also obtained data on tariffs and non-tariff measures (NTMs). Bilateral tariffs data, on the one hand, were sourced from the UNCTAD's TRAINS database (accessed through the WITS website) and collected at the 6-digit level of the HS Combined nomenclature.[1] Information on NTMs, on the other hand, is based on the existing evidence in the empirical trade literature. In the

[1] HS Combined is WITS internal nomenclature used for reporting tariff data that combines all revisions of HS.

simulations we also introduced trade cost associated with increased border inspections (and possible border delays), which we assumed to add 3.5 per cent to other trade costs (based on the secondary literature, such as CEPR, 2013; Francois *et al.*, 2013; Carrère and de Melo, 2004; Anson *et al.*, 2005; Cadot *et al.*, 2005; and Hayakawa, 2011).

Tariffs data

The base tariffs employed in the modelling are the effectively applied (AHS) rates. These refer to the actual tariff applied, and are defined as the lowest available tariff. Essentially the AHS rates take into account whether there is a preferential trade agreement between any pair of countries. If a preferential trade agreement is in place, the AHS rates are equal to the preferential tariff rates. In the absence of preferential treatment, the AHS rates are equal to the Most Favoured Nation (MFN) rates.

For the purpose of the modelling, tariffs need to be expressed as ad valorem, where the custom duty is calculated as a percentage of the value of imports. In the majority, tariffs which are applied are ad-valorem, however, some tariff schedules include a variety of non ad-valorem components, such as specific tariffs.[2] For these tariff lines, from WITS, it is possible to download ad-valorem equivalent tariff rates, which are calculated using a standard methodology as applied by UNCTAD.

In our analysis, we use import-weighted average tariff rates. In practice, tariff rates are defined at a highly disaggregated level. In the EU, for example, tariff rates are set at the 10-digit Common Nomenclature (CN) level. This means that tariff data at 6-digit HS level as obtained from WITS are already averaged. Using simple average rates, on the one hand, fails to take into account the value of trade associated with each tariff line and it is also distorted by outliers. Using import-weighted average rates, on the other hand, gives more weight to those tariff lines that are an important component of a country's international trade but this suffers from an endogeneity problem - higher tariffs discourage imports and lead to a lower reported average tariff (Kee *et al.*, 2009). Indeed, at the extreme a prohibitive tariff which results in zero imports would therefore have a zero weight, even though it is highly restrictive.

In organising tariff data, to minimise the number of missing observations at the 6-digit HS level we inputted historic tariff rates in place of missing observations. For example, when the tariff rate for year 2016 was not available, we inputted the tariff rate for year 2015 (if this data were available). In this manner, we sought historic tariff data up until 2012 (i.e. four previous years), always inputting the most recent data available. A similar approach was adopted by Caliendo and Parro (2015) in their study of the trade and welfare effects of NAFTA.

[2] Among non ad valorem duties, a distinction is made between specific tariffs, compound tariffs and mixed tariffs. Specific tarrifs, for example, are charged based on the physical quantity of the good being imported. Compound tariffs, on the other hand, include both ad valorem and specific component, while mixed tariffs take either ad valorem or specific format, whichever generates the greatest tariff revenue.

Non-Tariff Measures (NTMs) data

Alongside tariffs, non-tariff measures (NTMs) are another trade policy instrument that impact on trade costs. But unlike tariffs, NTMs are not simple numbers - "they are complex legal texts that are not easily amenable to quantification, comparison, or even standard formatting" (Cadot *et al.*, 2012).

Like with specific tariffs, to simulate the effect of policy changes involving NTMs, the ad valorem equivalent of an NTM must be calculated, i.e. the rate of a (hypothetical) tariff that would generate an equivalent reduction in imports (Cadot *et al.*, 2012). But the quantification of NTMs for different countries and different industries is complex and requires undertaking a cross-country econometric analysis - and this in part explains why these estimates are imprecise and vary across different studies (Cadot and Gourdon, 2014).

In our modelling of the effects of Brexit we make use of the ad valorem equivalents of NTMs as estimated by Cadot and Gourdon (2016), who compute these for sanitary and phytosanitary, technical-barriers-to trade and other measures for 21 sections of the HS classification using the direct price-gap estimation approach. In selecting to work with these estimates, we opted for the analysis that is based on more recent data. Cadot and Gourdon (2016) note that their estimates lie within a single-digit range and are substantially lower than previous estimates based on older data – something that the authors claim may reflect the progressive phasing out of instruments such as quantitative restrictions in many countries. And because the estimates of Cadot and Gourdon (2016) are computed for all 21 sections of the HS classification, they can be linked with a good degree of precision (utilising HS to ISIC4 conversion key) to the industry groups covering manufacturing.

