

How has Scotland's trade in goods been affected by the new EU-UK trade agreement?

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How has Scotland's trade in goods been affected by the new UK-EU trading arrangement so far?

Executive Summary

- On 1st of January 2021, trade between the UK and EU became governed by the new trading agreement, the Trade and Cooperation Agreement (TCA), which was expected to increase the cost of trading with the EU for Scottish businesses through the introduction of additional barriers to trade.
- To quantify the impact of the new relationship on Scotland's trade with the EU, it is necessary to estimate a counterfactual (the synthetic control) to provide an indication of what would have happened to Scotland's trade if there had been no change in the trading relationship. The difference between the actual trade performance and the performance of the counterfactual (synthetic control) represents the effect of the new agreement.
- The counterfactual is typically picked from a set of other countries that are similar to the exposed country but were not affected by the policy change.
- The analysis assumes that the impact of the pandemic or other common shocks on trade with the EU is already reflected in the counterfactual. The analysis only covers trade in goods as data on Scotland's trade in services in 2021 is not available. No trade with the rest of the UK is included in this analysis.
- Trade in oil and gas is excluded from the analysis as it is a globally traded commodity and likely to be more influenced by overall changes in demand for fuels and global developments rather than TCA-related changes.
- The analysis shows that Scotland's trade in goods with the EU has been lower in 2021 than it otherwise would have been under continued EU membership. The central estimate shows that trade in goods with the EU has been 12% lower (or £2.3 billion in cash terms). This takes into account the shortfall in imports between Q1 and Q4 2021, and the shortfall in exports in Q1 2021.
- The effect is driven primarily by lower imports of goods from the EU (£2.1 billion lower). The results suggest that there was no statistically significant impact of EU Exit on exports beyond the first quarter of 2021.

- Taking into account a range of uncertainty in the estimates, the estimated shortfall in trade in goods with the EU ranges from 10% to 14%, or £1.9 billion to £2.7 billion in cash terms.
- Robustness checks suggest that the estimated gap in Scotland's imports from the EU is not affected by any specific country included in the comparator. The significance of the effect on Scottish exports to the EU in Q1 2021 is somewhat sensitive to the inclusion of Norway in the synthetic control.
- Some differences in estimates are obtained when the policy date is backdated or a smaller sample of controls is used to pick the synthetic control but all estimates follow the same pattern in 2021, with a large negative gap in trade after EU Exit.
- Finally, the gap in overall trade in goods is not significant when some sectors are excluded from the total which may be expected if EU exit has affected some sectors more than others.
- The findings for Scotland from this analysis are broadly consistent with the research at a UK level. A recent study by the Centre of Economic Performance has found that the implementation of the new UK-EU trade relationship led to a sudden and persistent 25% fall in UK imports from the EU, relative to the rest of the world. The decline in relative UK exports to the EU was also found to be small and temporary. Findings from the study by UK Trade Policy Observatory also indicate a stronger effect on imports from the EU than exports.
- This study provides a detailed illustration of how Brexit has affected Scotland's trade in goods with the EU so far, however it should be noted that data on post-Brexit trade is still emerging.
- Updated estimates of the impact of the TCA could be produced as more data becomes available. Future work could also incorporate improvements in the methodology and extend the analysis to cover a wider range of trade measures and estimate the effect of the TCA for each sector separately.

Introduction

On 1st of January 2021, trade between the UK and EU became governed by the Trade and Cooperation Agreement (TCA). While this agreement guarantees tariff free trade, preference utilisation rates (how much companies take up on low tariffs), higher administrative barriers, and border controls all theoretically cause an increase in the cost of trading with the EU. Measuring this increase is not possible because the counterfactual of Scotland and the UK remaining in the EU – i.e., what would have happened in the absence of the policy change - is not observed, therefore it must be estimated.

In impact evaluation, the counterfactual is typically picked from a set of other countries that are similar to the exposed country but were not affected by the policy change. This means that the choice of the country or countries that represent the counterfactual is not formalised and is based on the researcher's judgement. The Synthetic Control Method (SCM) formalises the selection of countries that will form the counterfactual for the affected country (the synthetic control) using a data driven solution. The difference between the actual trade performance and the performance of the synthetic control represents the effect of the TCA.

Methodology

Synthetic Control Method

Synthetic Control Method (SCM) was first introduced by by Abadie and Gardeazabal (2003)¹ through the study that estimated the impact of terrorism on economic activity. Since then the method became very influential tool in policy evaluation literature across the social sciences.² The SCM uses a weighted average of similar countries which closely track the variable of interest before a policy intervention (in our case Scotland's trade with the EU before EU Exit). This weighted average of similar countries is the "synthetic control group", it is an estimated counterfactual (or a "doppelgänger") version of Scotland which does not experience the effects of EU Exit. The synthetic control can be used as a comparison with the "treatment" group, e.g., actual trade, after the policy intervention. The divergence between the synthetic control Scotland and real Scotland allows an empirical estimate of the impact of the intervention.

The SCM model is estimated through the R package Multivariate Synthetic Control Method using Time Series (MSCMT) which solves the underlying optimisation problem of finding a set of weights such that the resulting synthetic control resembles the affected country before the policy change.³

There are several advantages of SCM over similar treatment-control methods. A weighted average of countries usually provides a better control group than a single country or a simple average of other countries. SCM is highly transparent, since the countries in the control group, and the weights on each country, are not chosen by the researcher, and the usually small number of selected controls can be easily reported and scrutinised. Furthermore, SCM allows for the effect of the intervention to change over time; for instance, a country might be observed to diverge from the control group initially and then converge in later years as the impact of the policy

¹ [The Economic Costs of Conflict: A Case Study of the Basque Country - American Economic Association \(aeaweb.org\)](https://www.aeaweb.org)

² For a more formal exposition of the SC method see Section 3 of Abadie, Alberto. 2021. "Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects." *Journal of Economic Literature*, 59 (2): 391-425. DOI: 10.1257/jel.20191450.

³ For a detailed description of algorithms used in the MSCMT package see Becker, Martin and Klößner, Stefan. 2018. "Fast and reliable computation of generalized synthetic controls", *Econometrics and Statistics*, Volume 5, 1-19. DOI: <https://doi.org/10.1016/j.ecosta.2017.08.002>.

wears off. Finally, SCM is interpretable; results are easily visualised and the magnitude of the impact from intervention is possible to calculate.

