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Economic Structures (2021) 10:11
https://doi.org/10.1186/s40008-021-00241-9

Journal of Economic Structures

RESEARCH Open Access

International trade barriers and regional employment: the case of a no-deal Brexit

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Abstract

We use the World Input–Output Database (WIOD) combined with regional sectoral employment data to estimate the potential regional employment effects of international trade barriers. We study the case of a no-deal Brexit in which imports to the United Kingdom (UK) from the European Union (EU) would be subject to tariffs and non-tariff trade costs. First, we derive the decline in UK final goods imports from the EU from industry-specific international trade elasticities, tariffs and non-tariff trade costs. Using input–output analysis, we estimate the potential output and employment effects for 56 industries and 43 countries on the national level. The absolute effects would be largest in big EU countries which have close trade relationships with the UK, such as Germany and France. However, there would also be large countries outside the EU which would be heavily affected via global value chains, such as China, for example. The relative effects (in percent of total employment) would be largest in Ireland followed by Belgium. In a second step, we split up the national effects on the NUTS-2 level for EU member states and additionally on the county (NUTS-3) level for Germany. The share of affected workers varies between 0.03% and 3.4% among European NUTS-2 regions and between 0.15% and 0.4% among German counties. A general result is that indirect effects via global value chains, i.e., trade in intermediate inputs, are more important than direct effects via final demand.

Keywords: Brexit, Employment, European Union, International trade, Tariffs, Trade barriers

JEL Classification: C67, D57, F16, R15

1 Introduction

The British people has voted to leave the European Union (EU) by applying article 50 of the Treaty on European Union in June 2016. The United Kingdom (UK) has left the EU on January 31, 2020. However, the UK had still unlimited access to the Single Market until December 31, 2020. For most of the time during the year 2020, it has not been clear whether Brexit will lead to tariffs on trade between the UK and the remaining EU (EU-27). Without the last-minute agreement between the EU and the UK of December 24, 2020 (Trade and Cooperation Agreement, TCA), exports from the remaining EU member countries to the UK would have become subject to tariffs according to World Trade Organization standards (WTO-Scenario) as of January 1, 2021.

We analyze the regional employment effects of tariffs and non-tariff trade barriers. In general, tariffs reduce international trade and result in more unemployment (Furceri et al. 2018) and increase prices for consumers (Amiti et al. 2019). However, sign and magnitude of the effect can depend on the nature and the persistence of the trade shock. In this paper, we add to the literature on employment effects of trade shocks by studying the employment effects in more than 40 countries (both EU member states and other countries) due to increasing trade costs in case of a Brexit, where there is no agreement in place for trade between the UK and the EU (WTO-Scenario). In particular, we show how the regional distribution of the effects within the EU can be estimated using regional sectoral employment data.

The UK is an important trading partner for EU-27 countries. After the U.S., the UK has been the second largest destination outside the EU of goods and services exports from EU-27 countries in 2020 accounting for about 14% of total EU-27 exports.[1] A degradation of the trading framework between EU-27 and UK may have important economic consequences on production and employment in EU-27 countries and regions. Because product groups are not all affected in the same way and because of regional agglomeration of production, regions within the EU-27 will face heterogeneous consequences from Brexit. It is important to understand this heterogeneity to develop appropriate policy responses.

If the negotiations between the EU and the UK had failed, a no-deal Brexit would have implied that exports from the remaining EU member countries to the UK would be subject to tariffs. Even without formal tariffs, there are non-tariff trade costs, which consist of organizational cost (waiting, e.g.) at the borders and of substantial paperwork for the producers to document that rules of origin are complied to. Accordingly, the British demand for EU products is likely to decrease due to these trade costs. We study the international potential employment effects of the decline in British import demand. To quantify these effects we take into account that production of final goods depends on intermediate inputs. Not only firms that directly export goods or services to UK are affected by Brexit but also firms that deliver intermediate inputs to these firms. Similar to studies which assess the impact of Brexit on production on the national level, we use input–output analysis in a first stage to quantify the countries and industries that are most affected by a decline in UK import demand from EU-27 due to a no-deal Brexit. Assuming that existing production structures and final goods prices need time to adapt to the changing trade framework between UK and EU-27, input–output analysis can be informative about potential short-term effects due to the decline in UK import demand from EU-27 and thereby complement results from general-equilibrium models which in general are more informative about the long-run.

British firms are also affected themselves due to their participation in global value chains. The results that we report for the UK only refer to the effects of less intermediate input production for foreign firms that export to the UK. It should be stressed that the results that we present are partial effects of a negative trade shock. We do not consider macroeconomic general equilibrium effects. We do not aim to estimate the total effects

[1] https://ec.europa.eu/eurostat/statistics-explained/index.php/Extra-EU_trade_in_goods.

of Brexit on employment in the UK or in any other country. Trade diversion is also not considered. Moreover, it is not only international trade in goods and services that will be affected by Brexit.[2] Overall, our results are more informative for the EU-27 countries than for the UK, because the aspects that are not covered here are much more important for the UK than for the EU-27 countries.

We use the World Input–Output Database (WIOD) to document (i) which industries, (ii) in which countries will be affected most by a decline of British imports from EU member countries and (iii) what the according regional and sectoral employment effects will be. For the EU, we provide a regional breakdown on the NUTS-2 level; for Germany, we additionally provide a detailed regional breakdown on the NUTS-3 (county) level. Chen et al. (2018) also provide a regional breakdown of Brexit exposure on the NUTS-2 level; however, they do not look at employment but only at GDP and labour income, which can be directly inferred from the World Input–Output Database. Our contribution is to combine WIOD with regional and sectoral employment data.

The paper is organized as follows. First, we describe the data and our methodology in Sect. 2. Then, we explain the results by country, by industry and by region in Sect. 3. Finally, we provide conclusions in Sect. 4.

2 Conceptual framework

2.1 World Input–Output table

The main data source for our analysis is the World Input–Output Database (WIOD).[3] We use the 2016 edition (Timmer et al. 2015, Timmer et al. 2016), which covers 43 countries (plus rest of the world) and 56 industries. The countries and the industries are listed in the appendix. We use the most recent available data which refers to the year 2014. Table 1 shows the general structure of the World Input–Output table. Among the 44 (including rest of the world) countries, we distinguish between the $m = 27$ countries which remain in the EU, the UK (country $m + 1$) and $M - m - 1$ non-EU countries (including rest of the world).

The matrix $X = \left\{x_{ij}^{k\ell}\right\}$ is called transaction matrix.[4] Dividing the elements of X by column sums $x^{k\ell}$ yields matrix $A = \left\{\frac{x_{ij}^{k\ell}}{x^{k\ell}}\right\}$. Total output ($x$) in the $M \times N = 44 \times 56 = 2464$ supply–country–industry combinations can now be written as follows:

$$x = Ax + y,$$

where the $(M \times N) \times 1$ vector $y = \left\{\sum_{i=1}^{M} y_i^{k\ell}\right\}$ denotes final demand in the M countries covered by the 2464 supply–country–industry combinations, respectively. For a given vector of final demand y, the corresponding total output vector including the intermediate inputs necessary for production can be recovered:

[2] A general overview of studies on the economic impact of Brexit is provided by Bisciari (2019), for example. For early overviews of channels through which Brexit could affect the economy, see Kierzenkowskii et al. (2016), Cumming and Zahra (2016) and Broadbent et al. (2019). Dhingra et al. (2018) discuss foreign direct investment after Brexit, for example, and Powdthavee et al. (2019) the effect of Brexit on subjective well-being. Los et al. (2017) and Dhingra et al. (2017b) discuss local consequences of the Brexit in the UK. Bloom et al. (2019) provide firm-level evidence.

[3] http://www.wiod.org/home.

[4] For a general discussion of input–output analysis see Miller and Blair (2009) and for a comprehensive discussion of the analysis of international trade using input–output analysis see Los (2017).