A weakness of NTMs estimates of Cadot and Gourdon (2016) is that they are not importer-specific. But Cadot and Gourdon (2016) analyse how the regional trade agreements (RTAs) affect the impact of NTMs on prices, and find that deep integration clauses with provisions related to standards (harmonisation or mutual recognition) dampen the price-rising effect of NTMs. As such we use their ad valorem equivalents of NTMs in the presence of deep integration clauses in RTAs as a proxy for the NTM-related trade costs within the European Single Market. For any other bilateral trade relationships, a set of estimates thought of as the counterfactual ad valorem equivalents of NTMs in the absence of a RTA is used.

Conversions

Modelling was done at the 4-digit classes of the ISIC4 Rev.4. To run the simulations, we reconciled production, trade and tariffs data, which are typically reported in different systems of classification. We used the OECD Bilateral Trade in Goods by Industry and End-use ISIC Rev.4 conversion key to express bilateral trade flows and trade costs data (originally reported in HS classification system) at the 4-digit ISIC4 level.

Parameters

The model also depends on a set of critical parameters, which include:

- the elasticity of demand for an aggregate product: in our study we make use of demand elasticities of Ghodsi *et al.* (2016);
    - Ghodsi *et al.* (2016) compute importer-specific import demand elasticities for 167 countries and 5,124 commodities at the 6-digit level of the HS1996 for the period 1996-2014; across all HS 6-digit products and countries, a mean value of import demand elasticity is estimated to be equal to -1.20;
- the elasticity of substitution between different varieties of the same product – set at -3 for those sectors that largely manufacture differentiated goods, and at -6 for those sectors that manufacture homogenous goods;
    - the categorisation of 122 manufacturing sectors into differentiated and homogenous is outlined in Table 2;
    - these values are broadly comparable to the simple average substitution elasticity of 4 for 3-digit HTS goods for 1990-2001, as per paper of Broda and Weinstein (2006), who estimate elasticities of substitution among goods at various levels of aggregation and different time periods; at the lowest level of aggregation, Broda and Weinstein (2006) estimate close to 30,000 elasticities;
- the elasticity of supply – for domestic suppliers to the domestic market the supply elasticity is set at 6, for other suppliers the supply elasticity is set at 15.

Number of firms

To run simulation using partial equilibrium model with imperfect competition, we need to obtain the approximate number of firms competing in each of the 122 manufacturing sectors.

For this purpose, we used the ONS data on enterprises by 4-digit UK SIC2007 and employment size band to calculate the Herfindahl index (i.e. measure of market concentration) for each of the 122 manufacturing sectors.[3] The inverse of the Herfindahl index is assumed to represent the number of equivalent-sized firms in each sector.

To reflect that production and competition even in sectors as 'narrow' as 4-digit classes of ISIC Rev.4 or UK SIC2007 occurs in smaller sub-sectors, we used the ONS publication "UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007) Structure and explanatory notes" [4] to count the number of sub-markets, where the ONS publication details

[3] It required use to convert UK SIC2007 classification to ISIC Rev.4 classification. Here, we made use of the fact that the UK SIC2007 and NACE Rev.2 (European classification) are identical at the 4-digit level, and that each one 4-digit NACE Rev.2 code can be mapped to a single 4-digit ISIC Rev.4 code. To convert from NACE Rev.2 to ISIC Rev.4 we made use of the official UNSD product concordance table.

[4] This official ONS publication is available at: https://www.ons.gov.uk/file?uri=/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksic2007/uksic2007web.pdf.

of the number of subsectors within a given 4-digit class of the UK SIC2007. For example, for the manufacture of footwear, we assume that this sector has three distinct sub-sectors.

Figure 2: Counting the number of sub-sectors for the manufacture of footwear sector

15.20 Manufacture of footwear

This class includes:

- manufacture of footwear for all purposes, of any material, by any process, including moulding (see below for exceptions)
- manufacture of leather parts of footwear: manufacture of uppers and parts of uppers, outer and inner soles, heels etc.
- manufacture of gaiters, leggings and similar articles

This class excludes:

- *manufacture of footwear of textile material without applied soles, see 14.19*
- *manufacture of wooden shoe parts (e.g. heels and lasts), see 16.29*
- *manufacture of rubber boot and shoe heels and soles and other rubber footwear parts, see 22.19*
- *manufacture of plastic footwear parts, see 22.29*
- *manufacture of ski boots, see 32.30*
- *manufacture of orthopaedic shoes, see 32.50*

Aggregation to sectoral groups, R&D groups and homogenous-differentiated goods' sectors

The simulated impact on prices, exports, imports and output for 122 manufacturing sectors is also presented as sets of grouped results, where 122 manufacturing sectors have been aggregated into 11 sectoral groups, and 4 groups defined according to the R&D intensity of the main production activities.