Previous Analysis of Brexit Impacts

Several papers have used SCM to study the impact of leaving the EU on the UK. Using SCM, UKTPO (Ayele et al, 2021) estimated that the new trading arrangements have reduced UK exports to the EU by 26% and imports by 27% in the first two months of 2021 relative to a scenario in which the UK did not leave the EU⁴. The Centre for European Reform (Springford, 2021) estimated that leaving the single market and customs union had reduced UK goods trade by 14.9 per cent by December 2021.⁵ A more recent study by the Centre for Economic Performance has found that the implementation of the new trade relationship led to a sudden and persistent 25% fall in UK imports from the EU, relative to the rest of the world. The decline in relative UK exports to the EU was found to be small and temporary. The report also found that the TCA has reduced the number of trade relationships between the UK and the EU. The TCA led to a fall of around 30% in the number of export relationships (or export “varieties”) with the EU relative to the rest of the world and a smaller, but still significant, drop in the relative number of import relationships. The decline in export relationships is moreover driven by the exit of low-value relationships.⁶

A separate study published by the UK in Changing Europe (2021)⁷ estimated an average annual shortfall of £18.5 billion of services exports for the UK between 2016 and 2019 as a result of Brexit, which translates to 5.7% lower total services exports in 2019. The Centre for Economic Performance (Breinlich et al, 2019) studied capital flight after the Brexit referendum and found a 17% increase in the number of UK outward investment transactions to EU member states.⁸

Other papers have used SCM to study the effect of the Brexit on output. Born et al (2019) use SCM to look at the impact of the Brexit vote on UK GDP, finding an

⁴ Y. Ayele, G. LARBALÉSTIER, N. TAMBERI (2021). [Post-Brexit: UK Trade in Goods. UKTPO.](#)

⁵ [The cost of Brexit: December 2021 | Centre for European Reform \(cer.eu\)](#)

⁶ [UK trade in the wake of Brexit - UK in a changing Europe \(ukandeu.ac.uk\)](#)

⁷ [Brexit and service trade - UK in a changing Europe \(ukandeu.ac.uk\)](#)

⁸ Holger Breinlich, Elsa Leromain, Dennis Novy, Thomas Sampson (2020). [Voting with their money: Brexit and outward investment by UK firms. European Economic Review. Volume 124, 103400.](#)

output loss of 1.7 to 2.5% by the end of 2018.⁹ Similarly, Fetzer (2020) does the same for regional level output, with results indicating that the leave vote has already exacerbated regional inequalities compared to a counterfactual of no vote to leave, with Northern Ireland, the West Midlands, and the South West the hardest hit.¹⁰ This work builds upon these studies by looking at the case of Scotland, analysing the impact of EU Exit on Scotland's trade with the EU using the synthetic control model.

Potential Controls

The individual trade flows composing the synthetic control are selected from a pool of candidate controls. From a researcher's perspective, it is not immediately clear which trade flows may represent a good counterfactual for Scotland's trade with the EU. The choice of candidate controls is important, as the inclusion of arbitrary controls can lead to overfitting and biased measurements of the treatment effect (Abadie, 2021). Reasonable controls for Scotland's trade with the EU were thought to be trade flows between the EU as a whole and individual states. Therefore, the potential control pool includes both individual EU member states' trade with the rest of the EU (as a whole) and total EU27 trade with individual external (non-EU) partners. The SCM approach uses a data driven solution to select countries from this pool that best approximate a counterfactual based on historical performance.

More specifically, the control countries for Scotland's trade with the EU (or Scotland's trade with a specific EU member state) are selected from a pool of ~60 trading relationships. This control pool consists of non-EU member states' trade with the 27 EU member states as a whole (34 trade flows), and 27 EU member states' trade with all other EU member states as a whole (intra-EU trade, 27 trade flows). In other words, the first set of potential controls includes total EU27 trade with the USA, China and other non-member partners; and the second set includes trade between the Netherlands and the rest of the EU27 as a whole, trade between France and the rest of the EU27 as a whole and so on. Data on trade flows for potential controls is sourced from the Eurostat database. Scotland's trade with the EU is sourced from the HMRC Regional Trade Statistics publication. The analysis only covers trade in

⁹ Benjamin Born, Gernot J. Müller, Moritz Schularick, Petr Sedlacek (2019). [The Costs of Economic Nationalism: Evidence from the Brexit Experiment](#). *Economic Journal*, 129(10), pp. 2722–2744.

¹⁰ Fetzer (2020). [Exacerbating regional inequalities: the economic impact of Brexit UK in a Changing Europe](#)

goods as data on Scotland's trade in services is not available. No trade with the rest of the UK is included in this analysis.

All trade flows which were subject to new free trade agreements with the EU¹¹ or major sanctions from the EU¹² between 2013 and 2021 were excluded since these could be biased controls for Scotland-EU trade, as their performance is affected by other trade policy changes. The affected countries are Croatia, Iran, Russia, Ukraine, Japan, Canada, Singapore, Kazakhstan, South Africa and South Korea.

Assumptions

SCM requires several assumptions for obtaining statistically unbiased estimates. Since SCM finds a weighted average of similar countries to emulate Scotland – EU trade, this trade flow cannot be an extreme case in the pre-treatment period. If Scotland – EU trade is higher (or lower) than any other trade flow in the candidate pool, then no weighted average of other trade flows can model EU – Scotland trade well. This can be easily confirmed to not be the case.

A stricter assumption is that the treatment (i.e., EU Exit) affects only EU-Scotland trade flows (note that UK-EU trade is excluded from the candidate control pool). If EU Exit has a large impact on EU member states' trade with one another, or EU27 trade with external members, then the synthetic control will not be a good estimate for Scotland without EU Exit. This might be the case if there is significant trade diversion - e.g., countries replacing trade with Scotland (and the UK) for trade with other countries. Assuming that Brexit will have a detrimental effect on UK trade with the EU and a positive effect on other countries' trade with the EU, the effect of EU Exit may be overestimated as the gap between actual and the counterfactual might be larger. Considering that trade with the UK is only a fraction of any country's total trade with the EU prior to Brexit, it might be expected that the effects of trade diversion on non-UK trade flows will not be large enough to significantly bias the results.

