POST-BREXIT: UK TRADE IN GOODS
UKTPO BRIEFING PAPER 57

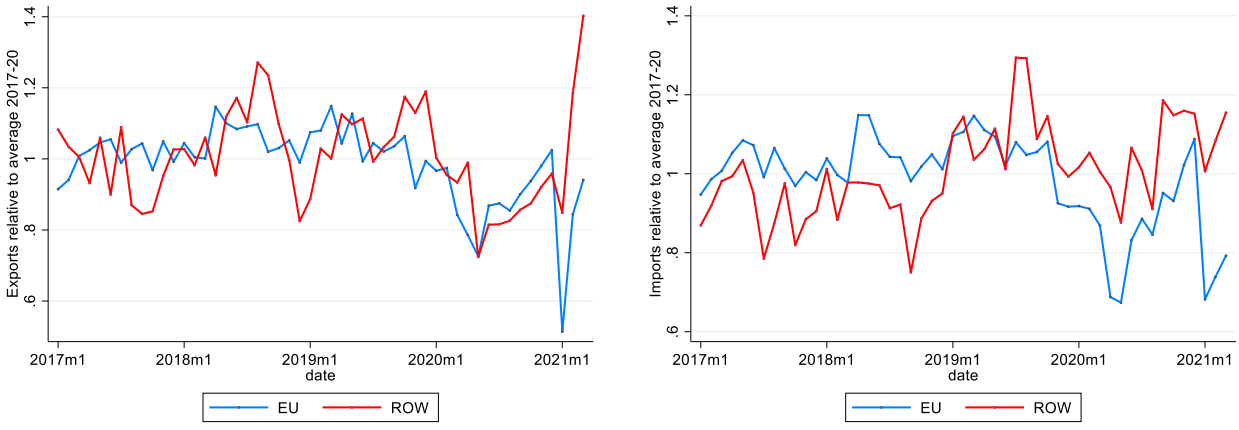
APPENDIX
MAY 2021

This appendix gives detailed information on the difference-in-differences and synthetic control analyses reported in the main text.

We use data for the period 2017-2021 of UK trade with the EU and a non-EU control group composed of non-EU OECD plus BRICS countries, which account for most of UK trade with non-EU.[1] We exclude Canada and Japan because they sign a trade agreement with the EU (and UK) in the considered period, but results are robust to their inclusion. We refer to the control group as ROW. The pre-TCA period is therefore 2017-20 and the post-TCA is 2021 onwards. Some authors reported that UK trade in 2017-20 was down relative to the pre-referendum period, suggesting a structural break in the trade series in 2016. Therefore, we exclude the pre-referendum period from the analysis.

Before turning to the estimation, we show two pictures representing the quantities we are going to estimate with OLS and PPML estimators. Figure 1 shows the indexes of the UK's exports and imports with EU and non-EU over the period 2017-21. The indexes are computed relative to the monthly average of the pre-treatment period 2017-20. That is, UK's exports to the EU in Jan2021 are divided by the average of exports to the EU in Jan17, Jan18, Jan19 and Jan20. Similarly for February and March. For exports, we see clear drop in January 2021 but the difference with ROW is not so marked in Feb-Mar 2021. On the other hand, for imports we see a more constant gap in 2021.

Figure 1: Total UK trade with EU vs control group, relative to average 2017-20 m-o-m



a) Exports b) Imports

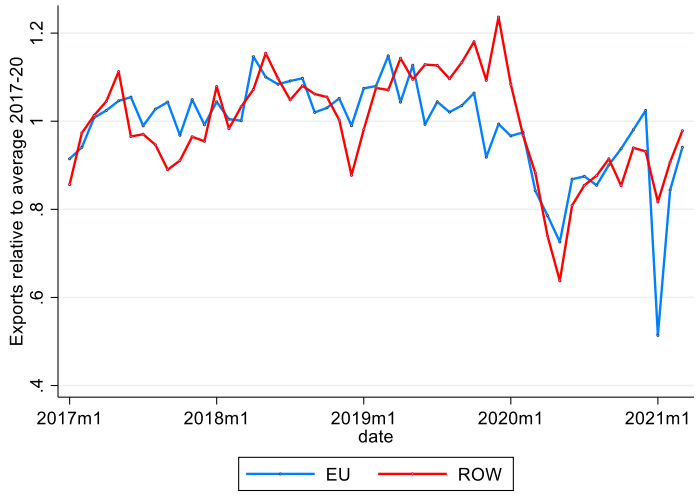
Source: authors' elaboration of HMRC data. The figure show trade in a given month divided by the average of the same month over the years 2017-20. The control group is composed by non-EU OECD countries and BRICS.

Figure 1 shows the evolution of total trade with EU/ROW. Another way of looking at this is to compute a geometric average of trade across EU partners (and across ROW). The exports series show a very large gap between the EU and the control group in all three months of 2021. We note that the large gap for February and March 2021 is almost entirely due to UK exports to Switzerland, which passed from £1.3b in January 2021 to £3.1b in February and £5.7b in March. Other control units did not experience such a sharp rise in exports. In a regression framework, Switzerland's exceptionality will be reflected in the size of standard

[1] The control group is composed of Australia, Brazil, Switzerland, Chile, China, Colombia, Israel, India, Iceland, South Korea, Mexico, Norway, New Zealand, Russia, Turkey, the US and South Africa.

errors, which will point to not significant results. For comparison, Figure 2 replicates Figure 1 for exports excluding Switzerland from the control group. We can see that the gap between EU and non-EU in February and March 2021 is very narrow.

Figure 2: Total UK exports to EU vs control group excluding Switzerland, 2017-20 m-o-m



While the total trade, or arithmetic average, gives more importance to what happens to large countries, the geometric average treats every trade partner equally in proportional terms. That is, a 10% change in exports to Germany is treated equivalently to a 10% in exports to Estonia. As for total trade, we compute an index of trade as the geometric average across EU (ROW) countries relative to the geometric average of EU (ROW) in the same month of years 2017-20. The index of the geometric average is reported in Figure 3, and tells pretty much the same story for exports, but suggests that for imports most of the action happened with large partners, in particular for ROW.