The 11 sectoral groups are not standard groups from any official publication, but have been designed by the authors to aid the presentation of data. The four R&D intensity groups have been designed with the use of the OECD taxonomy of that categorises sectors into high, medium-high, medium, medium-low and low R&D intensity groups; none of the manufacturing sectors is considered to belong to low R&D intensity group).

It also shows the categorisation of sectors into those that produce differentiated goods, and those that produce homogenous ones (which subsequently determines the value of the elasticity of substitution used in the simulations).

Table 2 below shows the allocation of 122 manufacturing sectors (4-digit classes of the ISIC Rev.4) to 11 sectoral groups and R&D groups. It also shows the categorisation of sectors into those that produce differentiated goods, and those that produce homogenous ones (which subsequently determines the value of the elasticity of substitution used in the simulations).

Table 2: Categorisation of 122 manufacturing sectors

	Manufacturing sector (4-digit class of ISIC Rev.4)	Sectoral group	R&D intensity group (using the OECD taxonomy)	Homogenous-versus-differentiated
1.	1010 Processing/preserving of meat	Food processing	Medium-low R&D	Homogenous
2.	1020 Processing/preserving of fish, etc.	Food processing	Medium-low R&D	Homogenous
3.	1030 Processing/preserving of fruit,vegetables	Food processing	Medium-low R&D	Homogenous
4.	1040 Vegetable and animal oils and fats	Food processing	Medium-low R&D	Homogenous
5.	1050 Dairy products	Food processing	Medium-low R&D	Homogenous
6.	1061 Grain mill products	Food processing	Medium-low R&D	Homogenous
7.	1062 Starches and starch products	Food processing	Medium-low R&D	Homogenous
8.	1071 Bakery products	Food processing	Medium-low R&D	Differentiated
9.	1072 Sugar	Food processing	Medium-low R&D	Homogenous
10.	1073 Cocoa, chocolate and sugar confectionery	Food processing	Medium-low R&D	Differentiated
11.	1074 Macaroni, noodles, couscous, etc.	Food processing	Medium-low R&D	Homogenous
12.	1079 Other food products n.e.c.	Food processing	Medium-low R&D	Homogenous
13.	1080 Prepared animal feeds	Food processing	Medium-low R&D	Homogenous
14.	1101 Distilling, rectifying and blending of spirits	Food processing	Medium-low R&D	Differentiated
15.	1102 Wines	Food processing	Medium-low R&D	Differentiated
16.	1103 Malt liquors and malt	Food processing	Medium-low R&D	Differentiated
17.	1104 Soft drinks,mineral waters,other bottled waters	Food processing	Medium-low R&D	Differentiated
18.	1200 Tobacco products	Not classified	Medium-low R&D	Differentiated
19.	1311 Preparation and spinning of textile fibres	Textiles, apparel and footwear	Medium-low R&D	Homogenous
20.	1312 Weaving of textiles	Textiles, apparel and footwear	Medium-low R&D	Homogenous
21.	1391 Knitted and crocheted fabrics	Textiles, apparel and footwear	Medium-low R&D	Homogenous
22.	1392 Made-up textile articles, except apparel	Textiles, apparel and footwear	Medium-low R&D	Differentiated
23.	1393 Carpets and rugs	Textiles, apparel and footwear	Medium-low R&D	Homogenous
24.	1394 Cordage, rope, twine and netting	Textiles, apparel and footwear	Medium-low R&D	Homogenous
25.	1399 Other textiles n.e.c.	Textiles, apparel and footwear	Medium-low R&D	Homogenous
26.	1410 Wearing apparel, except fur apparel	Textiles, apparel and footwear	Medium-low R&D	Differentiated
27.	1420 Articles of fur	Textiles, apparel and footwear	Medium-low R&D	Differentiated
28.	1430 Knitted and crocheted apparel	Textiles, apparel and footwear	Medium-low R&D	Differentiated
29.	1511 Tanning/dressing of leather; dressing of fur	Textiles, apparel and footwear	Medium-low R&D	Homogenous
30.	1512 Luggage,handbags,etc.;saddlery/harness	Textiles, apparel and footwear	Medium-low R&D	Differentiated
31.	1520 Footwear	Textiles, apparel and footwear	Medium-low R&D	Differentiated
32.	1610 Sawmilling and planing of wood	Wood, paper and printing	Medium-low R&D	Homogenous
33.	1621 Veneer sheets and wood-based panels	Wood, paper and printing	Medium-low R&D	Homogenous
34.	1622 Builders' carpentry and joinery	Wood, paper and printing	Medium-low R&D	Homogenous
35.	1623 Wooden containers	Wood, paper and printing	Medium-low R&D	Homogenous
36.	1629 Other wood products;articles of cork,straw	Wood, paper and printing	Medium-low R&D	Homogenous
37.	1701 Pulp, paper and paperboard	Wood, paper and printing	Medium-low R&D	Homogenous
38.	1702 Corrugated paper and paperboard	Wood, paper and printing	Medium-low R&D	Homogenous
39.	1709 Other articles of paper and paperboard	Wood, paper and printing	Medium-low R&D	Homogenous
40.	1811 Printing	Wood, paper and printing	Medium-low R&D	Homogenous