The estimated effect depends on the ability of the synthetic control to represent Scotland's trade with the EU in absence of a policy change. The analysis also assumes that the impact of the pandemic or other common shocks on trade with the

¹¹ [Negotiations and agreements - Trade - European Commission \(europa.eu\)](https://ec.europa.eu/economy_finance/press-room/2021/02/21-02-2021-01)

¹² [EU Sanctions Map](#)

EU is already reflected in the counterfactual, which means that the estimated effect reflects the impact of the TCA.

Most aggregate trade flows experienced a sharp fall at the start of the COVID-19 pandemic and have reached pre-pandemic levels in 2021, following recovery in the global demand for goods. However, the data indicates that services trade has been hit harder by COVID-19 and recovery has been slower than for trade in goods.¹³ This implies that any persistent COVID-19 effects are probably stronger for trade in services than trade in goods which are the focus of this analysis.

The common shock assumption implies that Scotland's trade in goods with the EU would have followed global recovery in absence of EU Exit. Aggregate trade in goods has recovered 2021, however trade in some specific product types are still affected by COVID-19 related factors as global shortages of inputs persist and logistical challenges remain acute in certain sectors. Any global supply chain challenges arising from the pandemic and product-specific trends, potentially impacting trade between Scotland and the EU, are assumed to be also affecting the EU's trade with other EU member states or external partners which form the counterfactual. Sensitivity analysis in the later part of the paper explores how trade in specific goods or inclusion of specific control flows in the counterfactual affects the estimated impact of the TCA.

¹³ [International trade during the COVID-19 pandemic: Big shifts and uncertainty \(oecd.org\)](https://www.oecd.org/trade/2021/04/international-trade-during-the-covid-19-pandemic-big-shifts-and-uncertainty/)

Results

Key Points

- The following section presents the estimated impact of the Trade and Cooperation Agreement (TCA) on Scotland's trade with the EU. All estimates exclude trade in mineral fuels. As a globally traded commodity it is expected that trade in oil and gas is likely to be more influenced by overall changes in demand for fuels and global developments rather than TCA-related changes.
- Overall, the analysis suggests that Scotland's trade in goods with the EU has been 10%-14% lower in 2021 compared to a scenario where Scotland and the UK did not leave the EU. In cash terms, this is equivalent to a loss of £1.9 billion to £2.7 billion in trade value in 2021. The central estimate shows that trade with the EU has been 12% lower (or £2.3 billion in cash terms), driven primarily by lower imports from the EU (£2.1 billion lower).
- To determine whether the estimated gap in trade is significant, the model is estimated separately for each country, as if a policy intervention had happened at the time of EU Exit.
- Gaps for each country can then be compared. If many other trade flows also diverge as far as Scotland from their counterfactual post intervention, the estimated effect is not deemed to be significant.
- When the impact on imports and exports are estimated separately, EU exit is found to have a significant effect on imports from the EU, an effect which has persisted in each quarter of 2021. The model suggests that imports from the EU in 2021 are 18% to 25% lower than they otherwise would be, equivalent to between £1.7 and £2.5 billion in cash terms. The central estimate suggests that imports have been 22% lower (or £2.1 billion lower in cash terms).
- Meanwhile the model finds no significant impact of EU Exit on exports to the EU beyond the first quarter of 2021, suggesting an improvement in the export performance in late 2021. In Q1 2021, EU exports have been 9% to 14% lower than the counterfactual, equivalent to between £200 to £300 million in cash terms..

- These findings are consistent with the research by LSE CEP and UK Trade Policy Observatory that found a small and temporary effect of the TCA on UK exports to the EU and a persistent decline in EU imports.

Synthetic Control Estimate

The trade flows included in the synthetic control for Scotland are a combination of intra-EU trade and total EU27 trade with individual external (non-EU) partners. The three models are estimated for trade with the EU: total trade in goods, exports of goods and imports of goods.

For the total trade model, over 70% of trade is composed of non-EU countries' trade with the EU. The largest weights are allocated to trade flows between the EU and: Hong Kong (26%); Bulgaria (25%); Algeria (16%); and Chile (15%). The remaining 18% is divided between Egypt, Libya, Cyprus, China and Israel. The weights for the export and import models are presented in Table 1 in Annex.

Figure 1 shows all other EU trade flows and Scotland's trade with the EU. The figures exclude trade in mineral fuels. All trade flows experienced a fall at the start of the Covid-19 pandemic in 2020, with some trade flows returning to their pre-pandemic levels by the end of 2020. The chart also shows that Scotland's trade with the EU has somewhat underperformed in 2021 relative to most other trade flows. A similar pattern emerges for the UK as a whole, with trade as a share of GDP falling 12% since 2019, two and a half times more than in any other G7 country.¹⁴