Figure 3: Geometric average UK trade with EU vs control group, relative to average 2017-20 m-o-m

a) Exports b) Imports

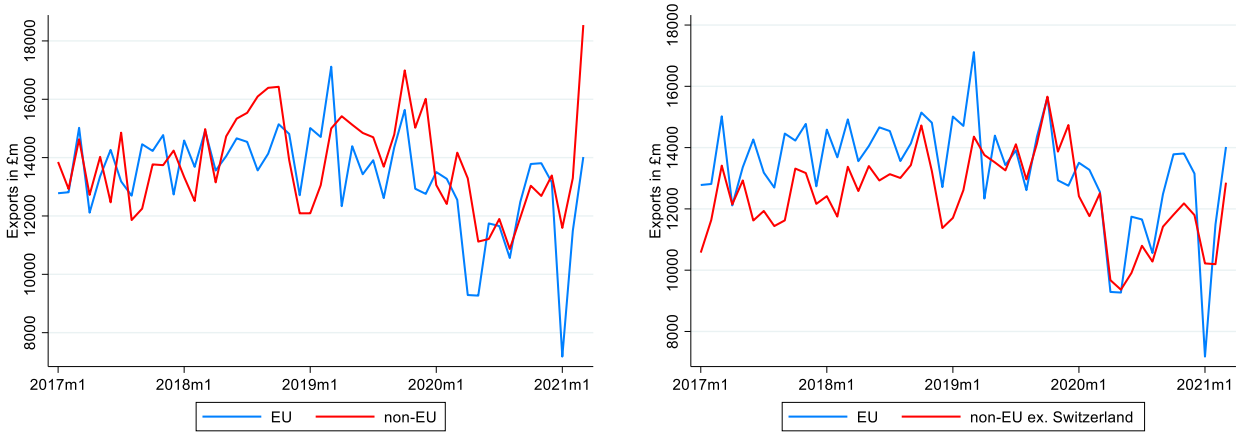
Source: authors' elaboration of HMRC data. The figure show the geometric average across partners of trade in a given month divided by the geometric average of the same month over the years 2017-20. The control group is composed by non-EU OECD countries and BRICS.

Switzerland's exceptionalism

Taking total trade at face values, we would conclude that UK exports to the EU have been hardly hit in all months of 2021. This is evident in Figure 1, but as we exclude Switzerland from the control group the

picture looks different. To reiterate on this point we show UK's total exports to the EU and non-EU partners over the period 2017-21 with no transformation to the data, both with and without Switzerland. The series is reported in Figure 4. In panel (a) we have UK exports to EU and non-EU, while in panel (b) we exclude Switzerland from the non-EU group. The pictures are very different: we still see a drop in UK's exports to the EU in January 2021, but not in February or March 2021.

Figure 4: UK exports to the EU and non-EU



a) Exports to EU and non-EU

b) Exports to EU and non-EU ex. Switzerland

UK exports to Switzerland have been exceptional in February and March 2021, and this is entirely due to exports of gold (HS 7108). Table 1 reports UK exports to Switzerland in 2021 for HS 71, the sub-category HS 7108 and total exports. As we can see, the sharp rise in exports is all due to gold, which is not exactly the type of counterfactual that we want to have for UK exports to the EU.

Table 1: UK exports to Switzerland in 2021, £m

HS code	Description	2021m1	2021m2	2021m3
71	Pearls and precious metals	1,032	2,823	5,338
7108	Gold	893	2,712	5,228
Total	Total	1,371	3,101	5,689

Difference-in-differences with HMRC data

Figure 1 and Figure 3 above show the quantities that we will estimate in a difference-in-differences (DD) exercise. We consider two estimators: Poisson PML and OLS with logs.

PPML: $$Y_{it} = \exp[\alpha_i + \alpha_t + \beta^{PPML}(EU_i \times 2021) + \epsilon_{it}] \quad \text{Eq. 1}$$

OLS: $$\ln Y_{it} = \alpha_i + \alpha_t + \beta^{OLS}(EU_i \times 2021) + \epsilon_{it} \quad \text{Eq. 2}$$

Where Y_{it} is either exports or imports, α_i are partner dummies, α_t are time dummies, EU_i equals one for EU partners and zero otherwise and 2021 is a dummy for 2021. There are 27 EU partners and 17 non-EU partners in the control group (OECD+BRICS).

The two estimators will give us slightly different answers. The PPML estimator of Eq. 1 will tell us what happened to UK's total trade with the EU relative to total trade with the control group. This means that the treatment effect β^{PPML} will strongly depend on what happened to trade with the largest countries:

Germany, France and Italy for EU and US, China and Switzerland for non-EU. If the TCA affected more strongly trade with small EU countries, this estimator is less likely to detect any effect. Formally, the PPML estimator will give us:

$$\beta^{PPML} = \ln\left(\frac{\bar{Y}_{EU,2021}/\bar{Y}_{EU,2017-20}}{\bar{Y}_{non-EU,2021}/\bar{Y}_{non-EU,2017-20}}\right)$$

Where the bar indicates the arithmetic average, so that $\bar{Y}_{EU,2021} = \frac{1}{N_{EU}T_{2021}}\sum_{i\in EU}\sum_{t\in 2021} Y_{it}$ is the average of trade with EU in 2021. Substituting the definition of averages in β^{PPML} all N and T terms cancel out, so we are left with the ratio of totals:

$$\beta^{PPML} = \ln\left(\frac{Y_{EU,2021}/Y_{EU,2017-20}}{Y_{non-EU,2021}/Y_{non-EU,2017-20}}\right)$$

The quantity estimated with PPML are essentially those reported in Figure 1.[2]

On the other hand, the log-linear OLS treats each country equally. If in 2021 UK's trade with the EU felt by 10% with Germany or Portugal the OLS will record a fall by 10%, without considering the size of the country. This is because the OLS estimator will give us the difference in the average of the log, that is, the log of the geometric averages:

$$\beta^{OLS} = \left(\overline{\ln Y_{EU,2021}} - \overline{\ln Y_{EU,2017-20}}\right) - \left(\overline{\ln Y_{non-EU,2021}} - \overline{\ln Y_{non-EU,2017-20}}\right)$$

Consider

$$\overline{\ln Y_{EU,2021}} = \frac{1}{N_{EU}T_{2021}}\sum_{i\in EU}\sum_{t\in 2021}\ln Y_{it} = \ln\left[\left(\prod_{i\in EU}\prod_{t\in 2021} Y_{it}\right)^{\frac{1}{N_{EU}T_{2021}}}\right] = \ln(\overline{Y^G}_{EU,2021})$$

Where $\overline{Y^G}$ indicates the geometric average. Then we can write the OLS estimator as:

$$\beta^{OLS} = \ln\left(\frac{\overline{Y^G}_{EU,2021}/\overline{Y^G}_{EU,2017-20}}{\overline{Y^G}_{non-EU,2021}/\overline{Y^G}_{non-EU,2017-20}}\right)$$

Given the multiplicative nature of the geometric average, a proportional change in one of the elements of the average (e.g., exports with Portugal) from 2017-20 to 2021 is considered independently of the flow's size. The graphical illustration of what the OLS estimates is in Figure 3.