41.	1812 Service activities related to printing	Wood, paper and printing	Medium-low R&D	Homogenous
42.	1820 Reproduction of recorded media	Wood, paper and printing	Medium-low R&D	Differentiated
43.	1910 Coke oven products	Not classified	Medium-low R&D	Homogenous
44.	1920 Refined petroleum products	Not classified	Medium-low R&D	Homogenous
45.	2011 Basic chemicals	Chemicals and pharmaceuticals	Medium-high R&D	Homogenous
46.	2012 Fertilizers and nitrogen compounds	Chemicals and pharmaceuticals	Medium-high R&D	Homogenous
47.	2013 Plastics and synthetic rubber in primary forms	Chemicals and pharmaceuticals	Medium-high R&D	Homogenous
48.	2021 Pesticides and other agrochemical products	Chemicals and pharmaceuticals	Medium-high R&D	Differentiated
49.	2022 Paints,varnishes;printing ink and mastics	Chemicals and pharmaceuticals	Medium-high R&D	Differentiated
50.	2023 Soap,cleaning and cosmetic preparations	Chemicals and pharmaceuticals	Medium-high R&D	Differentiated
51.	2029 Other chemical products n.e.c.	Chemicals and pharmaceuticals	Medium-high R&D	Differentiated
52.	2030 Man-made fibres	Chemicals and pharmaceuticals	Medium-high R&D	Differentiated
53.	2100 Pharmaceuticals,medicinal chemicals, etc.	Chemicals and pharmaceuticals	High R&D	Differentiated
54.	2211 Rubber tyres and tubes	Rubber and plastic	Medium R&D	Differentiated
55.	2219 Other rubber products	Rubber and plastic	Medium R&D	Differentiated
56.	2220 Plastics products	Rubber and plastic	Medium R&D	Differentiated
57.	2310 Glass and glass products	Metals and non-metallic minerals	Medium R&D	Homogenous
58.	2391 Refractory products	Metals and non-metallic minerals	Medium R&D	Homogenous
59.	2392 Clay building materials	Metals and non-metallic minerals	Medium R&D	Homogenous
60.	2393 Other porcelain and ceramic products	Metals and non-metallic minerals	Medium R&D	Homogenous
61.	2394 Cement, lime and plaster	Metals and non-metallic minerals	Medium R&D	Homogenous
62.	2395 Articles of concrete, cement and plaster	Metals and non-metallic minerals	Medium R&D	Homogenous
63.	2396 Cutting, shaping and finishing of stone	Metals and non-metallic minerals	Medium R&D	Homogenous
64.	2399 Other non-metallic mineral products n.e.c.	Metals and non-metallic minerals	Medium R&D	Homogenous
65.	2410 Basic iron and steel	Metals and non-metallic minerals	Medium R&D	Homogenous
66.	2420 Basic precious and other non-ferrous metals	Metals and non-metallic minerals	Medium R&D	Homogenous
67.	2431 Casting of iron and steel	Metals and non-metallic minerals	Medium R&D	Homogenous
68.	2511 Structural metal products	Metals and non-metallic minerals	Medium-low R&D	Differentiated
69.	2512 Tanks, reservoirs and containers of metal	Metals and non-metallic minerals	Medium-low R&D	Differentiated
70.	2513 Steam generators, excl. hot water boilers	Metals and non-metallic minerals	Medium-low R&D	Differentiated
71.	2593 Cutlery, hand tools and general hardware	Metals and non-metallic minerals	Medium-low R&D	Differentiated
72.	2599 Other fabricated metal products n.e.c.	Metals and non-metallic minerals	Medium-low R&D	Differentiated
73.	2610 Electronic components and boards	Electronic and scientific	High R&D	Differentiated
74.	2620 Computers and peripheral equipment	Electronic and scientific	High R&D	Differentiated
75.	2630 Communication equipment	Electronic and scientific	High R&D	Differentiated
76.	2640 Consumer electronics	Electronic and scientific	High R&D	Differentiated
77.	2651 Measuring/testing/navigating equipment,etc.	Electronic and scientific	High R&D	Differentiated
78.	2652 Watches and clocks	Electronic and scientific	High R&D	Differentiated
79.	2660 Irradiation/electromedical equipment,etc.	Electronic and scientific	High R&D	Differentiated
80.	2670 Optical instruments and photographic equipment	Electronic and scientific	High R&D	Differentiated
81.	2710 Electric motors,generators,transformers,etc.	Electrical	Medium-high R&D	Differentiated
82.	2720 Batteries and accumulators	Electrical	Medium-high R&D	Differentiated