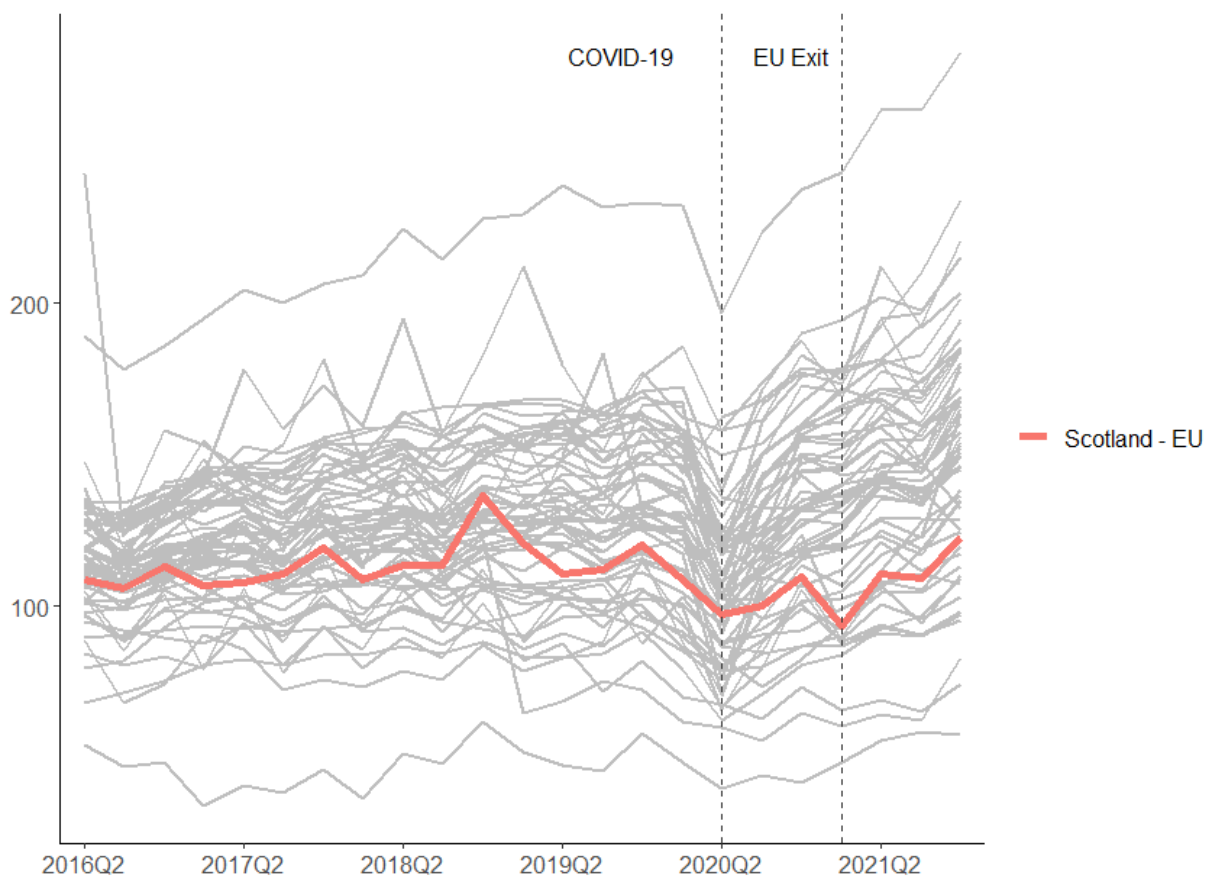
Figure 2 shows that Scotland's trade with the EU has diverged from its synthetic control in 2021. Figures 1 and 2 in Annex show gaps estimated for imports and exports. Prior the policy change, the gap between Scotland's trade and its synthetic control is fluctuating around zero, with the largest deviation observed in the end of 2018. The large positive gap is driven by a spike in EU imports in Q4 of 2018, driven by increased imports of Machinery & Transport equipment. The ONS have previously found similar evidence of stockpiling in the UK trade data ahead of EU Exit deadlines in 2019, also driven by increased EU imports of Machinery &

¹⁴ [The latest evidence on the impact of Brexit on UK trade - Office for Budget Responsibility \(obr.uk\)](#)

Transport.¹⁵ The lack of a similar spike across other trade flows reinforces this potential explanation.

Overall, the largest negative gap in Scotland's trade with the EU following the implementation of the TCA in 2021 has been observed in Q1, with recovery in exports in later quarters of the year. Further steps are taken to determine the significance of the observed effect and are described below.

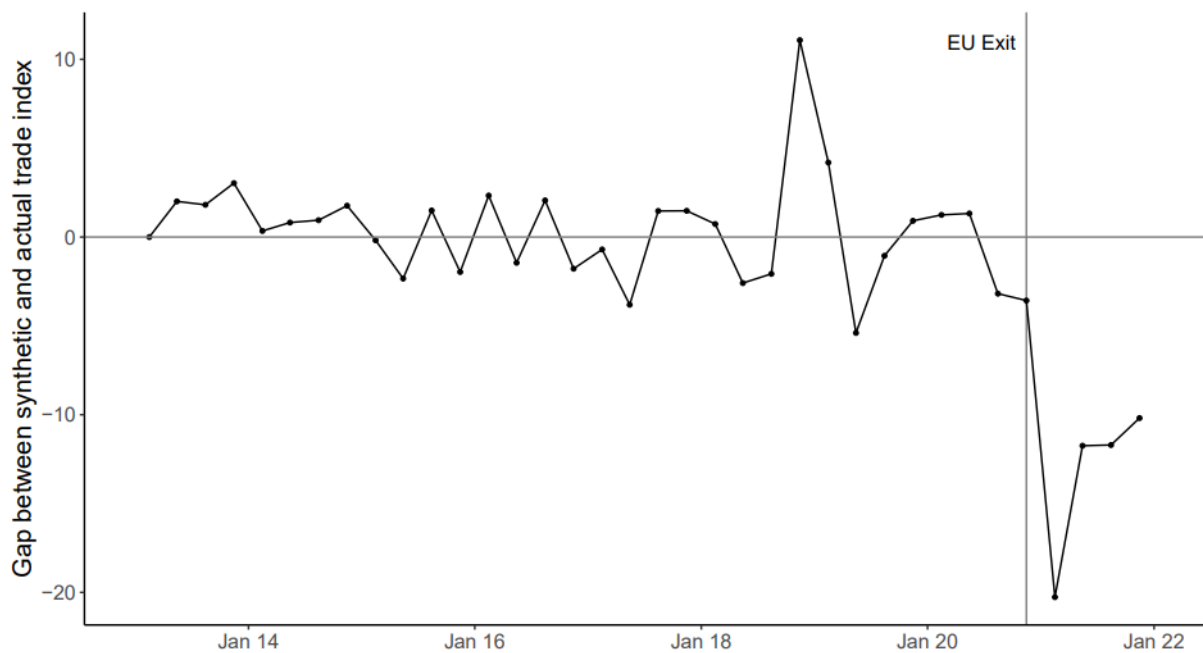
Figure 1 – Evolution of Scotland's trade with the EU and other country trade with the EU



Source: OCEA analysis using Eurostat and HMRC data. All values are indexed to Q1 2013, exclude trade in mineral fuels and are expressed in EUR.