Table 1 Stylized World Input–Output table

			Intermediate use						**Final use**		**Total use**
			Country 1		.	**Country** *M*			**Countries**		
			Industries			**Industries**					
			1	*N*	.	**1**	*N*		**1** .	*M*	(*x*)
Supply	EU-	Ind. 1	x_{11}^{11}	x_{1N}^{11}		x_{M1}^{11}	x_{MN}^{11}		y_1^{11}	y_M^{11}	x^{11}
	Country	.									
	(1)	Ind. N	x_{11}^{1N}	x_{1N}^{1N}		x_{M1}^{1N}	x_{MN}^{1N}		y_1^{1N}	y_M^{1N}	x^{1N}
	EU-	Ind. 1	x_{11}^{m1}	x_{1N}^{m1}		x_{M1}^{m1}	x_{MN}^{m1}		y_1^{m1}	y_M^{m1}	x^{m1}
	Country	.									
	(*m*)	Ind. N	x_{11}^{mN}	x_{1N}^{mN}		x_{M1}^{mN}	x_{MN}^{mN}		y_1^{mN}	y_M^{mN}	x^{mN}
	United	Ind. 1	$x_{11}^{m+1,1}$	$x_{1N}^{m+1,1}$		$x_{M1}^{m+1,1}$	$x_{MN}^{m+1,1}$		$y_1^{m+1,1}$	$y_M^{m+1,1}$	$x^{m+1,1}$
	Kingdom	.									
	($m+1$)	Ind. N	$x_{11}^{m+1,N}$	$x_{1N}^{m+1,N}$		$x_{M1}^{m+1,N}$	$x_{MN}^{m+1,N}$		$y_1^{m+1,N}$	$y_M^{m+1,N}$	$x^{m+1,N}$
	Non-EU	Ind. 1	$x_{11}^{m+2,1}$	$x_{1N}^{m+2,1}$		$x_{M1}^{m+2,1}$	$x_{MN}^{m+2,1}$		$y_1^{m+2,1}$	$y_M^{m+2,1}$	$x^{m+2,1}$
	Country	.									
	($m+2$)	Ind. N	$x_{11}^{m+2,N}$	$x_{1N}^{m+2,N}$		$x_{M1}^{m+2,N}$	$x_{MN}^{m+2,N}$		$y_1^{m+2,N}$	$y_M^{m+2,N}$	$x^{m+2,N}$
	Non-EU	Ind. 1	x_{11}^{M1}	x_{1N}^{M1}		x_{M1}^{M1}	x_{MN}^{M1}		y_1^{M1}	y_M^{M1}	$x^{M,1}$
	Country	.									
	(*M*)	Ind. N	x_{11}^{MN}	x_{1N}^{MN}		x_{M1}^{MN}	x_{MN}^{MN}		y_1^{MN}	y_M^{MN}	$x^{M,N}$
Value added by labour and capital											
Gross output (x')			x^{11}	x^{1N}		$x^{M,1}$	$x^{M,N}$				

Source: Own exhibition. $x_{ij}^{k\ell}$ denotes intermediate inputs used in country *i* and industry *j* and supplied by industry ℓ in country *k*. $y_i^{k\ell}$ denotes final demand in country *i* from industry ℓ in country *k*. The last row and column show column and row sums, respectively

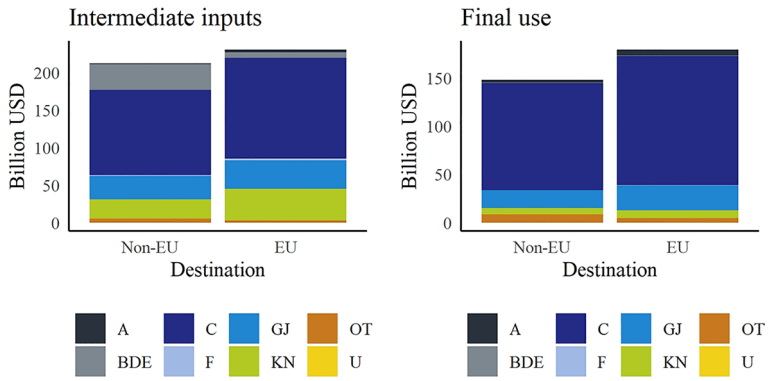

Fig. 1 UK imports from EU and non-EU countries in 2014. *Source:* World Input–Output Database, data for 2014, and own calculations. NACE sectors are defined in Tables 5 and 6 in the appendix

$$x = (I - A)^{-1}y,$$

where $(I - A)^{-1}$ is called inverse Leontief matrix. Accordingly, changes in final demand Δy affect total output:

$$\Delta x = (I - A)^{-1}\Delta y.$$

2.2 British final import demand and EU gross output after Brexit

For both intermediate inputs and final use, the EU is quantitatively the most important trading partner of the UK. Figure 1 shows that the UK imports more goods and services from the EU than from all other trading partners together (exports to the UK by country are reported in Table 7 in the appendix).

The potential consequences of Brexit on British import demand from the remaining EU countries depend on the exit scenario.[5] Without a formal agreement, trade between the UK and the EU would follow World Trade Organization rules after Brexit. This implies that tariffs would apply between the UK and the EU. Cars and car parts, for example, would be taxed at 10%. Agricultural tariffs are even higher. Average tariffs imposed on final goods imported to the UK are estimated to amount to 8.6% (Cappariello et al. 2018). Non-tariff costs would also increase.[6] Higher import prices will lead to less import demand. We use the post-Brexit tariffs, trade elasticities and non-tariff trade barrier estimates provided by Cappariello et al. (2018) and Cappariello et al. (2020) to estimate the country-sector specific trade effects of tariffs and non-tariff trade barriers on final goods imported from the remaining EU countries to the UK. Denote the sector-specific tariff for final goods imports by τ_y^ℓ, the absolute sector-specific trade elasticity by ϵ^ℓ, and the sector-specific non-tariff trade barrier ad-valorem equivalent by μ^ℓ

[5] IJtsma et al. (2018) provide insights in the position of the UK in global value chains and discuss the implications for the UK's post-Brexit trade policy.

[6] Dhingra et al. (2017a) estimate the increase in non-tariff costs to amount to about 8% in case of a no-deal Brexit. This figure is also used in the Brexit simulations by Vandenbussche et al. (2019).

($\ell = 1, \ldots, 56$). Then, the change in final import demand triggered by a no-deal Brexit is given by

$$\Delta y_{m+1}^{k\ell} = -\left(\epsilon^{\ell} \times \tau_{y}^{\ell} + \frac{\mu^{\ell}}{1+\mu^{\ell}}\right) \times y_{m+1}^{k\ell},$$

for $k \in$ {EU-27}. The according sector-specific percentage reductions in UK imports are provided in Tables 8 and 9 in the appendix. Averaging over all remaining EU countries and all industries, the reduction in UK imports of final demand goods from remaining EU countries amounts to 41% (see Table 10 in the appendix).

These magnitudes are a little bit lower than the long-run effects reported by Hantzsche et al. (2018) who estimate that a no-deal Brexit would reduce bilateral trade between the UK and the EU by 56% in the long-run and that about half of this effect would occur immediately. Other estimates of the change in UK imports have a similar order of magnitude; Dhingra et al. (2017a) report a short-run estimate of 34% (including intermediate inputs) based on a trade model which considers the respective tariffs to be expected in the various industries and Campos and Timini (2019) estimate from a gravity model that trade would drop by 30%. Vandenbussche et al. (2019) also use WIOD data and derive the change in trade flows from sector-specific trade elasticities and the change in (tariff and non-tariff) trade barriers which results in substantially larger effects than our approach.

2.3 Employment effects

To quantify the employment effects that are associated with changes in total output (Δx) we use employment data from the Social–Economic Accounts provided by the World Input–Output Database.[7] Similar to Los et al. (2015) and Feenstra and Sasahara (2018), we construct coefficients $b^{k\ell}$ which indicate how many employed persons produce one unit of output in a given industry, using employment by country and industry ($n^{k\ell}$):

$$b^{k\ell} = \frac{n^{k\ell}}{x^{k\ell}}$$

and a corresponding $(k \times \ell) \times 1$ vector $b = \left\{b^{k\ell}\right\}$. The change in employment by country and industry triggered by a decline in British final imports from remaining EU member countries including all effects through provision of intermediate inputs is given by:

$$\Delta b = b * \Delta x,$$

where $*$ denotes elementwise multiplication.