83.	2731 Fibre optic cables	Electrical	Medium-high R&D	Homogenous
84.	2732 Other electronic and electric wires and cables	Electrical	Medium-high R&D	Homogenous
85.	2733 Wiring devices	Electrical	Medium-high R&D	Homogenous
86.	2740 Electric lighting equipment	Electrical	Medium-high R&D	Homogenous
87.	2750 Domestic appliances	Electrical	Medium-high R&D	Differentiated
88.	2790 Other electrical equipment	Electrical	Medium-high R&D	Differentiated
89.	2811 Engines/turbines,excl.aircraft,vehicle engines	Machinery	Medium-high R&D	Differentiated
90.	2812 Fluid power equipment	Machinery	Medium-high R&D	Differentiated
91.	2813 Other pumps, compressors, taps and valves	Machinery	Medium-high R&D	Differentiated
92.	2814 Bearings, gears, gearing and driving elements	Machinery	Medium-high R&D	Differentiated
93.	2815 Ovens, furnaces and furnace burners	Machinery	Medium-high R&D	Differentiated
94.	2816 Lifting and handling equipment	Machinery	Medium-high R&D	Differentiated
95.	2817 Office machinery, excl.computers,etc.	Machinery	Medium-high R&D	Differentiated
96.	2818 Power-driven hand tools	Machinery	Medium-high R&D	Differentiated
97.	2819 Other general-purpose machinery	Machinery	Medium-high R&D	Differentiated
98.	2821 Agricultural and forestry machinery	Machinery	Medium-high R&D	Differentiated
99.	2822 Metal-forming machinery and machine tools	Machinery	Medium-high R&D	Differentiated
100.	2823 Machinery for metallurgy	Machinery	Medium-high R&D	Differentiated
101.	2824 Mining, quarrying and construction machinery	Machinery	Medium-high R&D	Differentiated
102.	2825 Food/beverage/tobacco processing machinery	Machinery	Medium-high R&D	Differentiated
103.	2826 Textile/apparel/leather production machinery	Machinery	Medium-high R&D	Differentiated
104.	2829 Other special-purpose machinery	Machinery	Medium-high R&D	Differentiated
105.	2910 Motor vehicles	Transport	Medium-high R&D	Differentiated
106.	2920 Automobile bodies, trailers and semi-trailers	Transport	Medium-high R&D	Differentiated
107.	2930 Parts and accessories for motor vehicles	Transport	Medium-high R&D	Differentiated
108.	3011 Building of ships and floating structures	Transport	Medium R&D	Differentiated
109.	3012 Building of pleasure and sporting boats	Transport	Medium R&D	Differentiated
110.	3020 Railway locomotives and rolling stock	Transport	Medium-high R&D	Differentiated
111.	3030 Air and spacecraft and related machinery	Transport	High R&D	Differentiated
112.	3091 Motorcycles	Transport	Medium-high R&D	Differentiated
113.	3092 Bicycles and invalid carriages	Transport	Medium-high R&D	Differentiated
114.	3099 Other transport equipment n.e.c.	Transport	Medium-high R&D	Differentiated
115.	3100 Furniture	Other	Medium-low R&D	Differentiated
116.	3211 Jewellery and related articles	Other	Medium R&D	Differentiated
117.	3212 Imitation jewellery and related articles	Other	Medium R&D	Homogenous
118.	3220 Musical instruments	Other	Medium R&D	Differentiated
119.	3230 Sports goods	Other	Medium R&D	Differentiated
120.	3240 Games and toys	Other	Medium R&D	Differentiated
121.	3250 Medical and dental instruments and supplies	Other	Medium-high R&D	Differentiated
122.	3290 Other manufacturing n.e.c.	Other	Medium R&D	Differentiated

Note: Allocation to 11 sectoral groups and differentiated-homogenous groups is based on authors' own categorisation. Allocation to R&D intensity groups is based on the OECD Taxonomy of Economic Activities based on R&D Intensity.