¹⁵ [Did UK firms stockpile items ahead of the Brexit deadline? - Office for National Statistics \(ons.gov.uk\)](https://ons.gov.uk)

Figure 2 – Gap between actual Scotland’s trade with the EU and the synthetic control



Source: OCEA analysis using Eurostat and HMRC data

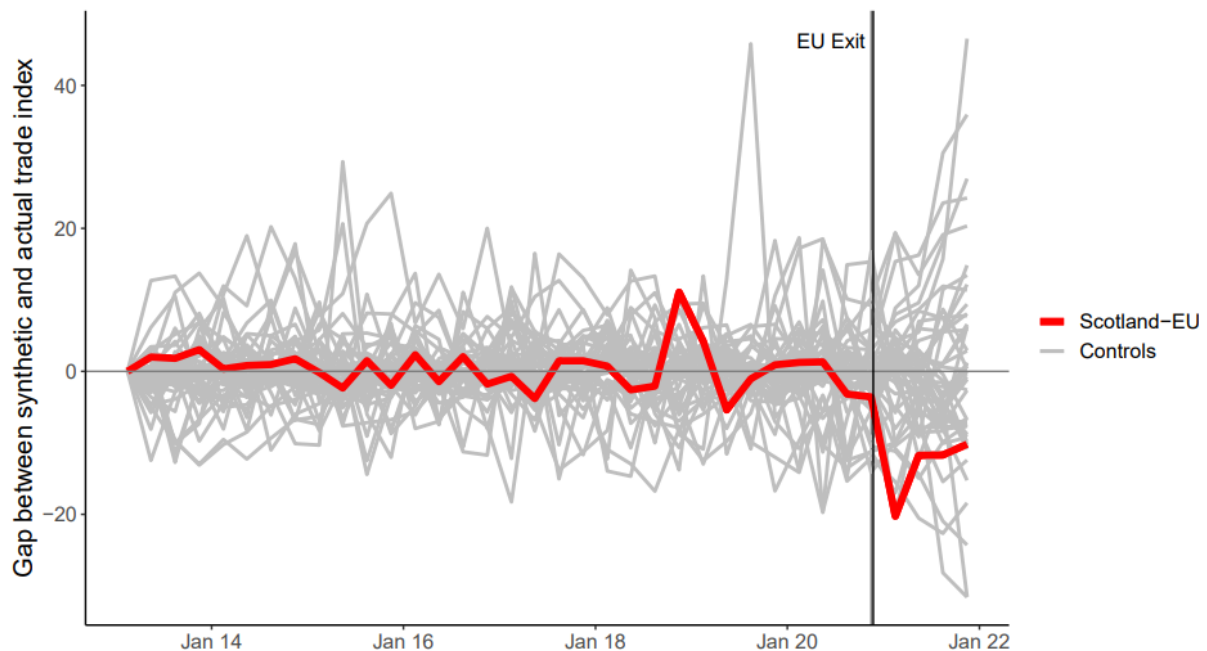
Is the effect significant?

The statistical significance test used is based on the approach proposed by Abadie, Diamond, and Hainmueller (2010) which essentially estimates the synthetic control model for each country included in the pool of potential controls, as if a policy intervention had happened at the time of EU Exit – i.e. in effect each country trade flow becomes the “treatment”. The estimates of “placebo effects” form a permutation distribution of gaps in trade. If many other trade flows also diverge as far as Scotland from their counterfactual post intervention, the estimated effect is not deemed to be significant.

Figure 3 shows the estimated gap between actual trade and the synthetic control for all other country trade flows included in the potential control set.¹⁶ The gap for Scotland has been persistently negative since the start of 2021 compared to most other trade flows. Divergence is observed also for some other trade flows, both positive and negative.

¹⁶ Figure 4 and 5 in the Annex show placebo gaps for imports and exports.

Figure 3 – Placebo trade gaps



Source: OCEA analysis using Eurostat and HMRC data

A more formal test statistic is used to establish the significance of the effect. The statistic measures the ratio of the post-intervention fit relative to the pre-intervention fit.

The ability of a synthetic control to replicate each country trade flow varies, leading to differences in pre-intervention fit (how well the synthetic control estimates track the real data). The fit is measured by Root Mean Squared Prediction Error (RMSPE). Therefore, a high post-intervention gap between the synthetic control and the affected unit does not necessarily mean that there is a significant effect from a policy if the pre-intervention fit was also poor. To control for the quality of the fit, the ratio of post-to-pre RMSPE is used. This can be considered an estimate for how extreme a post intervention divergence from the counterfactual is relative to pre-intervention fit for each trade flow.

Conventional p-values can be calculated based on the distribution of post-to-pre RMSPE ratios, which are sorted from the largest to smallest. The p-value reflects the position of the affected unit relative to the total number of placebo estimates (eg. if there are 30 controls, and the treated unit has the second highest post-to-pre ratio,

then the p-value is $2/30 = 0.067$). A desired level of significance can be chosen, such as 1%, 5% or 10%.

Table 1 uses the distribution of RMSPE ratios from the placebo estimates to calculate the p-value for Scotland's trade with the EU from the models estimated separately for imports, exports and total trade. The p-value reflects the significance of the effect for the whole of 2021.

The distribution of RMSPE ratios used for inference includes trade flows that diverged positively or negatively from their synthetic control. As the expected effect of Brexit on trade is negative, a further p-value is presented using a distribution of RMSPE ratios for placebo estimates with negative gaps in 2021.

The calculated p-value for imports is 0.039, which implies that the estimated effect is significant at the 5% level. The effect on exports is not significant at 10% level. When a model is estimated for combined exports and imports (i.e. total trade), the effect is not significant when looking at both positive and negative trade gaps but significant at 10% level using a distribution of negative gaps only.¹⁷

Table 1 - Significance of the effect on trade in Q1 – Q4 2021 with the EU

	<i>p-value: two-sided distribution</i>	<i>p-value: negative distribution</i>
<i>Imports</i>	0.039	0.038
<i>Exports</i>	0.137	0.167
<i>Total</i>	0.118	0.094

Source: OCEA analysis using Eurostat and HMRC data

Table 2 shows p-values of the estimated effect for individual quarters. To check the significance of the observed gap in each quarter a p-value is calculated for each quarter using the distributions of placebo gaps in that quarter.