The employment effect can be decomposed into a direct and an indirect effect. The direct effect refers to the first-round effect of lower British imports without taking into account that affected firms will demand fewer intermediate inputs from other firms. The direct employment effect is then given by

[7] A different approach is followed by Vandenbussche et al. (2019) who apply employment elasticities which measure the drop in employment after a 1% decrease in value added.

$$\Delta b^D = b * \Delta y.$$

Finally, we can calculate the indirect effect:

$$\Delta b^{Ind} = \Delta b - \Delta b^D.$$

2.4 Regional disaggregation

Using the distribution of employment by industry, we allocate the industry-specific employment effects to the NUTS-2 regions and, for Germany, to its 401 German counties. However, employment by industry and region is only available for more general sectors not for the 56 industries covered by the World Input–Output Database. Employment data for NUTS-2 regions is available for sectors A, B–E, F, G–I, J, K, L, M–N, O–Q, R–U from Eurostat and for sectors A, B–E, F, G–J, K–N, O–T on the German county level from the working group "Regional Accounts" of the statistical offices of the 16 German states, the Federal Statistical Office and the German Association of Cities and Towns. We group the 56 industries accordingly.[8]

Let the number of affected employed persons in a sub-country region k and industry ℓ be denoted by $n^{k\ell}$ and the total number of affected employed persons in the sectors A, B–E, F, ... by $n^{\cdot\ell}$. Then, the number of affected employed persons in a region is given by

$$n^{k\ell} = n^{\cdot\ell} \times w^{k\ell},$$

where $w^{k\ell}$ is the share of region k in total employment in industry ℓ. Finally, the corresponding share of affected persons in region k is $n^{k\ell}/n^k$, where n^k denotes total employment in region k.

3 Results and discussion

3.1 Output effects by country

Output effects of the decline in British imports are shown in Table 2. The results fall within the range of previous studies. For Germany, for example, Vandenbussche et al. (2019) estimate a loss in value added due to a no-deal Brexit of 1.76%, while our results indicate a loss in gross output of 0.61% and in value added of 0.49%, respectively. Felbermayr et al. (2017) discuss the effects of Brexit on individual industries and estimate a no-deal-Brexit-induced decline in German GDP by about 0.2%. Note that direct effects for non-EU countries (including UK) are zero, because the respective trade regimes do not change after Brexit. However, non-EU countries are affected via intermediate inputs delivered to firms in EU countries which export goods and services to the UK.

3.2 Potential employment effects by country

If final import demand from the UK declines by 41% as implied by sector-specific elasticities and increased trading costs, then in total about one million employed persons are affected in 43 countries (without rest of the world), of which only 280,000 persons

[8] The NUTS-2 level employment data published by Eurostat does not sum up to the same country–industry employment figures in the World Input–Output Database. Therefore, we scale data on the NUTS-2 level by country–industry-specific factors to yield identical sums on the country–industry level for both data sources.

Table 2 Output effects of a decline in UK import demand for final goods from the EU (no-deal Brexit) by country

Country	Direct	Indirect	Total	Total
	In relation to gross output (in %)			In relation to value added (in%)
AUS	0.00	0.01	0.01	0.01
AUT	0.10	0.21	0.31	0.24
BEL	0.46	0.37	0.83	0.62
BGR	0.07	0.16	0.23	0.20
BRA	0.00	0.02	0.02	0.01
CAN	0.00	0.01	0.01	0.01
CHE	0.00	0.08	0.08	0.07
CHN	0.00	0.02	0.02	0.01
CYP	0.15	0.44	0.59	0.47
CZE	0.26	0.42	0.68	0.52
DEU	0.29	0.32	0.61	0.49
DNK	0.28	0.26	0.54	0.39
ESP	0.21	0.24	0.45	0.31
EST	0.06	0.12	0.18	0.16
FIN	0.04	0.11	0.16	0.12
FRA	0.18	0.22	0.40	0.30
GBR	0.00	0.08	0.08	0.07
GRC	0.06	0.06	0.13	0.11
HRV	0.09	0.13	0.22	0.21
HUN	0.22	0.34	0.56	0.42
IDN	0.00	0.02	0.02	0.01
IND	0.00	0.01	0.01	0.01
IRL	1.82	0.56	2.38	1.87
ITA	0.15	0.24	0.38	0.29
JPN	0.00	0.01	0.01	0.01
KOR	0.00	0.03	0.03	0.02
LTU	0.11	0.15	0.27	0.22
LUX	0.15	0.34	0.50	0.39
LVA	0.06	0.13	0.19	0.16
MEX	0.00	0.01	0.01	0.01
MLT	4.25	1.73	5.98	5.09
NLD	0.29	0.34	0.63	0.51
NOR	0.00	0.08	0.08	0.08
POL	0.23	0.35	0.58	0.50
PRT	0.17	0.20	0.37	0.26
ROU	0.09	0.18	0.28	0.24
RUS	0.00	0.04	0.04	0.04
SVK	0.44	0.46	0.90	0.64
SVN	0.06	0.20	0.26	0.21
SWE	0.11	0.19	0.30	0.25
TUR	0.00	0.06	0.06	0.05
TWN	0.00	0.04	0.04	0.03
USA	0.00	0.02	0.02	0.02
EU-27	0.25	0.27	0.53	0.40

The table shows estimated direct and indirect output effects of a decline in British final goods imports due to tariffs and non-tariff trade costs after a no-deal Brexit derived from input–output analysis. General-equilibrium effects and other relevant channels such as trade diversion are not included. *Source:* World Input–Output Database, data for 2014, own calculations

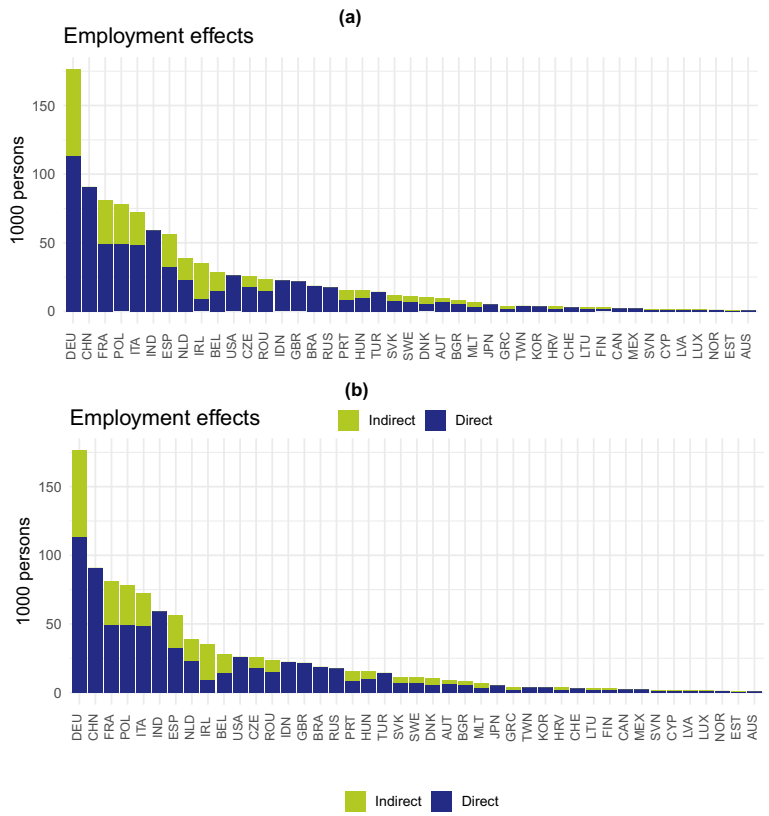

Fig. 2 Potential employment effects of a decline in UK import demand for final goods from the EU (no-deal Brexit). **a** Absolute effect and **b** Relative effect. The figures shows estimated direct and indirect employment effects of a decline in British final goods imports due to tariffs and non-tariff trade costs after a no-deal Brexit derived from input–output analysis. General-equilibrium effects and other relevant channels such as trade diversion are not included. *Source:* World Input–Output Database, data for 2014, and own calculations

in firms within the European Union that directly export final goods to the UK. About 730,000 persons will be affected by second-round effects that hit firms delivering intermediate inputs.

The overall effect on absolute employment is largest for Germany (Fig. 2a), where about 176,000 persons are potentially affected (see also Table 3).

The absolute effect is also relatively large for China (about 91,000 persons) although there are no direct effects, because China is not a member country of the EU. However, China will be affected via intermediate inputs of firms that export to the UK. Relative to total employment, Malta and Ireland are heavily affected. In these two countries, exports to the UK amount to 13.5% (Malta) and 7.3% (Ireland) of total production (see Table 7 in the appendix). In Malta, the reduction of trade with the UK may potentially affect 3.4% and in Ireland 1.9% of all employed persons (Fig. 2b).