From this discussion, it should be clear that PPML will tell us what happens in total, and it gives more importance to large trade partners, while the OLS treats every partner equally independently of their size. The two estimators will give the same answer only if the proportional changes were the same for each partner. While we might prefer the PPML estimator because we are interested in what happened to total trade, we should acknowledge that the counterfactual group is also mainly driven by large countries. This would be problematic if the US, China or Switzerland are not good comparisons for the EU. However, we also note that exceptionalism of a particular country will be accounted for by the standard errors in the regression.

Table 2 reports the estimation results of Eq. 1 and Eq. 2. The regressions are estimated using data for the months of Jan-Mar for the years 2017-21 so that we are comparing the same months. The results should be evident from the visual inspection of Figure 1 and Figure 3. For exports, both estimators give pretty much

[2] 'Essentially' because each month will have different weights, depending on how much trade was carried out in each month, but differences are minor.

the same answer, suggesting that the negative effect is homogeneous across partners. The OLS gives an effect of -26% while PPML -33%. On the other hand, for imports the OLS estimator gives a smaller coefficient than PPML. The OLS effect is -16% while PPML gives -32%. This suggests that imports from the main EU partners have been more affected than those from smaller partners. However, this partly depends on the US, China and Switzerland playing a bigger role in the counterfactual.

Overall, we prefer the PPML estimations as they report effects for total trade, the quantity we care about.

Table 2: DD estimation, Jan-Mar 2017-2021

	Exports		Imports	
	OLS	PPML	OLS	PPML
EU x 2021	-0.295***	-0.404**	-0.179***	-0.378***
	(0.0607)	(0.135)	(0.0521)	(0.0669)
Time FE	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes
Observations	660	660	660	660

Robust s.e. in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable for the OLS regression is log of exports/imports while in the PPML regression it is exports/imports. The periods considered are all months from January, February and Mar 2017-21. Data sourced from HMRC.

Table 3: DD estimation without Switzerland, Jan-Mar 2017-2021

	Exports		Imports	
	OLS	PPML	OLS	PPML
EU x 2021	-0.223***	-0.161**	-0.177**	-0.383***
	(0.0487)	(0.0491)	(0.0544)	(0.0700)
Time FE	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes
Observations	645	645	645	645

Robust s.e. in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable for the OLS regression is log of exports/imports while in the PPML regression it is exports/imports. The periods considered are all months from January, February and Mar 2017-21. Data sourced from HMRC.

As a robustness, we also estimate the models using all months from January 2017 to March 2021. In this case, the period Jan-Mar 2021 is compared to the period Jan2017-Dec2020. Results are reported in Table 4. While there are some differences in terms of magnitude, they pretty much confirm the previous results. We consider the results of Table 4 less accurate as we are not comparing the same months.

Table 4: DD estimation, all months 2017-2021

	Exports		Imports	
	OLS	PPML	OLS	PPML
EU x 2021	-0.243***	-0.326*	-0.149**	-0.291***
	(0.0565)	(0.142)	(0.0473)	(0.0587)
Time FE	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes
Observations	2244	2244	2244	2244

Robust s.e. in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable for the OLS regression is log of exports/imports while in the PPML regression it is exports/imports. The periods considered are all months from Jan 2017 to Mar 2021. Data sourced from HMRC.

Table 5: DD estimation with ONS data excluding Switzerland, all months 2017-2021

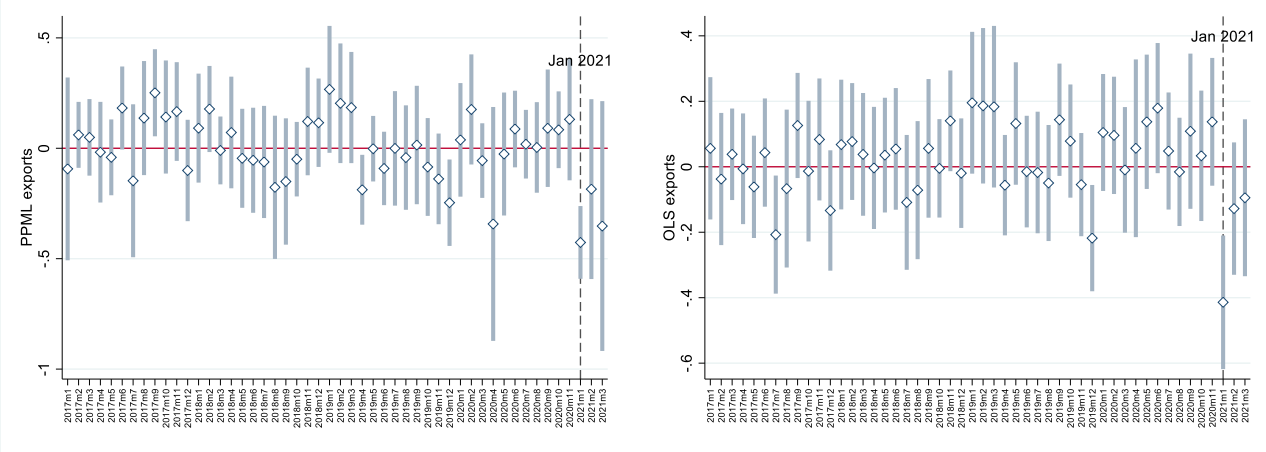
	Exports		Imports	
	OLS	PPML	OLS	PPML
EU x 2021	-0.179***	-0.0981*	-0.148**	-0.312***
	(0.0436)	(0.0472)	(0.0493)	(0.0589)
Time FE	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes
Observations	2193	2193	2193	2193

Robust s.e. in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable for the OLS regression is log of exports/imports while in the PPML regression it is exports/imports. The periods considered are all months from Jan 2017 to Mar 2021. Data sourced from HMRC.

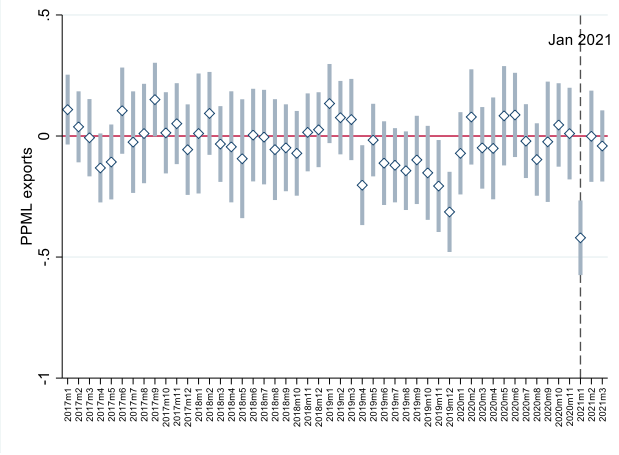
One possible concern with the pre-TCA period is the inclusion of 2020 and the Covid-19 pandemic. We therefore checked whether dropping the year 2020 from the dataset makes any differences, but the estimated coefficients remain very similar. We believe that this is because the pandemic affected developed countries' trade in similar ways.