The effect on imports from the EU is significant at 5% level in the first two quarters and remains significant at 10% level in the last two quarters of 2021. The effect on

¹⁷ It should be noted that the total trade effect becomes significant at the 10% level (using the two-sided distribution) when Hong Kong is excluded from the controls. Hong Kong has the largest weight and its trade with the EU has not recovered to pre-pandemic levels (see Sensitivity Analysis).

EU exports is only significant at 10% level in the first quarter of 2021, whereas the effect on total trade is significant in the first and second quarters.

Declining significance for total trade shows that other control flows in the placebo distribution have also diverged from their counterfactuals while Scotland-EU trade converged back to the counterfactual to some extent. As greater number of control flows have diverged from their counterfactuals in later quarters of 2021, the estimated gap between Scotland's trade and its synthetic control becomes less extreme and, with improved performance of exports, the overall effect less significant.

Table 2 - Significance of the effect (p-value) on trade by time period

	Q1	Q2	Q3	Q4
<i>Imports</i>	0.02 (0.038)	0.02 (0.038)	0.059 (0.038)	0.059 (0.077)
<i>Exports</i>	0.078 (0.1)	0.745 (0.7)	0.314 (0.333)	0.118 (0.167)
<i>Total</i>	0.02 (0.031)	0.039 (0.062)	0.137 (0.062)	0.353 (0.281)

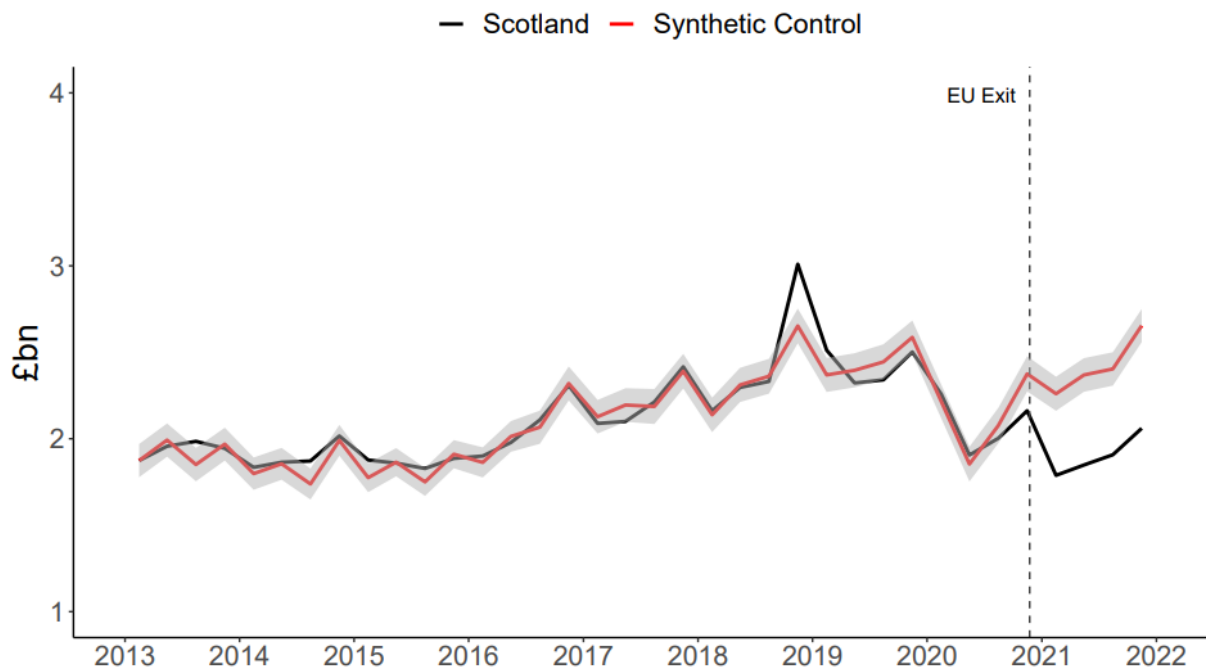
Source: OCEA analysis using Eurostat and HMRC data. The p-value using distribution of negative gaps is given in brackets.

Key Result

The synthetic control model was estimated separately for imports from the EU, exports to the EU and total trade with the EU. The effect of EU exit on imports from the EU is highly significant, and robust to sensitivity checks. Figure 4 shows this divergence between actual imports and the counterfactual, if EU Exit had not occurred. To reflect some uncertainty around the point estimate of the TCA impact, Figure 4 shows a shaded area for the synthetic control. The area is measured as +/- one standard deviation of difference between the actual trade and the synthetic control prior the policy change.

The model suggests that imports from the EU are 18% to 25% lower than they otherwise would be in 2021, equivalent to between £1.7 and £2.5 billion in cash terms. Imports show minimal signs of recovery, with the gap between actual imports from the EU and the counterfactual still statistically significant at 10% level in Q4 2021. The central estimate suggests that imports have been 22% lower (or £2.1 billion lower in cash terms).