Overall, the variation in the relative employment effects is mainly driven by the heterogeneity in the output effects: in a scatter plot (Fig. 3) of relative total-output effect and relative employment effect, the observations lie very close to a fitted regression line.

In countries above the regression line, the employment effect is relatively large compared to the output effect; this implies that the affected sectors exhibit a relatively low labor productivity. On the other hand, in countries below the regression line, labor

Table 3 Potential employment effects of a decline in UK import demand for final goods from the EU (no-deal Brexit)

Country	Affected persons			Total	Share of affected persons		
	Direct (1000 pers.)	Indirect (1000 pers.)	Sum (1000 pers.)	Employment (1000 pers.)	Direct (%)	Indirect (%)	Sum (%)
AUS	0.000	0.751	0.751	11,863	0.000	0.006	0.006
AUT	2.773	6.624	9.397	4268	0.065	0.155	0.220
BEL	13.338	14.837	28.175	4547	0.293	0.326	0.620
BGR	2.401	5.857	8.258	3602	0.067	0.163	0.229
BRA	0.000	18.711	18.711	104,029	0.000	0.018	0.018
CAN	0.000	2.298	2.298	18,449	0.000	0.012	0.012
CHE	0.000	3.129	3.129	5084	0.000	0.062	0.062
CHN	0.000	90.862	90.862	858,368	0.000	0.011	0.011
CYP	0.431	1.082	1.513	357	0.121	0.303	0.424
CZE	7.906	17.813	25.719	5111	0.155	0.349	0.503
DEU	63.068	113.281	176.349	42,706	0.148	0.265	0.413
DNK	4.505	5.805	10.310	2765	0.163	0.210	0.373
ESP	23.463	32.456	55.918	17,966	0.131	0.181	0.311
EST	0.411	0.572	0.983	620	0.066	0.092	0.159
FIN	0.726	2.091	2.818	2502	0.029	0.084	0.113
FRA	31.536	49.104	80.640	27,295	0.116	0.180	0.295
GBR	0.000	21.754	21.754	30,726	0.000	0.071	0.071
GRC	1.622	2.378	4.000	3965	0.041	0.060	0.101
HRV	1.848	1.887	3.736	1569	0.118	0.120	0.238
HUN	5.420	10.251	15.671	4235	0.128	0.242	0.370
IDN	0.000	22.484	22.484	168,808	0.000	0.013	0.013
IND	0.000	59.128	59.128	658,776	0.000	0.009	0.009
IRL	26.168	9.356	35.524	1914	1.367	0.489	1.856
ITA	23.917	48.262	72.179	24,371	0.098	0.198	0.296
JPN	0.000	5.112	5.112	61,232	0.000	0.008	0.008
KOR	0.000	3.861	3.861	24,446	0.000	0.016	0.016
LTU	1.148	1.738	2.886	1319	0.087	0.132	0.219
LUX	0.367	0.996	1.364	403	0.091	0.247	0.338
LVA	0.411	1.019	1.430	900	0.046	0.113	0.159
MEX	0.000	2.283	2.283	38,997	0.000	0.006	0.006
MLT	3.296	3.181	6.478	190	1.735	1.674	3.409
NLD	15.484	22.897	38.381	8727	0.177	0.262	0.440
NOR	0.000	1.137	1.137	2747	0.000	0.041	0.041
POL	29.122	49.445	78.567	15,577	0.187	0.317	0.504
PRT	7.133	8.543	15.676	4546	0.157	0.188	0.345
ROU	8.423	14.844	23.267	8805	0.096	0.169	0.264
RUS	0.000	17.501	17.501	74,286	0.000	0.024	0.024
SVK	4.158	7.418	11.577	2227	0.187	0.333	0.520
SVN	0.438	1.490	1.928	941	0.047	0.158	0.205
SWE	4.044	7.045	11.090	4750	0.085	0.148	0.233
TUR	0.000	14.249	14.249	32,326	0.000	0.044	0.044
TWN	0.000	3.998	3.998	20,207	0.000	0.020	0.020
USA	0.000	26.222	26.222	155,769	0.000	0.017	0.017
EU-27	283.556	440.273	723.832	196,178	0.145	0.224	0.367

The table shows estimated direct and indirect output effects of a decline in British final goods imports due to tariffs and non-tariff trade costs after a no-deal Brexit derived from input–output analysis. General-equilibrium effects and other relevant channels such as trade diversion are not included. *Source:* World Input–Output Database, data for 2014, own calculations

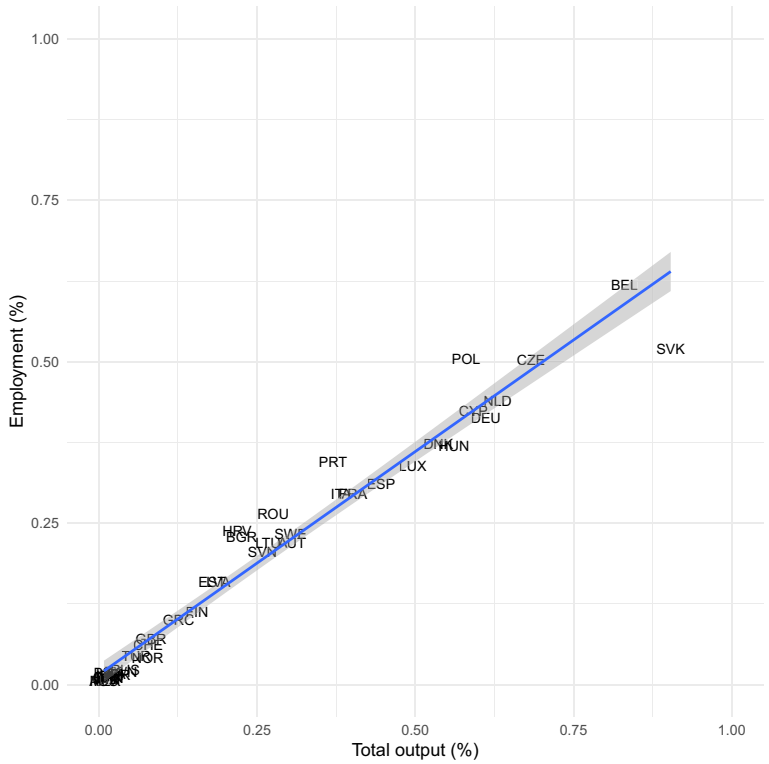

Fig. 3 Negative output and potential employment effects of a decline in UK import demand for final goods from the EU (no-deal Brexit). *Source:* World Input–Output Database, data for 2014, and own calculations. We restrict the range to (0,1) on both axes which implies that two outliers, Malta (output: 5.98%, employment: 3.41%) and Ireland (output: 2.38%, employment: 1.86%), are not shown. However, these two countries are not excluded from the calculation of the regression line

productivity in affected sectors is high, as in Slovakia, for example, where manufacturing of cars is the most affected sector.

3.3 Potential employment effects by industry

Which industries are affected most varies from country to country (see Table 11 in the appendix). Figure 4 shows country-specific heat maps of the employment effects. Light colored squares indicate that the effect is relatively small in an industry, while dark colored squares indicate a relatively large effect (based on the absolute total employment effect by country and industry).

In some countries, such as Bulgaria or Brazil, for example, agriculture is heavily affected. In other countries, such as Czech Republic and Germany, the effects are largest in manufacturing industries. In France and in the Netherlands, wholesale trade shows the strongest exposure. In the United States, administrative and support services are strongly affected. Note that the UK itself is also affected due to intermediate inputs exported by UK firms to non-UK firms which deliver to firms exporting from the remaining EU to the UK directly or indirectly via global value chains.