We then use an event study approach where we interact the dummy for EU with dummies for each period, including all periods from Jan2017 to Mar2021. Standard errors are heteroscedasticity-robust, but not clustered. We select as base period December 2020 – the last pre-treatment period. All plots show a negative impact in January 2021 but we cannot reject the null hypothesis of no differences between trade with EU and the control group in Feb-Mar 2021 for either exports or imports. We note that with s.e. clustered at the partner level we find negative and significant effects for the PPML imports equation in Feb-Mar2021, but no differences for the other regressions.

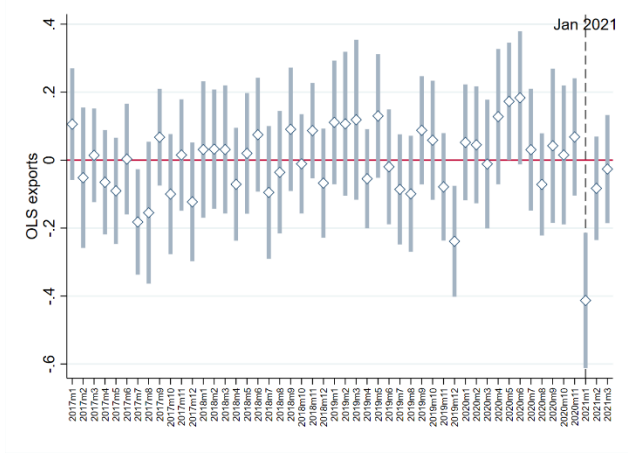
Figure 5: Event study with HMRC data



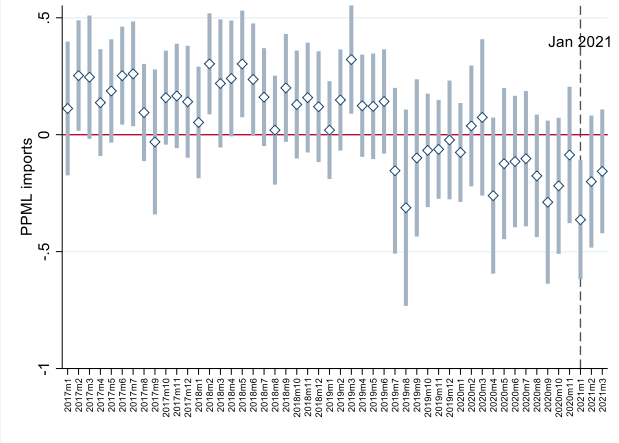
a) PPML exports b) OLS exports



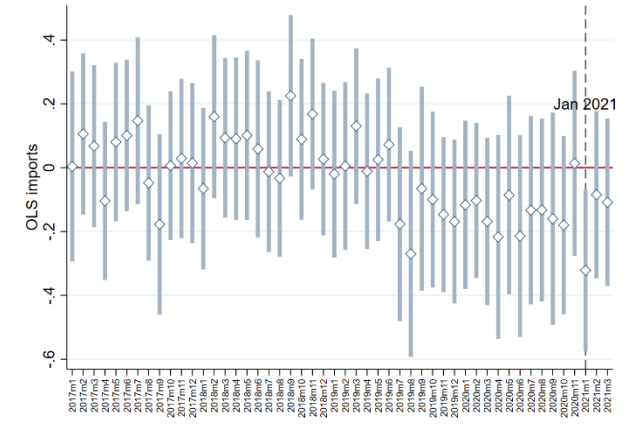
c) PPML exports excluding Switzerland



d) OLS exports excluding Switzerland



e) PPML imports



f) OLS imports

Including partners' information

So far using HMRC data we have not included information on partner countries. The literature on the gravity model of international trade suggests that trade flows between two countries are the result of exporter-specific, importer-specific and bilateral characteristics and therefore including information on partner countries can be important. In terms of counterfactual, the analysis above only considers UK trade with other countries as the control group. However, another potential control group for UK's exports to the EU is EU imports from other countries, including itself. To see whether incorporating such information changes the results obtained with UK only data, we expand the dataset to include EU's trade data. For each EU27 member (and for the UK) we include trade with the EU, OECD and BRICS countries. The same dataset will then be used for the synthetic control.

At the moment, this expansion comes at a cost: not all EU countries reported trade for March 2021. We therefore limit the analysis to February 2021. Data come from three different sources. For the UK we use HMRC data. For Germany we source data from the German statistical office (Statistisches Bundesamt). This is because Eurostat does not report data for March 2021 while the national office does, and we will later use these data for the synthetic control.[3] For all other EU countries data are sourced from Eurostat.

Bilateral flows are reported twice, both as exports and imports. We give preference to exports as coverage of intra-EU trade is more accurate for exports than for imports (see p.40 of Eurostat manual on trade data).

[3] Compared to Eurostat data, the German statistical office records trade on a country of origin/destination, while Eurostat records in on a country of consignment basis (see this article). The only major differences arise in trade with the Netherlands and with Belgium.

We also perform two adjustments for intra-EU trade. First, we mirror exports with imports when the former are missing and the latter are not. Second, we interpolate missing values for a month *t* when trade is positive in both *t*-1 and *t*+1. Finally, we replace with zeroes the remaining missing values, which are very few. For extra-EU trade (non-EU OECD and BRICS) we do not mirror flows and use the reported imports data as non-EU exports to EU or the UK (that is UK imports from US are used as US exports to UK). All values are converted in GBP using the monthly GBP-EUR exchange rate from the Bank of England.

We estimate a triple difference estimation where we compare UK's trade with the EU vs the control group (first difference) before and after 2021 (second difference) relative to the pre-post difference between EU-control group for EU27 countries (third difference). This method allows us to control for anything which affected EU's imports differently from the control group's imports common to all exporters. The equations estimated are:

PPML: $$Y_{ijt} = \exp\left[\alpha_{it} + \alpha_{jt} + \alpha_{ij} + \beta^{PPML}(EU \times UK \times 2021) + \epsilon_{ijt}\right] \quad \text{Eq. 3}$$

OLS: $$\ln Y_{ijt} = \alpha_{it} + \alpha_{jt} + \alpha_{ij} + \beta^{OLS}(EU \times UK \times 2021) + \epsilon_{ijt} \quad \text{Eq. 4}$$

Where Y_{ijt} is either exports or imports from reporter country *i* (UK or EU27 member) to partner *j* (EU27, OECD and BRICS) in time *t*. The α_{it}, α_{jt} and α_{ij} terms are reporter-time, partner-time and reporter-partner (pair) dummies. EU is a dummy that equals one if partner *j* is an EU27 member and UK is a dummy if reporter *i* is the UK. We exclude UK exports to Switzerland from the dataset and consider the months Jan-Feb for years 2017-21. Results are reported in Table 6 and they confirm those obtained with the UK only data. For exports, the regression includes exports from UK and EU27 to EU27 and control group. For the imports regression we have imports of UK from EU27 and control group as well as EU27 imports from itself and from the control group.