Imperfect competition model versus Armington model results

Throughout our paper, we reported the results of the simulations on the basis of the partial equilibrium model, which assumes imperfectly competitive market structure.

We do however also ran simulations using the Armington version of the partial equilibrium model, which gave qualitatively similar results. Figures 3 and 4 below compare the 'average impact' results obtained using the imperfect competition and the Armington models.

Figure 3: Imperfect competition model: impact of Brexit on prices, exports, imports and output

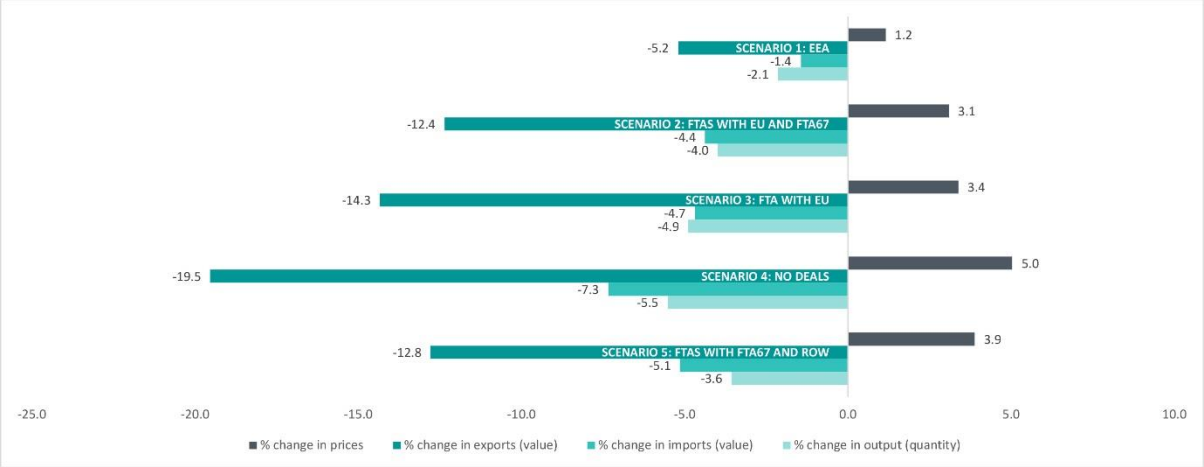
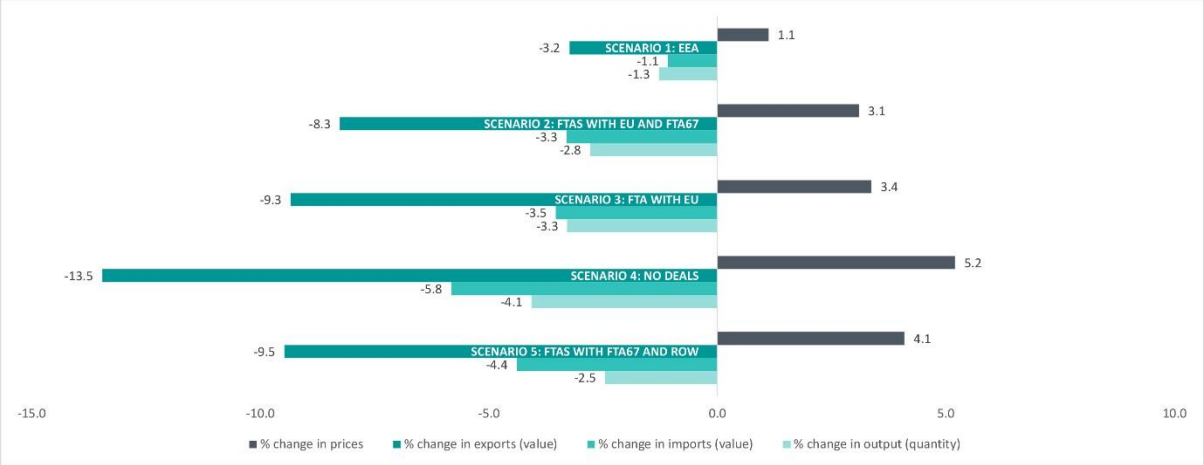


Figure 4: Armington model: impact of Brexit on prices, exports, imports and output



Impact on different sectors: FTA with EU and FTA67, and FTA with EU, compared to 'no deals' scenario

In the briefing paper we look at the distribution of price, exports, imports and output (percentage) changes in three Brexit scenarios, but on purely aesthetic considerations (i.e. for ease of presentation) we do not display results for Scenarios 2 ('FTA with EU and FTA67') and 3 ('FTA with EU').