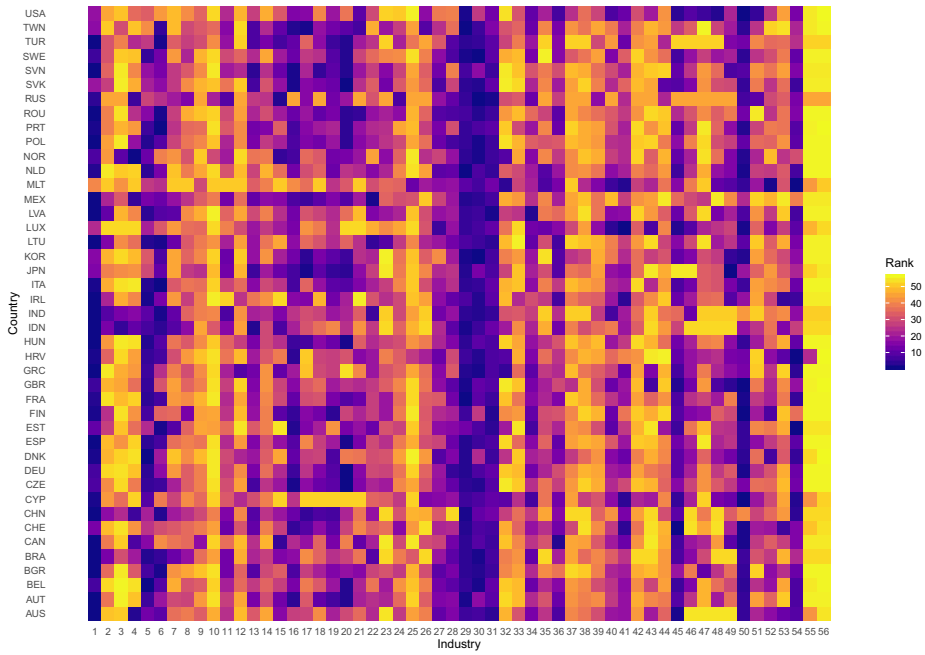

Fig. 4 Absolute total potential employment effects of a decline in UK import demand for final goods from the EU (no-deal Brexit) by country and industry. Light color: relative small effect, dark color: relative large effect. Based on ranked absolute total (direct and indirect) employment effects by country of a decline in British final goods imports due to tariffs and non-tariff trade costs after a no-deal Brexit derived from input–output analysis. General-equilibrium effects and other relevant channels such as trade diversion are not included. *Source:* World Input–Output Database, data for 2014, and own calculations

The industry-specific relative effects are large in Belgium, Malta and Ireland. While many sectors are strongly affected in Ireland and Malta, manufacturing is strongly affected in Belgium (manufacturing of cars 7.5%, textiles 4.2%, other transport equipment 4.0%). In most other countries, relative effects are large in some specific industries, such as the car industry in Germany (3.2%) and Spain (3.6%) or manufacturing of textiles in the Netherlands (3.8%) and in Sweden (3.3%).[9]

3.4 Regional employment effects

The share of affected workers if final import demand by the UK decreases due to a no-deal Brexit varies between 0.03% and 3.4% among European NUTS-2 regions and between 0.15% and 0.4% among German counties. Besides Malta and the regions in Ireland, Belgian provinces, the region Západné Slovensko (sector B–E) in the Slovak Republic, the regions Severovýchod (B–E), Strední Morava (B–E) and Jihozápad (B–E) in the Czech Republic as well as regions in Poland exhibit a relatively large employment exposure (see Table 12 in the appendix). Overall, while in Malta, Ireland, Belgium, Slovak Republic and Poland almost the whole country exhibits a similar exposure, the effects are more concentrated in some regions in Italy and Spain, see Fig. 5.

Within Germany, the county which is affected most in terms of relative employment effect is Dingolfing-Landau (449 of about 67,000 employed persons) followed

[9] Aichele and Felbermayr (2015) also find that the car industry is the most-affected industry in Germany.

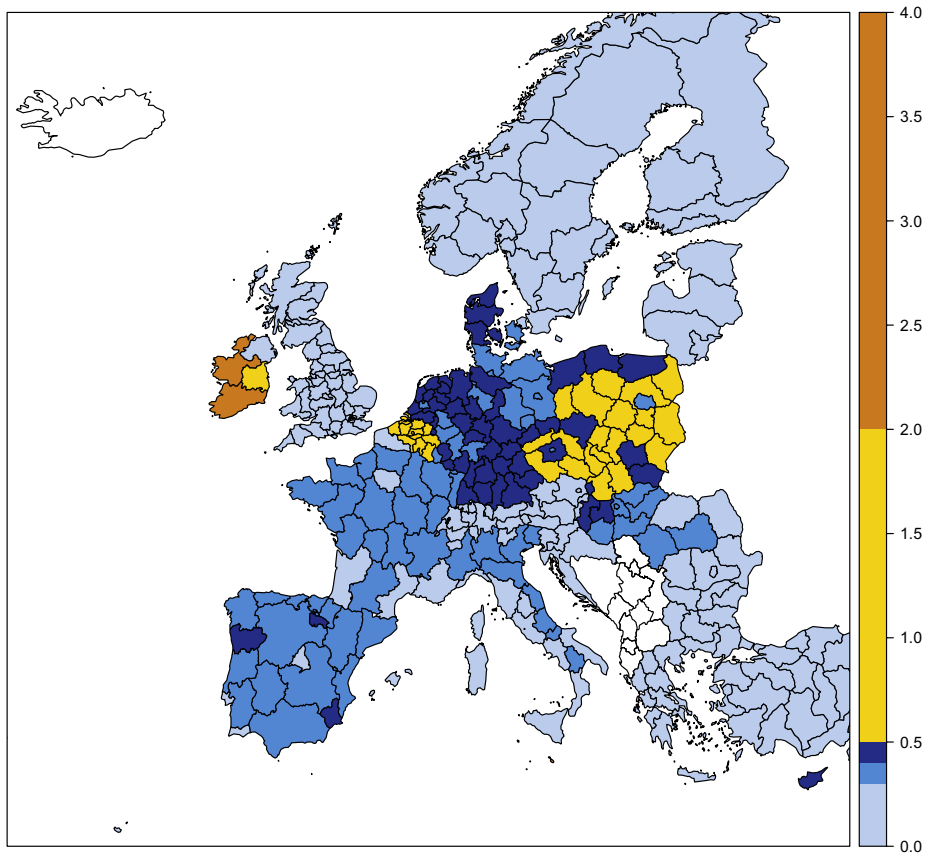

Fig. 5 Potential regional employment effect of a decline in UK import demand for final goods from the EU (no-deal Brexit) in European NUTS-2 regions. Employment effect in relation to total employment by region in percent. *Source:* World Input–Output Database, Eurostat (regional employment data) and own calculations. EuroGeographics for the administrative boundaries. Cuts in the color code at {0.3, 0.4, 0.5, 2.0}.

by Wolfsburg (835 of about 127,000 employed persons), see Table 13. The distribution across German counties is depicted in Fig. 6.

Overall, counties such as Wolfsburg (Volkswagen) or Dingolfing-Landau (BMW) in which production and trade of cars and car parts are relatively important are affected more than other counties.

4 Conclusions

Tariffs and non-tariff trade barriers make internationally traded products more expensive. Therefore, the demand for foreign products decreases if tariffs are introduced. We analyze the regional employment effects of tariffs and non-tariff trade barriers on trade between the UK and the EU after a no-deal Brexit. If the UK had left the EU without an agreement on international trade in goods and services many countries would have been affected by the corresponding decline in exports to the UK. Since production is organized in global value chains, not only would firms in the remaining EU countries suffer from declining exports to the UK, but also firms that supply intermediate inputs to firms that deliver final goods to the UK. The international integration of trade can be disentangled using World Input–Output tables. If