Table 6: DDD estimation, Jan-Feb 2017-2021

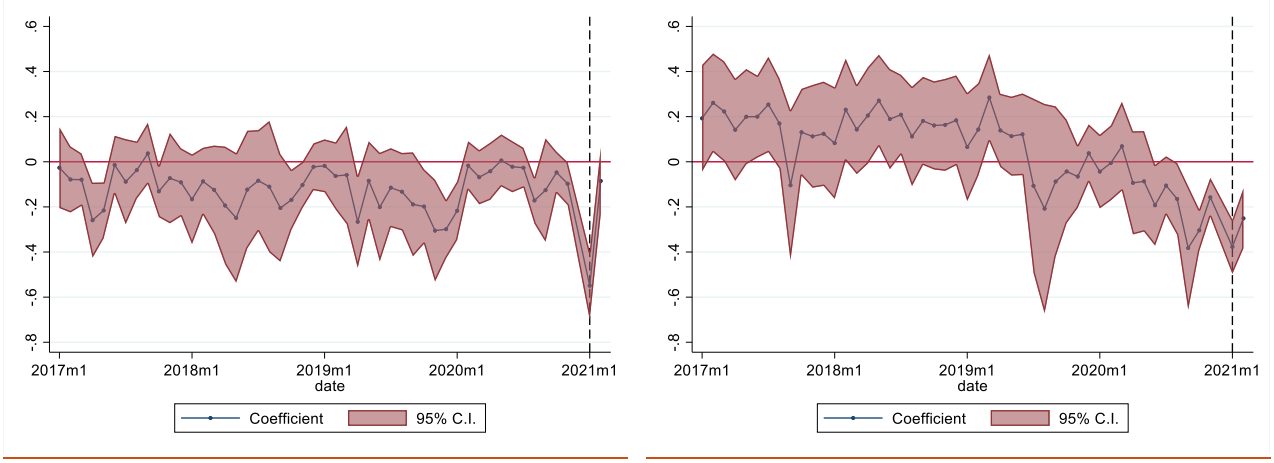
	Exports		Imports	
	OLS	PPML	OLS	PPML
EU x UK x 2021	-0.299***	-0.205***	-0.353***	-0.425***
	(0.0740)	(0.0493)	(0.0763)	(0.0679)
Reporter-time FE	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes
Observations	12,038	12,040	12,045	12,050
TCA effect (%)	-25.87	-18.59	-29.74	-34.63

Robust s.e. in parenthesis clustered at the pair level. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable for the OLS regression is log of exports/imports while in the PPML regression it is exports/imports. The periods considered are Jan-Feb for the years 2017-21. The TCA effect is computed as 100*(exp(b)-1). Differences in number of observations between OLS and PPML are due to zeros.

Using the event study specification of the triple difference estimators where we interact the EU and UK interaction with dummies for each period we cannot reject the null hypothesis of no effect for exports in February 2021. On the other hand, for imports we find that a downward trend in the estimated coefficient suggesting that UK's imports from the EU started to lower around the second half of 2020.

Figure 6 reports the coefficients and 95% confidence interval for exports and imports. The reference period in this estimation is December 2020. While it might be argued that this is an odd reference period because of stockpiling for instance, when we repeat the exercise using as reference period the average 2017-19 we find very similar results.

Figure 6: Triple difference event study



a) Exports b) Imports

The figure plots the coefficient estimates of the triple difference estimated with the PPML estimator where the interaction between the UK and EU dummies is interacted with dummies for each period over Jan2017-Feb2021. The reference period is Dec2020 and confidence interval is based on robust standard errors clustered at the pair level.

A tailored counterfactual – the Synthetic Control Method

Our ability of estimating the 'TCA-effect' in the previous sections strongly depends on the quality of the control group that we chose for our comparison. While non-EU OECD countries and BRICS appear as a natural comparison group, it might be possible to improve the quality of our *anti monde*. Using the expanded dataset which includes EU countries' trade with other partners, we look for a combination of country-pairs trade that can closely resemble the UK's trade with a specific EU country and then use it as our 'what if' UK. This is done applying the Synthetic Control Method (SCM).

Considering UK exports to Germany, our potential set of comparison units is given by UK's exports to non-EU OECD and BRICS countries as well as Germany's imports from OECD (including EU) and BRICS. We then let the algorithm choose the combination of trade flows that best resembles UK's exports to Germany over the period July 2016-December 2020 which will result in a 'synthetic' UK-Germany trade, our *anti monde*. Finally, we compare the actual UK-Germany data with the ones predicted by the synthetic UK-Germany to measure the TCA effect.

Since not all EU countries reported trade for March 2021, we use the SCM in two applications. First, with a selected group of nine EU countries that reported trade for March 2021. Second, with all EU countries but limiting the time period to February 2021. The set of nine EU countries is composed of Czech Republic, Germany, Estonia, France, Greece, Ireland, Lithuania, Portugal and Spain. Together, these countries accounted for 57% of UK's exports to the EU and 52% of imports from the EU over the period 2017-19.

We run the SCM for each partner separately matching over exports (in £m) over all pre-TCA period – that is, all months from July 2016 to December 2020. The matching algorithm uses the regression-based approach to compute the V-matrix of predictors weight, the default option in Stata.

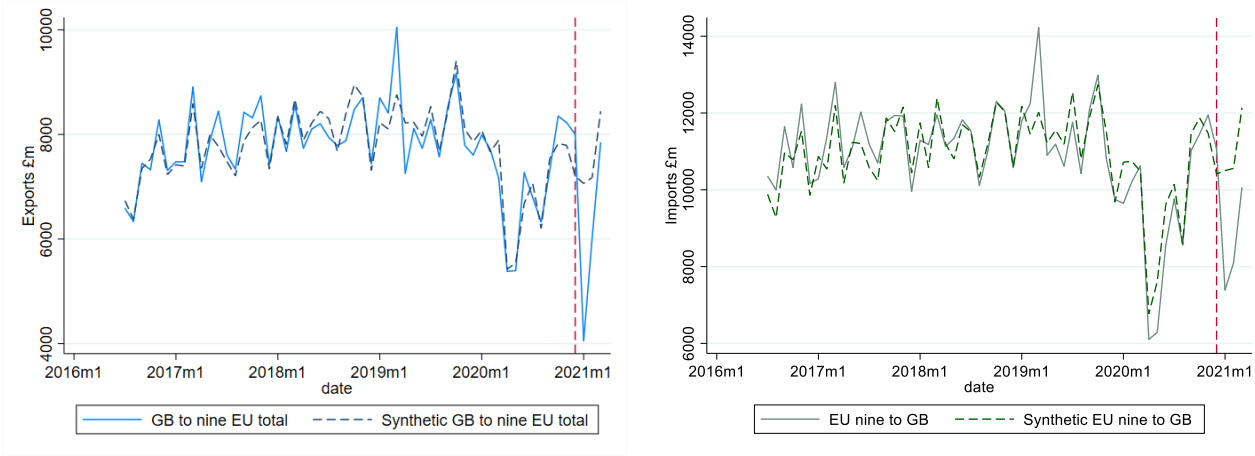
Inference: to assess the significance of the result, we perform the permutation test proposed by Abadie et al. (2003, 2010) re-assigning treatment to each EU country and then see how many times we observe a deviation between actual exports and the SCM in post-treatment period relative to the pre-treatment fit as large as the one observed for the UK. For instance, in the case of UK's exports to Germany, we compute the SCM for each other EU country's exports to Germany (CZ-DE, EE-DE, …, PT-DE for the nine-country group) and then compute the root mean square prediction error (RMSPE) for each series. Then we take the ratio of the average pre-treatment RMSPE and post-treatment RMSPE:

$$P_j = \frac{post - RMSPE}{pre - RMSPE} = \frac{\sqrt{\frac{1}{T - T_0}\sum_{t=Jan2021}^{Feb2021}\left(Y_{jt} - \hat{Y}_{jt}\right)^2}}{\sqrt{\frac{1}{T_0}\sum_{t=Jul2016}^{Dec2020}\left(Y_{jt} - \hat{Y}_{jt}\right)^2}}$$

Where j indexed the EU countries, T is the length of the overall period and T_0 is the length of the pre-intervention period. Finally $\hat{Y}_{jt}$ is the estimated SCM and Y_{jt} is observed exports. The p-value is the computed counting for how many of the other EU countries we observed a value of P_j as large as the one obtained for the UK. When we evaluate this for each month separately, the nominator of the above expression is the RMSPE for one month only. When we compute the effects for total UK's exports to the nine EU members considered (or the EU27 in the second exercise), the permutations are performed re-assigning treatment to each one of the nine (27) EU countries exports to the total EU.

Note that this is a slightly different approach to the original permutation test proposed by Abadie et al. (2003, 2010). In their original proposal, the treatment would be re-assigned to each other unit in the pool of potential controls. For instance, if we were to apply the original permutation method to the UK-Germany case, where our potential controls are UK's exports to non-EU OECD and BRICS and Germany's imports from OECD+BRICS, re-assignment would imply fitting the SCM to UK-Japan or USA-Germany. However, in our dataset we miss trade data from non-EU countries trade (e.g., Japan-USA) and this limits our ability to fit the SCM to these units. Moreover, since the UK exited the EU, re-assigning treatment to trade among other EU members appears as a natural permutation exercise.

Figure 7: SC UK trade with selected nine EU countries total, Jan2016-Mar2021



a) Exports

b) Imports

Table 7 reports the results for UK exports to the nine EU countries up to March 2021. The percentage effect is computed as $(Y_{jt} - \hat{Y}_{jt})/\hat{Y}_{jt}$ and are comparable to the exponentiated regression coefficients. For the nine EU countries as a whole we find a strong negative result in January (-43%), a -16% in February which is not so extreme and essentially no effect in March 2021. The choice of the significance level in the permutation test should be somewhat more generous than the standard 10-5% so we choose a 20% level, meaning that we consider 'significant' an effect if only one other country sees a result as extreme as the UK given that we perfume 8 treatment re-assignment (plus UK it gives 9 results).

Table 7: SCM results for UK exports to nine EU countries

Importer	Average Jan-Mar 2021		January 2021		February 2021		March 2021	
	effect %	p-value	effect %	p-value	effect %	p-value	effect %	p-value
DE	**-19.83**	0.00	**-41.74**	0.00	**-14.12**	0.11	-0.04	0.56
FR	**-24.09**	0.00	**-47.63**	0.00	**-15.84**	0.00	-0.09	0.56
IE	-15.87	0.33	**-37.63**	0.00	-12.93	0.67	0.03	0.89
ES	**-31.35**	0.00	**-39.16**	0.00	**-28.42**	0.00	**-0.26**	0.11
CZ	**-29.03**	0.00	**-55.32**	0.00	**-22.13**	0.00	-0.10	0.56
PT	-28.12	0.22	**-50.23**	0.00	-5.80	0.44	**-0.28**	0.11
GR	**-41.53**	0.00	**-50.63**	0.00	**-39.71**	0.00	**-0.34**	0.11
LT	-6.97	0.56	-38.11	0.33	8.83	0.56	0.08	0.56
EE	-17.61	0.22	**-39.05**	0.11	1.03	0.89	**-0.15**	0.11
Total	**-21.90**	0.00	**-42.60**	0.00	**-16.09**	0.10	-0.07	0.70

Note: countries ranked by exports values in 2017. In bolds the effects for which the UK is the most extreme case (p-value of 0) or one other country at max is more extreme than UK (p-value of 1/9=0.11).

The results for UK's imports from the nine EU countries are reported in Table 8. Here permutations are performed re-assigning treatment to each importer. Overall we see that the impact on imports has been more distributed across months, with both the effects in January and February being negatively affected. Importantly, UK's imports from both France and Germany show a negative effect across all three months of 2021.

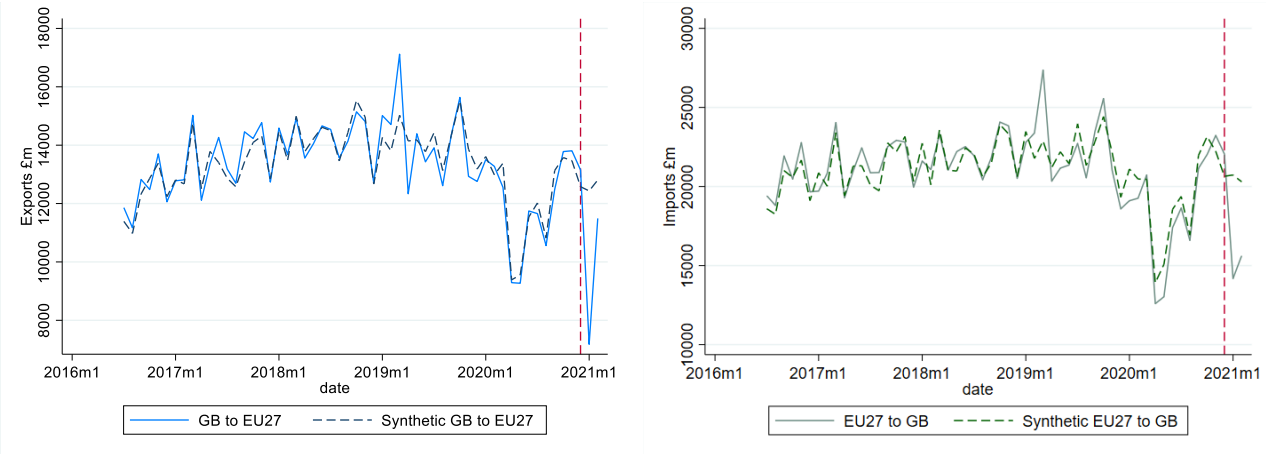
Table 8: SCM results for UK imports from nine EU countries