Figure 4 – Imports are significantly lower than without EU Exit



Source: OCEA analysis using Eurostat and HMRC data

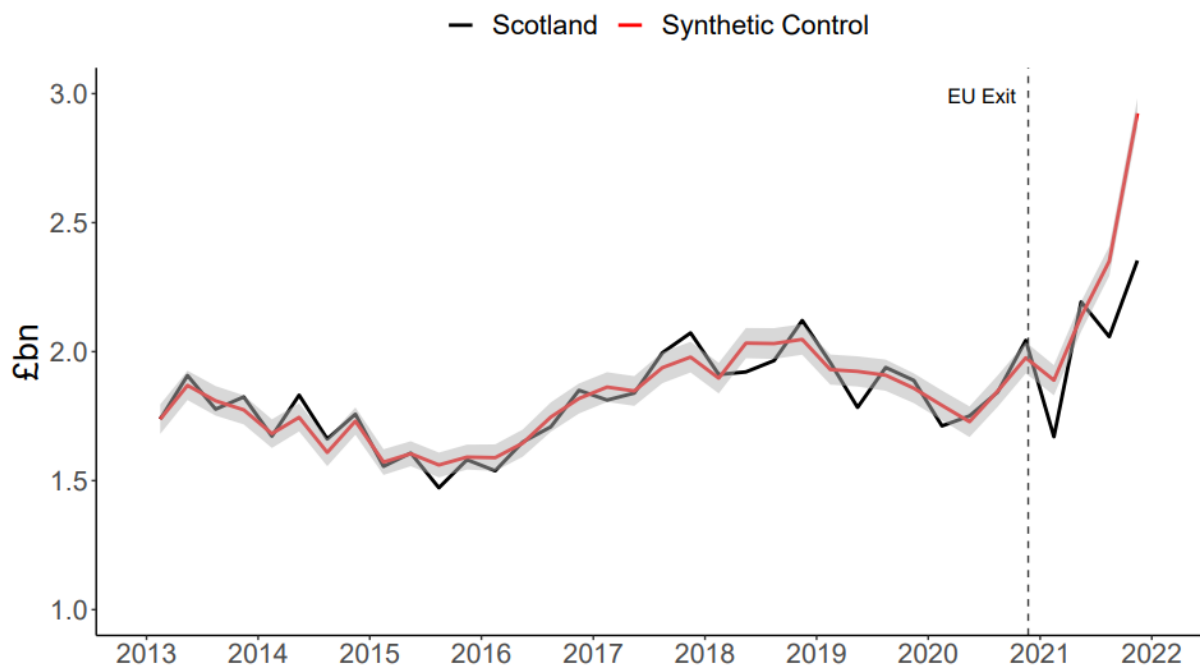
On the other hand, the results suggest that the impact of EU Exit on exports has not been statistically significant over the period from Q1 to Q4 2021. Figure 5 shows that the counterfactual has not diverged much from actual trade performance. The large spike in the Q4 2021 synthetic control is driven entirely by the inclusion of Norway – EU27 trade in the controls, excluding this trade flow, the synthetic control is in line with actual trade in Q4 2021.

As such, EU exit had a significant impact in Q1 2021, however exports recovered in the following periods (see Tables 1 and 2). These findings are consistent with the research by LSE CEP that found a small and temporary effect of the TCA on UK exports to the EU. The study also found a sharp drop in the number of

varieties/products exported to the EU while exports of high-value products have increased, supporting recovery in aggregate EU exports in 2021.¹⁸

EU exports were 9% to 14% lower than they otherwise would be in the first quarter of 2021, equivalent to between £200 to £300 million in cash terms.¹⁹

Figure 5 – Exports have not been significantly impacted by EU Exit



Source: OCEA analysis using Eurostat and HMRC data

Overall, the analysis suggests that Scotland's trade with the EU has been lower in 2021 compared to a scenario where Scotland and the UK did not leave the EU. The divergence is shown in Figure 6. However, the declines in trade with the EU have primarily been driven by decreases in imports from the EU across the whole of 2021. The effect on EU exports is only significant in the first quarter of 2021. The final impact on total trade with the EU in 2021 is reported as a sum of individual effects on imports and exports where they have been statistically significant in individual models.

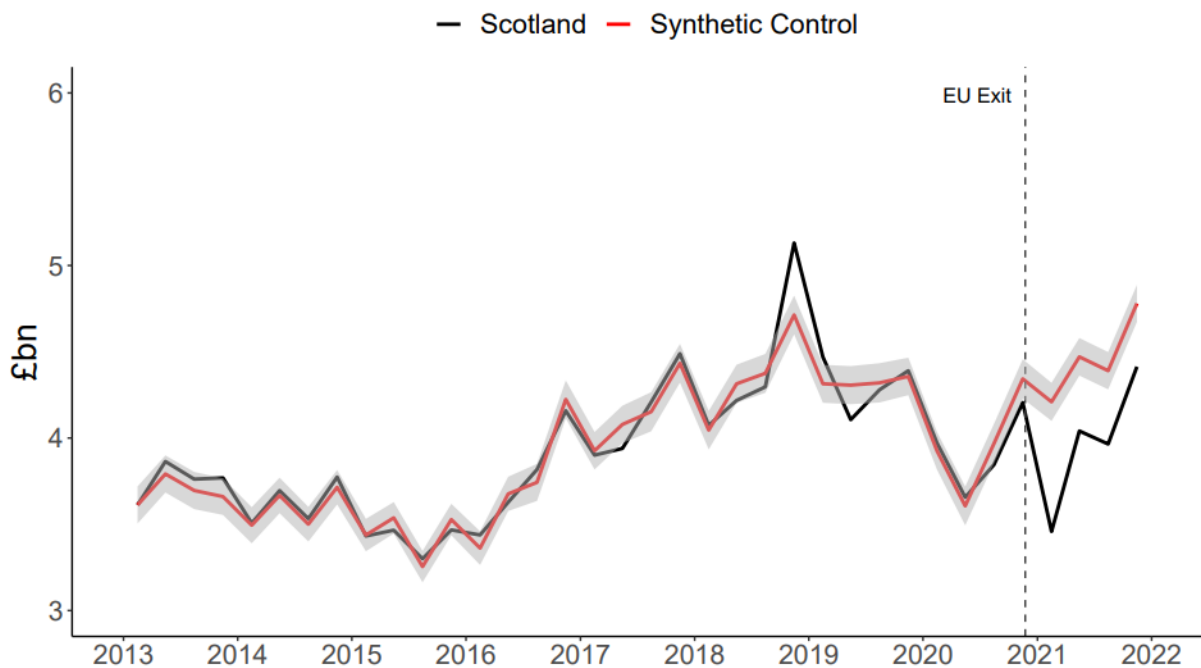
Table 3 shows the cash value of foregone trade that can be attributed to the EU exit. The foregone trade value shown in the table is calculated as a difference between

¹⁸ [UK trade in the wake of Brexit - UK in a changing Europe \(ukandeu.ac.uk\)](https://ukandeu.ac.uk)

¹⁹ The effect on aggregate EU exports in 2021 as a whole is not statistically significant and the shortfall for the whole of 2021 is not reported for that reason.

actual trade and the counterfactual where the effect has been significant at 10% level.

Figure 6 – Scotland’s trade has diverged from its counterfactual



Source: OCEA analysis using Eurostat and HMRC data

Table 3 - What value of foregone trade can we attribute to EU Exit?