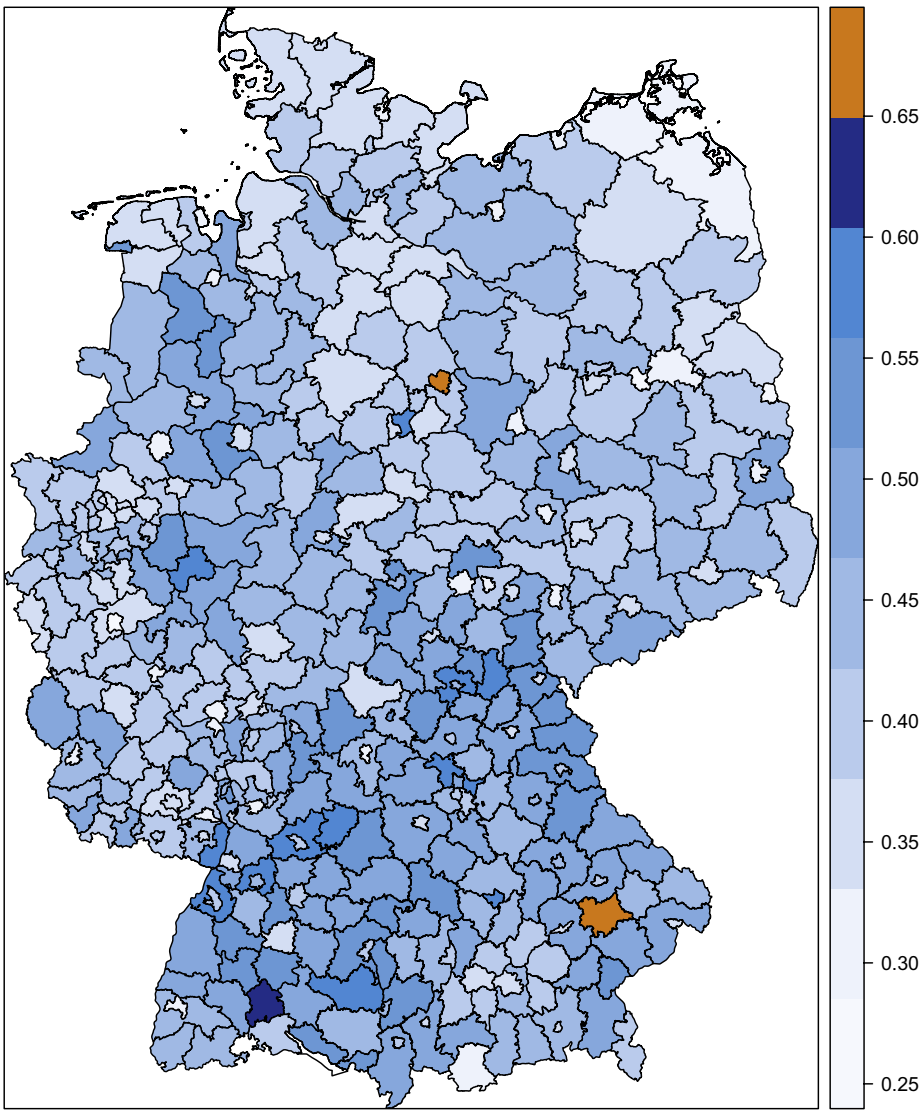

Fig. 6 Potential regional employment effects of a decline in UK import demand for final goods from the EU (no-deal Brexit) in German counties. Employment effect in relation to total employment by county in percent. *Source:* World Input–Output Database, VGR der Länder (regional employment data) and own calculations.

final import demand from the UK declines by 41% as implied by sector-specific elasticities and increased trading costs, then in total about one million employed persons are affected in 43 countries (without rest of the world), of which only 280,000 persons in firms within the European Union that directly export final goods to the UK. About 730,000 persons would be be affected by second-round effects that hit firms delivering intermediate inputs.

The motor vehicle industry would be the most affected industry (both manufacture and trade). In Germany alone, about 35,600 persons in the motor vehicle industry (2.1% of total employment in motor vehicle manufacturing and trade) would be directly or indirectly affected. Accordingly, within Germany important motor vehicle

manufacturing places would be most exposed to employment risks after a no-deal Brexit. However, there would also be considerable absolute effects in non-EU countries, such as China or India. The relative effect (in relation to total employment) in these countries would be rather low.

Our quantitative effects depend crucially on the assumption about the decline in UK final demand from the EU. The actual decline can be smaller or larger than assumed here. The results from the input–output analysis are linear in the size of the initial shock. If the decline in UK final demand from the EU is smaller, then our absolute figures and shares in total employment have to be adjusted proportionally. The relative distribution of the effects over countries and industries, however, would be unaffected by this. This also holds true for the regional distribution within countries.

Appendix

See Tables 4, 5, 6, 7, 8, 9, 10, 11, 12, 13.

Table 4 Countries in the World Input–Output Database

Acronym	Country	Acronym	Country	Acronym	Country
AUS	Australia	FRA	France*	MLT	Malta*
AUT	Austria*	GBR	United Kingdom	NLD	Netherlands*
BEL	Belgium*	GRC	Greece*	NOR	Norway
BGR	Bulgaria*	HRV	Croatia*	POL	Poland*
BRA	Brazil	HUN	Hungary*	PRT	Portugal*
CAN	Canada	IND	India	ROU	Romania*
CHE	Switzerland	IDN	Indonesia	RUS	Russian Federation
CHN	China	IRL	Ireland*	SVK	Slovakia*
CYP	Cyprus*	ITA	Italy*	SVN	Slovenia*
CZE	Czech Republic*	JPN	Japan	SWE	Sweden*
DEU	Germany*	KOR	South Korea	TUR	Turkey
DNK	Denmark*	LTU	Lithuania*	TWN	Taiwan
ESP	Spain*	LUX	Luxembourg*	USA	United States
EST	Estonia*	LVA	Latvia*		
FIN	Finland*	MEX	Mexico		

Remaining EU member countries after Brexit are marked by an asterisk

Table 5 Industry classification (A–F)

No.	NACE Code	Description
	A	*Agriculture, forestry and fishing*
1	A01	Crop and animal production, hunting and related service activities
2	A02	Forestry and logging
3	A03	Fishing and aquaculture
	B, C, D, E	*Manufacturing, mining and quarrying and other industry*
4	B	Mining and quarrying
5	C10–C12	Manufacture of food products, beverages and tobacco products
6	C13–C15	Manufacture of textiles, wearing apparel and leather products
7	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
8	C17	Manufacture of paper and paper products
9	C18	Printing and reproduction of recorded media
10	C19	Manufacture of coke and refined petroleum products
11	C20	Manufacture of chemicals and chemical products
12	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
13	C22	Manufacture of rubber and plastic products
14	C23	Manufacture of other non-metallic mineral products
15	C24	Manufacture of basic metals
16	C25	Manufacture of fabricated metal products, except machinery and equipment
17	C26	Manufacture of computer, electronic and optical products
18	C27	Manufacture of electrical equipment
19	C28	Manufacture of machinery and equipment n.e.c.
20	C29	Manufacture of motor vehicles, trailers and semi-trailers
21	C30	Manufacture of other transport equipment
22	C31_C32	Manufacture of furniture; other manufacturing
23	C33	Repair and installation of machinery and equipment
24	D35	Electricity, gas, steam and air conditioning supply
25	E36	Water collection, treatment and supply
26	E37–E39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
	F	*Construction*
27	F	Construction

Source: European Commission (2008)

Table 6 Industry classification (G–U)

No.	NACE code	Description
	G–T	*Trade and services*
28	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
29	G46	Wholesale trade, except of motor vehicles and motorcycles
30	G47	Retail trade, except of motor vehicles and motorcycles
31	H49	Land transport and transport via pipelines
32	H50	Water transport
33	H51	Air transport
34	H52	Warehousing and support activities for transportation
35	H53	Postal and courier activities
36	I	Accommodation and food service activities
37	J58	Publishing activities
38	J59_J60	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities
39	J61	Telecommunications
40	J62_J63	Computer programming, consultancy and related activities; information service activities
41	K64	Financial service activities, except insurance and pension funding
42	K65	Insurance, reinsurance and pension funding, except compulsory social security
43	K66	Activities auxiliary to financial services and insurance activities
44	L68	Real estate activities
45	M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities
46	M71	Architectural and engineering activities; technical testing and analysis
47	M72	Scientific research and development
48	M73	Advertising and market research
49	M74_M75	Other professional, scientific and technical activities; veterinary activities
50	N	Administrative and support service activities
51	O84	Public administration and defense; compulsory social security
52	P85	Education
53	Q	Human health and social work activities
54	R_S	Other service activities
55	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
56	U	Activities of extraterritorial organizations and bodies

Source: European Commission (2008).