Exporter	Average Jan-Mar 2021		January 2021		February 2021		March 2021	
	effect %	p-value	effect %	p-value	effect %	p-value	effect %	p-value
DE	**-23.35**	0.00	**-33.90**	0.00	**-21.87**	0.00	**-0.14**	0.00
FR	**-30.99**	0.11	**-38.73**	0.11	**-27.40**	0.00	**-0.27**	0.11
ES	-15.09	0.22	**-17.65**	0.11	**-14.18**	0.11	-0.13	0.44
IE	-19.59	0.22	-12.40	0.22	**-34.08**	0.00	-0.12	0.44
CZ	**-27.57**	0.00	**-32.91**	0.00	**-24.84**	0.00	**-0.25**	0.00
PT	**-18.35**	0.00	**-18.51**	0.00	-18.16	0.44	**-0.18**	0.11
GR	**-20.37**	0.11	-11.04	0.22	**-28.23**	0.11	**-0.22**	0.11
LT	-6.81	0.56	7.34	0.56	-9.45	0.56	-0.18	0.44
EE	-5.61	0.78	-6.87	0.78	-14.05	0.44	0.04	0.78
Total	**-23.34**	0.00	**-29.62**	0.00	**-23.34**	0.00	-0.17	0.20

Note: countries ranked by imports values in 2017. In bolds the effects for which the UK is the most extreme case (p-value of 0) or one other country at max is more extreme than UK (p-value of 1/9=0.11).

We then re-run the SCM for all 27 EU countries but with data up to February 2021. Note that while the % effects for the nine EU countries remain unchanged, p-values change because the permutations are performed re-assigning treatment to other 26 EU countries, while in the previous exercise it was re-assigned only 8 times. In evaluating the 'significance' of results here we are a bit more generous and allow up to two placebos to show an effect as extreme as the UK. This corresponds to a p-value of 0.07.

Figure 8: SC UK trade with EU27, Jan2016-Feb2021



a) Exports b) Imports

Table 9: SCM results for UK's exports to EU27 up to February 2021

Exporter	Average Jan-Feb 2021		January 2021		February 2021	
	effect %	p-value	effect %	p-value	effect %	p-value
DE	**-27.93**	0.00	**-41.74**	0.00	**-14.12**	0.07
FR	**-31.73**	0.00	**-47.63**	0.00	**-15.84**	0.04
NL	**-17.28**	0.07	**-35.36**	0.00	0.81	0.93
IE	-25.28	0.22	**-37.63**	0.07	-12.93	0.48
BE	**-1.34**	0.00	**-35.53**	0.00	**32.86**	0.04
ES	**-33.79**	0.00	**-39.16**	0.00	**-28.42**	0.00
IT	**-31.97**	0.00	**-56.32**	0.00	-7.61	0.33
SE	**-24.61**	0.07	-36.87	0.11	-12.35	0.30
PL	**-49.21**	0.00	**-66.23**	0.00	**-32.19**	0.04
DK	**-28.44**	0.00	**-38.18**	0.00	-18.70	0.15
CZ	**-38.72**	0.04	**-55.32**	0.00	**-22.13**	0.04
AT	-46.39	0.30	-53.12	0.19	-39.65	0.37
PT	**-28.01**	0.04	**-50.23**	0.00	-5.80	0.63
HU	**-27.45**	0.00	**-44.11**	0.00	-10.79	0.33
FI	**-30.49**	0.07	**-39.08**	0.04	-21.89	0.15
RO	**-37.05**	0.00	**-47.58**	0.00	**-26.51**	0.00
GR	**-45.17**	0.07	-50.63	0.11	**-39.71**	0.07
SK	-27.95	0.15	-41.69	0.15	-14.22	0.67
LT	-14.64	0.56	-38.11	0.37	8.83	0.81
MT	-24.61	0.89	-20.91	0.74	-28.32	0.81
BG	**-45.30**	0.04	-49.20	0.11	**-41.39**	0.07
CY	-42.33	0.11	-42.56	0.22	-42.10	0.11
LV	**-35.51**	0.04	**-61.08**	0.00	-9.93	0.48
SI	-39.70	0.41	-52.00	0.26	-27.40	0.41
LU	**56.83**	0.04	**136.28**	0.04	-22.62	0.22
EE	**-19.01**	0.04	**-39.05**	0.04	1.03	0.93
HR	-58.47	0.11	-64.67	0.11	-52.27	0.19
Total	**-26.26**	0.00	**-42.26**	0.00	**-10.27**	0.04

Note: countries ranked by exports values in 2017. In bolds the effects for which the UK is the most extreme case (p-value of 0) or two other country at max is more extreme than UK (p-value of 2/27=0.07).

Results for exports are reported in Table 9. In this case we find evidence of an effect in both January and February 2021, with the effect in January being much larger. Across the two months UK's exports have been 26% lower than what they could have been if it remained in the EU. The only country for which we find a positive effect is Luxembourg, but the nature of UK's trade with Luxembourg probably follows different rationale than trade with other EU countries.

Imports results are reported in Table 9. Overall they show that UK's imports from the EU27 has been down by 27% with smaller differences between Jan and Feb compared to UK's exports. As for exports, the SCM results for the EU27 point to an effect in both Jan and Feb 2021 similarly to the gravity DD regressions and opposed to the DD regression using only UK data.