For completeness, in this appendix we look at the distribution of these changes for Scenarios 2 and 3, using the most pessimistic Scenario 4 ('no deals') as a comparator.

Figure 5: Percentage change in prices across different manufacturing sectors

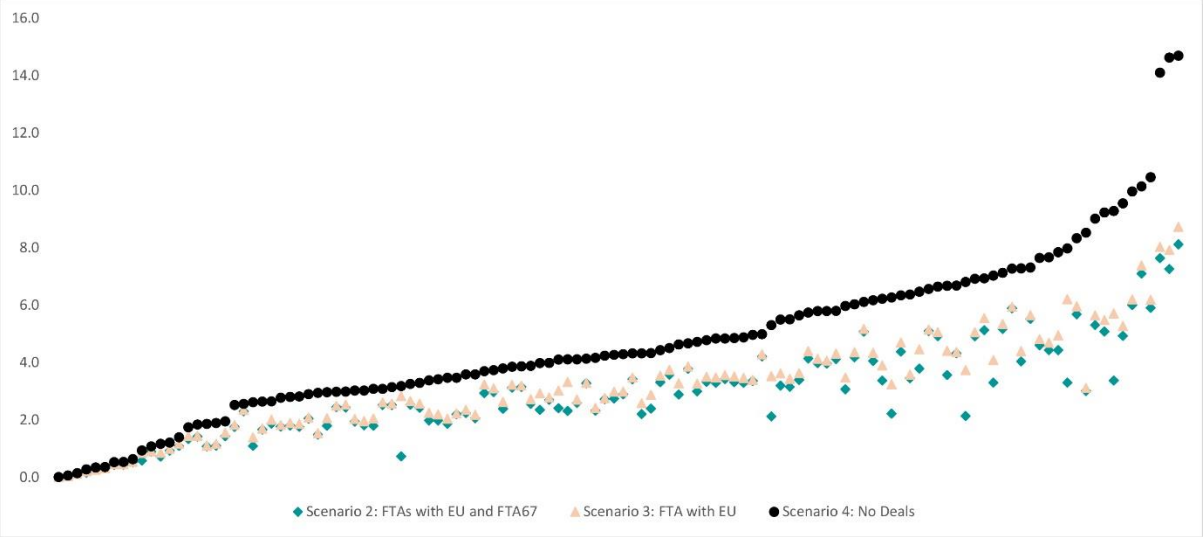


Figure 6: Percentage change in exports across different manufacturing sectors