Table 7 Exports to the UK by country

Country	Exports to UK (Million USD)	Total exports (Million USD)	Total output (Million USD)	Share of exports to UK	
				In total exports (%)	In total output (%)
AUS	3,736	287,162	2,723,737	1.30	0.14
AUT	5,452	210,995	809,631	2.58	0.67
BEL	27,883	383,014	1,110,756	7.28	2.51
BGR	767	31,698	122,873	2.42	0.62
BRA	4,779	270,263	4,103,502	1.77	0.12
CAN	13,649	563,511	3,252,175	2.42	0.42
CHE	12,649	352,570	1,398,665	3.59	0.90
CHN	51,850	2,425,464	31,745,102	2.14	0.16
CYP	352	9,347	39,448	3.77	0.89
CZE	6,825	161,570	492,772	4.22	1.38
DEU	103,347	1,682,253	7,066,741	6.14	1.46
DNK	10,686	170,293	614,582	6.28	1.74
ESP	21,498	389,005	2,567,905	5.53	0.84
EST	458	18,266	54,483	2.50	0.84
FIN	4288	100,453	513,658	4.27	0.83
FRA	60,107	75,9654	5,020,134	7.91	1.20
GRC	1779	5,6261	375,244	3.16	0.47
HRV	548	23,269	97,419	2.35	0.56
HUN	4521	116,445	284,430	3.88	1.59
IDN	2056	210,599	1,714,343	0.98	0.12
IND	12,221	369,456	398,3527	3.31	0.31
IRL	37,295	262,751	509,477	14.19	7.32
ITA	33,780	588,585	4,075,402	5.74	0.83
JPN	9647	817,514	8,668,736	1.18	0.11
KOR	7848	697,935	3,403,854	1.12	0.23
LTU	1266	32,723	85,668	3.87	1.48
LUX	3209	118,439	211,968	2.71	1.51
LVA	669	14,719	64,726	4.54	1.03
MEX	2094	368,185	2,130,489	0.57	0.10
MLT	3914	13,420	28,915	29.16	13.53
NLD	43,525	575,068	1,671,177	7.57	2.60
NOR	25,676	188,131	835,079	13.65	3.07
POL	14,176	251,642	1,105,444	5.63	1.28
PRT	3805	76,633	414,281	4.97	0.92
ROU	2160	77,648	398,280	2.78	0.54
RUS	9321	493,789	3,381,079	1.89	0.28
SVK	4635	82,119	229,289	5.64	2.02
SVN	574	30,812	94,238	1.86	0.61
SWE	12,119	235,354	1,018,189	5.15	1.19
TUR	12,805	249,783	1,494,428	5.13	0.86
TWN	4896	369,923	1,220,629	1.32	0.40
USA	73,796	1,927,091	30,971,023	3.83	0.24

Source: World Input–Output Database, intermediate and final use in destination country, data for 2014, own calculations

Table 8 Industry-specific tariffs, elasticities, non-tariff trade barriers, and reductions in trade volumes (A–F)

No.	NACE Code	Tariff Final (%)	Tariff Intermediate (%)	Elasticity	MFN NTB (%)	Reduction Final (%)	Reduction Intermediate (%)
1	A01	7.8	1.0	1.96	47.0	47.3	33.9
2	A02	10.4	0.2	1.87	30.0	42.5	23.5
3	A03	10.0	4.2	3.58	3.0	38.7	17.9
4	B	0.0	0.0	3.58	3.0	2.9	2.9
5	C10–C12	18.7	11.2	1.63	34.0	55.9	43.6
6	C13–C15	9.9	6.2	3.58	10.0	44.5	31.3
7	C16	1.6	2.2	3.58	8.0	13.1	15.3
8	C17	1.6	0.0	1.04	33.0	26.5	24.8
9	C18	0.0	0.3	2.04	3.0	2.9	3.5
10	C19	0.0	2.4	6.04	6.0	5.7	20.2
11	C20	2.3	4.8	3.78	19.0	24.7	34.1
12	C21	0.0	0.7	7.63	17.0	14.5	19.9
13	C22	5.8	5.3	2.82	28.0	38.2	36.8
14	C23	10.1	3.1	1.42	35.0	40.3	30.3
15	C24	0.0	2.2	4.72	14.0	12.3	22.7
16	C25	3.1	2.8	1.84	35.0	31.6	31.1
17	C26	2.5	1.4	5.73	8.0	21.7	15.4
18	C27	2.7	2.5	6.42	14.0	29.6	28.3
19	C28	1.7	1.9	7.51	8.0	20.2	21.7
20	C29	10.0	5.9	4.39	19.0	59.9	41.9
21	C30	5.2	3.0	5.17	9.0	35.1	23.8
22	C31–C32	1.5	1.3	3.42	2.0	7.1	6.4
23	C33	0.0	0.0	1.56	117.0	53.9	53.9
24	D35	0.0	0.0	1.56	68.0	40.5	40.5
25	E36	0.0	0.0	1.56	3.0	2.9	2.9
26	E37–E39	0.0	0.0	1.56	56.0	35.9	35.9
27	F	0.0	0.0	1.56	74.0	42.5	42.5

Source: Tariffs (τ^{ℓ}) from Cappariello et al. (2018), Table B.8, elasticities (ϵ^{ℓ}) and ad-valorem non-tariff trade barrier (μ^{ℓ}) under WTO rule (MFN NTB) from Cappariello et al. (2020), Table 4. MFN NTB denotes by how much trade is inflated in the Single Market compared to non-EU. Reduction in trade calculated as $\left(\epsilon^{\ell} \times \tau^{\ell} + \frac{\mu^{\ell}}{1+\mu^{\ell}}\right)$

Table 9 Industry-specific tariffs, elasticities, non-tariff trade barriers, and reductions in trade volumes (G–U)

No.	NACE code	Tariff Final (%)	Tariff Intermediate (%)	Elasticity	MFN NTB (%)	Reduction Final (%)	Reduction Intermediate (%)
28	G45	0.0	0.0	1.56	113.0	53.1	53.1
29	G46	0.0	0.0	1.56	94.0	48.5	48.5
30	G47	0.0	0.0	1.56	117.0	53.9	53.9
31	H49	0.0	0.0	1.56	50.0	33.3	33.3
32	H50	0.0	0.0	1.56	74.0	42.5	42.5
33	H51	0.0	0.0	1.56	29.0	22.5	22.5
34	H52	0.0	0.0	1.56	18.0	15.3	15.3
35	H53	0.0	0.0	1.56	44.0	30.6	30.6
36	I	0.0	0.0	1.56	45.0	31.0	31.0
37	J58	0.0	0.0	1.56	21.0	17.4	17.4
38	J59–J60	0.0	0.0	1.56	21.0	17.4	17.4
39	J61	0.0	0.0	1.56	15.0	13.0	13.0
40	J62–J63	0.0	0.0	1.56	72.0	41.9	41.9
41	K64	0.0	0.0	1.56	65.0	39.4	39.4
42	K65	0.0	0.0	1.56	45.0	31.0	31.0
43	K66	0.0	0.0	1.56	55.0	35.5	35.5
44	L68	0.0	0.0	1.56	41.0	29.1	29.1
45	M69–M70	0.0	0.0	1.56	23.0	18.7	18.7
46	M71	0.0	0.0	1.56	99.0	49.7	49.7
47	M72	0.0	0.0	1.56	37.0	27.0	27.0
48	M73	0.0	0.0	1.56	18.0	15.3	15.3
49	M74–M75	0.0	0.0	1.56	57.0	36.3	36.3
50	N	0.0	0.0	1.56	28.0	21.9	21.9
51	O84	0.0	0.0	1.56	28.0	21.9	21.9
52	P85	0.0	0.0	1.56	58.0	36.7	36.7
53	Q	0.0	0.0	1.56	32.0	24.2	24.2
54	R–S	0.0	0.0	1.56	119.0	54.3	54.3
55	T	0.0	0.0	1.56	45.0	31.0	31.0
56	U	0.0	0.0	1.56	28.0	21.9	21.9

Source: Tariffs (τ_y^ℓ and τ_x^ℓ) from Cappariello et al. (2018), Table B.8, elasticities (ϵ^ℓ) and ad-valorem non-tariff trade barrier (μ^ℓ) under WTO rule (MFN NTB) from Cappariello et al. (2020), Table 4. MFN NTB denotes by how much trade is inflated in the Single Market compared to non-EU. Reduction in trade calculated as $\left(\epsilon^\ell \times \tau^\ell + \frac{\mu^\ell}{1+\mu^\tau}\right)$

Table 10 Decline in UK import demand for final goods from the EU (no-deal Brexit) by country