Table 10: SCM results for UK's imports from EU27 up to February 2021

Exporter	Average Jan-Feb 2021		January 2021		February 2021	
	effect %	p-value	effect %	p-value	effect %	p-value
DE	**-27.89**	0.00	**-33.90**	0.00	**-21.87**	0.04
NL	**-33.44**	0.00	**-35.45**	0.04	**-31.43**	0.00
FR	**-33.07**	0.04	**-38.73**	0.04	**-27.40**	0.04
BE	**-29.06**	0.00	**-38.48**	0.00	-19.65	0.11
IT	**-25.72**	0.00	**-34.08**	0.00	**-17.35**	0.07
ES	-15.91	0.15	-17.65	0.19	-14.18	0.19
IE	**-23.24**	0.04	-12.40	0.22	**-34.08**	0.00
PL	**-27.38**	0.00	**-28.82**	0.00	**-25.95**	0.04
SE	-17.51	0.19	-22.13	0.15	-12.90	0.22
CZ	**-28.88**	0.00	**-32.91**	0.00	**-24.84**	0.04
DK	-23.82	0.81	-30.85	0.52	-16.80	0.74
AT	**-14.54**	0.00	**-27.34**	0.00	-1.75	0.81
PT	**-18.34**	0.07	**-18.51**	0.04	-18.16	0.22
HU	**-33.15**	0.04	**-43.27**	0.04	-23.03	0.15
SK	**-40.27**	0.04	**-56.23**	0.00	**-24.32**	0.07
FI	-9.12	0.56	-0.17	0.96	-18.07	0.37
RO	**-20.27**	0.04	**-22.84**	0.07	**-17.70**	0.07
GR	**-19.63**	0.04	-11.04	0.19	**-28.23**	0.04
LT	-1.05	0.78	7.34	0.70	-9.45	0.67
LV	4.34	0.93	7.58	0.74	1.11	0.93
BG	-14.79	0.70	-19.10	0.52	-10.48	0.70
SI	-6.20	0.67	-14.46	0.48	2.06	0.78
LU	-44.41	0.11	-49.84	0.11	-38.98	0.19
EE	-10.46	0.78	-6.87	0.89	-14.05	0.52
CY	-11.49	0.48	-10.95	0.33	-12.04	0.41
MT	-17.10	0.74	-32.67	0.41	-1.54	0.96
HR	**-60.60**	0.00	**-74.25**	0.00	**-46.96**	0.07
Total	**-27.31**	0.00	**-31.59**	0.00	**-23.03**	0.00

Note: countries ranked by exports values in 2017. In bolds the effects for which the UK is the most extreme case (p-value of 0) or two other country at max is more extreme than UK (p-value of 2/27=0.07).

Analysis by product groups

In this section we provide the details of the analysis by product. We consider seven broad product groups (SOURCE), and Table 11 reports their trade values with the EU in 2017.

Table 11: Trade with the EU in 2017 by product groups

Product group	Exports		Imports	
	value £m	share	value £m	share
Advanced Manufacturing & Machinery	22,660	0.15	23,806	0.10
Agrifood	13,790	0.09	32,627	0.14
Automotive	20,429	0.13	48,603	0.20
Chemicals	32,754	0.21	46,609	0.20
Manufacturing & Electronics	21,716	0.14	40,312	0.17
Materials	35,196	0.23	36,225	0.15
Textiles	9,005	0.06	11,225	0.05
Total	156,000	1	239,000	1

Foreach product group we run the difference-in-differences regressions, both OLS and PPML. For each regression we consider the months of Jan-Mar for the years 2017-21. The control group is defined as above by OECD+BRICS. Results are reported in Table 12 to Table 16. Focusing on the PPML results, we find that Textile (-63%) and Materials (-57%) are the most severely affected products for exports, followed by Agrifood (-36%) and Automotive (-20%). On the other hand, Chemicals, Manufacturing & Electronics and Advanced Manufacturing do not appear to be affected.

Table 12: DD by product group, OLS exports

	Adv. Manuf.	Agrifood	Automotive	Chemicals	Man. & El.	Materials	Textile
EU x 2021	0.221*	-0.753***	0.008	-0.338***	-0.188**	-0.296*	-1.139***
	(0.101)	(0.067)	(0.080)	(0.054)	(0.065)	(0.124)	(0.107)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	660	660	660	660	660	660	660
TCA effect (%)	24.75	-52.88	0.79	-28.65	-17.17	-25.62	-67.97

Robust s.e. in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable is log of exports. The periods considered are the months Jan-Mar for the years 2017-21. Data sourced from HMRC. TCA effects computed as 100*(exp(b)-1).

Table 13: DD by product group, PPML exports

	Adv. Manuf.	Agrifood	Automotive	Chemicals	Man. & El.	Materials	Textile
EU x 2021	0.044	-0.440***	-0.221***	-0.190	0.065	-0.841***	-0.983***
	(0.088)	(0.087)	(0.056)	(0.118)	(0.058)	(0.251)	(0.093)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	660	660	660	660	660	660	660
TCA effect (%)	4.48	-35.57	-19.80	-17.32	6.68	-56.88	-62.57

Robust s.e. in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable is exports in £m. The periods considered are the months Jan-Mar for the years 2017-21. Data sourced from HMRC. TCA effects computed as 100*(exp(b)-1).

Table 14: DD by product group, PPML exports excluding Switzerland

	Adv. Manuf.	Agrifood	Automotive	Chemicals	Man. & El.	Materials	Textile
EU x 2021	0.040	-0.440***	-0.223***	-0.191	0.068	-0.126	-1.010***
	(0.090)	(0.089)	(0.057)	(0.123)	(0.055)	(0.144)	(0.096)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	645	645	645	645	645	645	645
TCA effect (%)	4.08	-35.56	-20.01	-17.40	6.99	-11.86	-63.59

Robust s.e. in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable is exports in £m. The periods considered are the months Jan-Mar for the years 2017-21. Data sourced from HMRC. TCA effects computed as 100*(exp(b)-1).

For imports we find negative and significant effects across all sectors but Advanced Manufacturing. The most affected sectors are Chemicals (-58%), Manufacturing & Electronics (-46%) and Automotive (-41%).

Table 15: DD by product group, OLS imports

	Adv. Manuf.	Agrifood	Automotive	Chemicals	Man. & El.	Materials	Textile
EU x 2021	0.272	-0.158*	-0.746***	-0.479***	-0.425***	-0.279**	-0.405***
	(0.140)	(0.077)	(0.187)	(0.089)	(0.075)	(0.099)	(0.103)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	660	660	660	660	660	660	660
TCA effect (%)	31.31	-14.64	-52.56	-38.06	-34.59	-24.35	-33.29

Robust s.e. in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable is log of imports. The periods considered are the months Jan-Mar for the years 2017-21. Data sourced from HMRC. TCA effects computed as 100*(exp(b)-1).

Table 16: DD by product group, PPML imports

	Adv. Manuf.	Agrifood	Automotive	Chemicals	Man. & El.	Materials	Textile
EU x 2021	0.033	-0.297***	-0.525***	-0.870***	-0.619***	-0.404***	-0.511***
	(0.112)	(0.053)	(0.127)	(0.142)	(0.088)	(0.091)	(0.059)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	660	660	660	660	660	660	660
TCA effect (%)	3.33	-25.71	-40.84	-58.11	-46.17	-33.23	-40.00

Robust s.e. in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. The dependent variable is imports in £m. The periods considered are the months from Jan-Mar for the years 2017-21. Data sourced from HMRC. TCA effects computed as 100*(exp(b)-1).