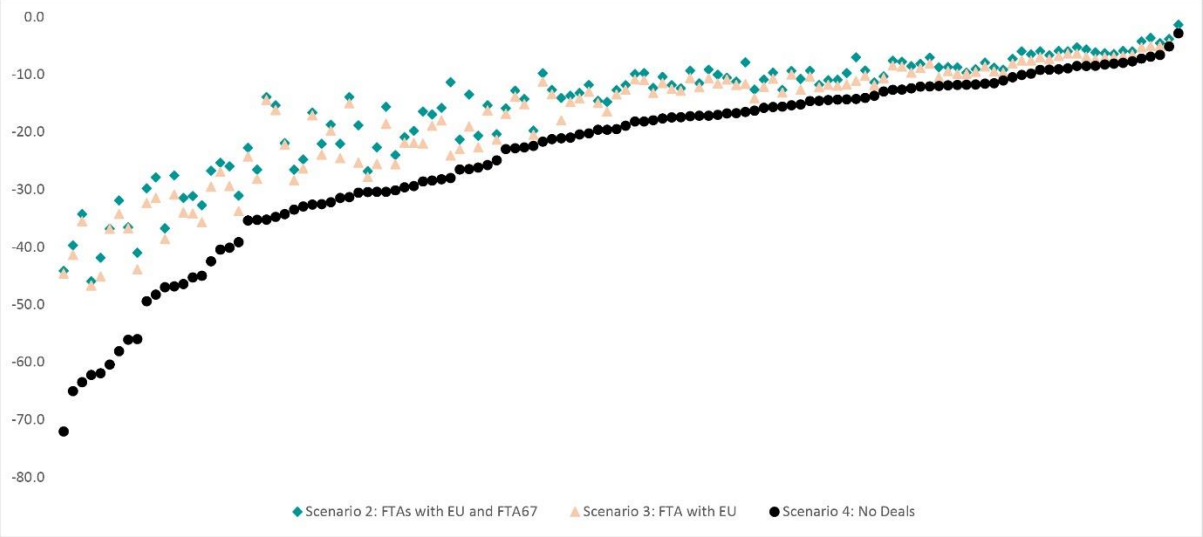


Figure 7: Percentage change in imports across different manufacturing sectors

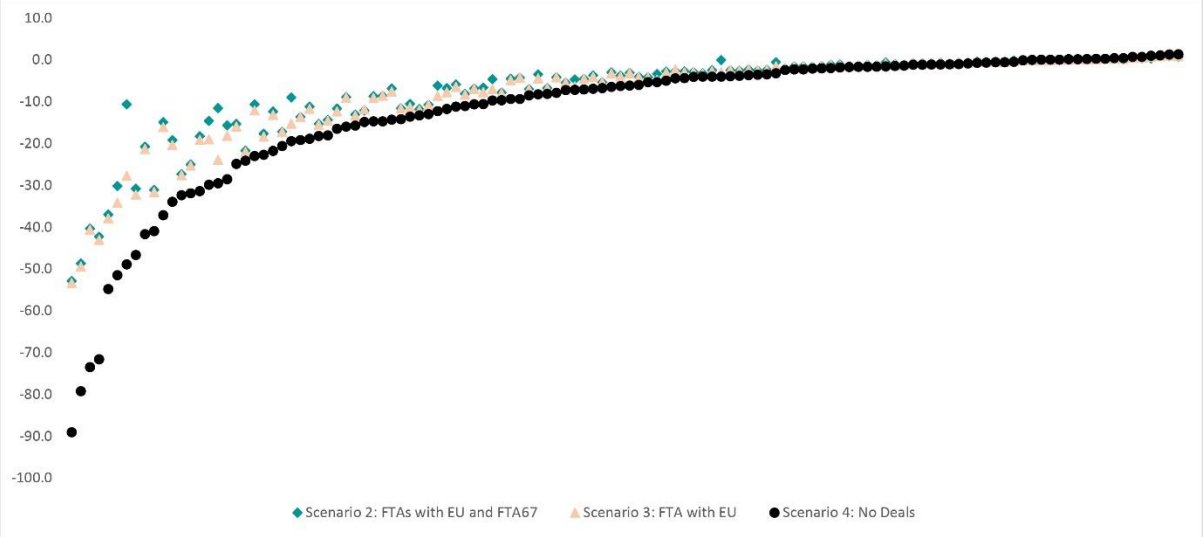
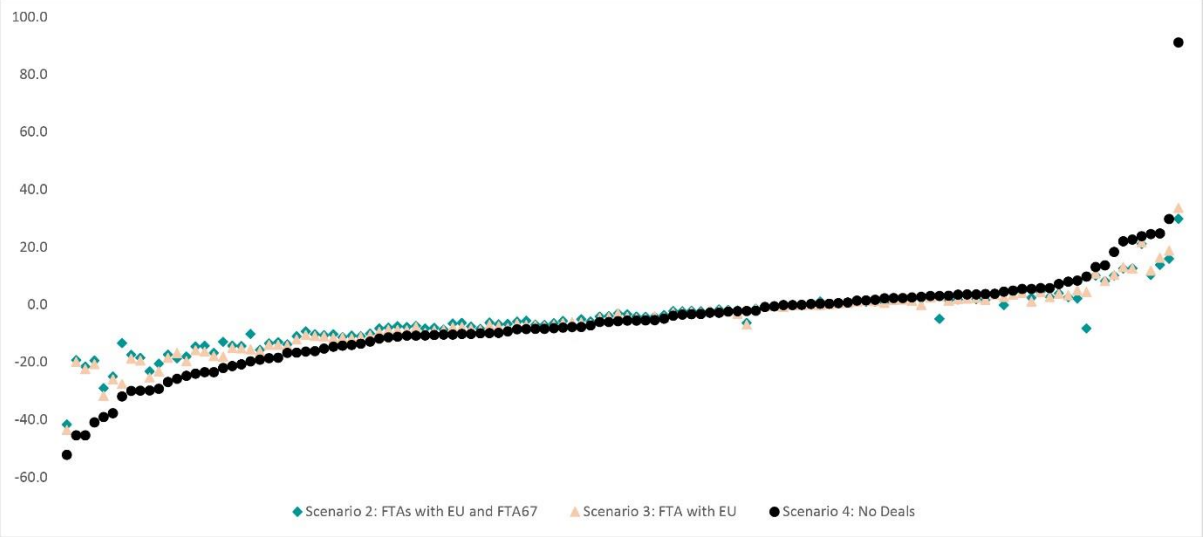


Figure 8: Percentage change in output across different manufacturing sectors



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