Country	Reduction in exports to UK	
	In relation to all exports (in %)	In relation to gross output (in %)
MLT	49.51	4.25
IRL	45.09	1.82
BEL	42.76	0.46
SVK	39.66	0.44
DEU	43.59	0.29
NLD	36.73	0.29
DNK	38.70	0.28
CZE	40.24	0.26
POL	38.60	0.23
HUN	35.23	0.22
ESP	45.37	0.21
FRA	37.70	0.18
PRT	40.64	0.17
LUX	35.94	0.15
CYP	38.45	0.15
ITA	36.36	0.15
SWE	28.73	0.11
LTU	21.82	0.11
AUT	36.19	0.10
ROU	36.37	0.09
HRV	40.69	0.09
BGR	32.06	0.07
SVN	27.95	0.06
GRC	36.01	0.06
EST	30.28	0.06
LVA	28.05	0.06
FIN	20.55	0.04
Total	40.64	0.25

Source: World Input–Output Database and own calculations

Table 11 Potential employment effects of a decline in UK import demand for final goods from the EU (no-deal Brexit) by country and industry (30 most affected country–industry combinations)

No.	Country	Industry	Direct (1000 pers.)	Indirect (1000 pers.)	Sum (1000 pers.)	Tot. Empl. (1000 pers.)	Share (%)
1	DEU	20	21.863	5.599	27.462	846	3.246
2	IND	1	0.000	24.232	24.232	253,883	0.010
3	CHN	1	0.000	15.233	15.233	175,119	0.009
4	DEU	50	0.259	14.738	14.997	3,010	0.498
5	POL	1	2.505	12.482	14.987	1,640	0.914
6	DEU	29	6.997	7.271	14.268	1,878	0.760
7	DEU	5	9.557	2.910	12.466	927	1.345
8	CHN	29	0.000	11.966	11.966	79,834	0.015
9	IRL	1	10.196	0.868	11.064	80	13.830
10	BRA	1	0.000	10.959	10.959	13,128	0.083
11	IDN	1	0.000	10.363	10.363	40,597	0.026
12	POL	30	6.107	4.164	10.271	1,430	0.718
13	FRA	29	5.449	4.243	9.691	1,110	0.873
14	ESP	1	5.340	3.983	9.324	667	1.398
15	ITA	6	5.691	3.475	9.166	515	1.780
16	IRL	5	8.411	0.109	8.521	54	15.779
17	FRA	50	0.814	7.520	8.334	2,059	0.405
18	FRA	1	1.705	6.500	8.205	715	1.148
19	DEU	28	0.979	7.121	8.100	824	0.983
20	FRA	5	6.047	2.027	8.074	607	1.330
21	USA	50	0.000	7.792	7.792	12,808	0.061
22	CHN	6	0.000	7.481	7.481	32,739	0.023
23	ITA	1	1.192	6.255	7.447	839	0.888
24	DEU	16	1.213	6.214	7.427	901	0.824
25	DEU	1	1.244	6.111	7.355	606	1.214
26	IND	6	0.000	7.291	7.291	21,927	0.033
27	DEU	30	0.629	6.569	7.199	3,209	0.224
28	DEU	19	3.672	3.496	7.168	1,129	0.635
29	POL	5	4.797	2.149	6.946	541	1.284
30	DEU	45	0.028	6.233	6.261	1,287	0.487

Ordered by absolute employment effect. *Source:* World Input–Output Database, data for 2014, own calculations

Table 12 Potential employment effects of a decline in UK import demand for final goods from the EU (no-deal Brexit) by NUTS-2 region (30 most affected regions)

No.	NUTS-2	Country	Region	Affected persons (1000 pers.)	Total employment (1000 pers.)	Share of affected persons (%)
1	MT0	MLT	Malta	6.478	190	3.409
2	IE4	IRL	Northern and Western	8.009	335	2.385
3	IE5	IRL	Southern	13.961	634	2.202
4	IE6	IRL	Eastern and Midland	13.553	944	1.436
5	BE25	BEL	Prov. West-Vlaanderen	3.477	503	0.691
6	BE22	BEL	Prov. Limburg (BE)	2.401	362	0.662
7	BE23	BEL	Prov. Oost-Vlaanderen	4.293	650	0.660
8	BE21	BEL	Prov. Antwerpen	5.005	762	0.656
9	BE34	BEL	Prov. Luxembourg (BE)	0.717	113	0.632
10	BE32	BEL	Prov. Hainaut	2.726	455	0.598
11	BE31	BEL	Prov. Brabant wallon	0.960	165	0.581
12	BE24	BEL	Prov. Vlaams-Brabant	2.859	494	0.579
13	BE33	BEL	Prov. Liège	2.286	397	0.575
14	SK2	SVK	Západné Slovensko	4.479	785	0.570
15	CZ5	CZE	Severovýchod	3.986	717	0.556
16	PL92	POL	Mazowiecki regionalny	6.256	1,136	0.551
17	CZ7	CZE	Střední Morava	3.113	566	0.549
18	PL72	POL	Swietokrzyskie	3.077	562	0.547
19	PL41	POL	Wielkopolskie	7.076	1,310	0.540
20	BE10	BEL	Région de Bruxelles-Capitale	2.417	448	0.538
21	BE35	BEL	Prov. Namur	1.035	193	0.535
22	PL82	POL	Podkarpackie	4.076	763	0.534
23	CZ8	CZE	Moravskoslezsko	2.994	562	0.532
24	PL84	POL	Podlaskie	2.408	453	0.531
25	CZ3	CZE	Jihozápad	3.165	596	0.531
26	PL71	POL	Lódzkie	6.638	1,256	0.528
27	PL61	POL	Kujawsko-Pomorskie	4.000	767	0.521
28	PL81	POL	Lubelskie	5.014	966	0.519
29	PL52	POL	Opolskie	1.835	355	0.516
30	CZ6	CZE	Jihovýchod	4.178	813	0.513

Ordered by share of affected persons. *Source:* World Input–Output Database, Eurostat (regional employment data) and own calculations

Table 13 Potential employment effects of a decline in UK import demand for final goods from the EU (no-deal Brexit) in German counties (30 most affected counties)

No.	County	Affected persons (1000 pers.)	Total employment (1000 pers.)	Share of affected persons (%)
1	Dingolfing-Landau	449	67,339	0.667
2	Wolfsburg	835	127,082	0.657
3	Tuttlingen	517	83,025	0.622
4	Salzgitter	343	56,968	0.602
5	Enzkreis	464	79,546	0.583
6	Germersheim	340	58,924	0.577
7	Erlangen-Höchstadt	345	59,896	0.577
8	Hohenlohekreis	397	69,060	0.574
9	Olpe	441	76,972	0.572
10	Ingolstadt	675	118,072	0.572
11	Heilbronn	940	164,491	0.571
12	Coburg	212	37,232	0.571
13	Biberach	601	105,286	0.570
14	Rastatt	640	113,006	0.566
15	Kronach	188	33,395	0.564
16	Donau-Ries	442	79,760	0.554
17	Märkischer Kreis	1182	214,231	0.552
18	Unterallgäu	370	67,096	0.551
19	Böblingen	1223	222,007	0.551
20	Neustadt a.d.Waldnaab	209	38,039	0.548
21	Rottweil	409	74,578	0.548
22	Hof	261	47,707	0.546
23	Haßberge	213	39,142	0.544
24	Main-Spessart	330	60,787	0.544
25	Saale-Orla-Kreis	219	40,305	0.543
26	Ludwigshafen am Rhein	669	123,478	0.542
27	Schweinfurt	354	65,896	0.538
28	Wartburgkreis	281	52,533	0.535
29	Bodenseekreis	640	120,470	0.531
30	Lindau (Bodensee)	227	42,759	0.531

Ordered by share of affected persons. *Source:* World Input–Output Database, data for 2014, VGR der Länder (regional employment data for 2014 as of August 2017) and own calculations

Acknowledgements
We thank Martina Kämpfe, Axel Lindner and three anonymous reviewers for helpful comments.

Authors' contributions
Both authors have developed the research idea and the concept of the project together. Both authors have worked on the computer code for the calculations and have written parts of the manuscript. Both authors read and approved the final manuscript.

Funding
This project has been funded by the regular budget of the Halle Institute for Economic Research (IWH).

Availability of data and materials
The data used for this project are publicly available and are described in section 2 Data and methodology.

Declarations

Competing interests
The authors declare that they have no competing interests.

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Received: 21 May 2019 Revised: 28 June 2021 Accepted: 1 July 2021
Published online: 12 July 2021

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