	Q1	Q2	Q3	Q4	Q1 - Q4
	(£ million)				(£ billion)
<i>Imports</i>	-472	-521	-496	-594	-2.1
<i>Exports</i>	-219	Insignificant	Insignificant	Insignificant	-0.2
<i>Total</i>	-659	-511	-475	-535	-2.3

Source: OCEA analysis using Eurostat and HMRC data. Central estimates.

Taken together, the analysis suggests that Scotland’s trade in goods with the EU has been 10% - 14 % lower in 2021 compared to a scenario where Scotland and the rest of the UK did not leave the EU. In cash terms, this is equivalent to a loss of £1.9 billion to £2.7 billion in trade value over the first four quarters of 2021. The central estimate shows that trade with the EU has been 12% lower (or £2.3 billion in cash terms). The total trade impact is driven primarily by lower imports from the EU (£2.1 billion lower).

Sensitivity Analysis

Key Points

- Sensitivity analysis can be performed to check the robustness of the estimated effect. The sensitivity results for Scotland's imports from the EU are presented here, since the impact of EU Exit on Scottish exports to the EU was not found to be significant over 2021 as a whole.
- Sensitivity analysis suggests that the estimated gap in imports is not dependent on the inclusion of any one individual country in forming the comparator (the synthetic control). The estimated effect remains significant when each country is excluded from the data. The significance of the effect on Scottish exports to the EU in Q1 2021 is somewhat sensitive to the inclusion of Norway in the synthetic control.
- Further sensitivity analysis explores whether Scotland's EU imports diverge from its comparator in the years prior the UK's departure from the EU. While there is some divergence in results as the policy date is backdated and a smaller sample is used to pick the synthetic control, all estimates follow the same pattern in 2021, with a large negative gap in trade after EU Exit.
- The final sensitivity check explores whether a particular sector is driving the gap in trade. The overall gap is not significant when some sectors are excluded from the total which may be expected if the EU exit has affected some sectors more than others. A more comprehensive analysis is required to estimate the effect of EU exit for each sector separately.

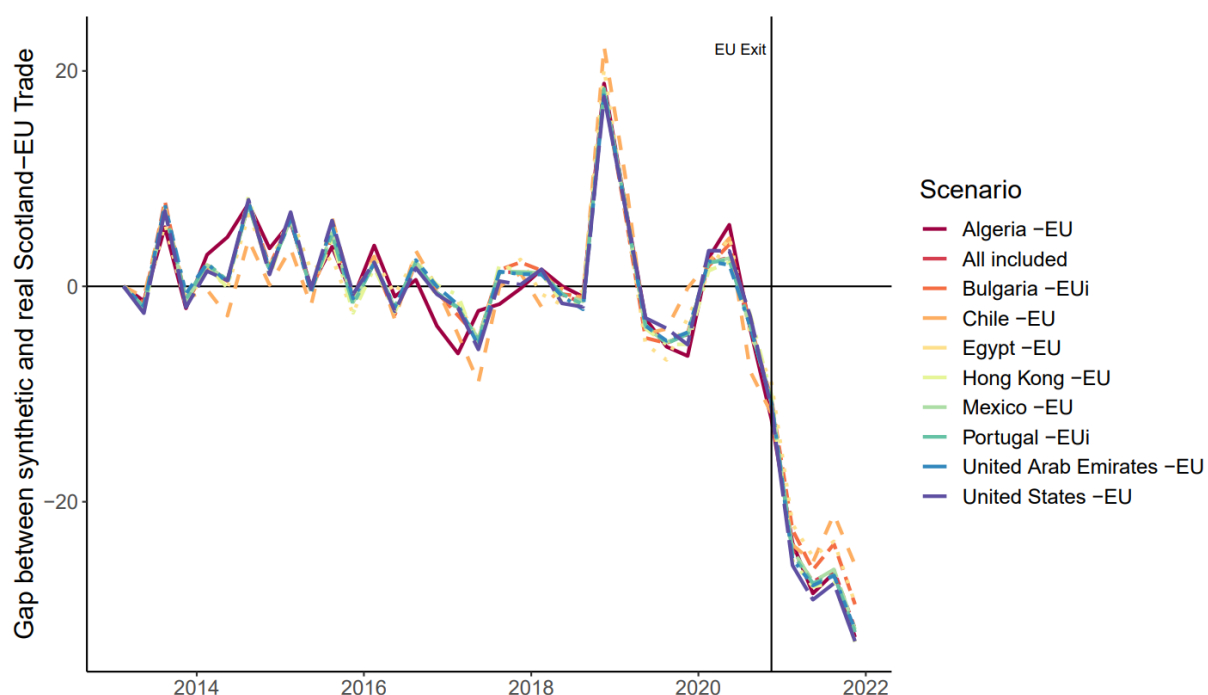
Are results skewed by any country included in the comparator?

Sensitivity analysis can be performed to check how sensitive the results are to the exclusion of certain trade flows from the control set. This is explored through robustness checks, where each country included in the synthetic control is dropped from the sample and the synthetic control model is re-estimated to recalculate the effect and placebo distribution.

Figure 7 presents results of the sensitivity analysis for imports, as the effect remains significant for the whole of 2021. The gaps follow similar pattern. The exclusion of the control unit with the highest weight (Chile's trade with the EU) does not impact on

the findings. No exclusion of a country eliminates the gap between synthetic control and actual trade in Scotland's imports from the EU. The Q1 - Q4 2021 divergence from the counterfactual is still significant at the 10% level in all scenarios (see Table 2 in Annex).

Figure 7 – Estimated gaps in imports when each country is excluded from the synthetic control



Source: OCEA analysis using Eurostat and HMRC data

In addition, the largest weight (26%) in the counterfactual for total trade is given to Hong Kong's trade with the EU, which remained below pre-pandemic level throughout 2021 unlike most other trade flows. EU exports to Hong Kong in 2021 have been impacted than imports from Hong Kong. While it is not entirely clear why HK-EU trade has not returned to pre-pandemic levels, some of this could be linked to the impact of 2019-2020 protests in Hong Kong and the zero-covid strategy adopted there.

More generally, lower HK-EU trade makes the gap for Scotland-EU trade – measured as a difference between the actual trade and the counterfactual - look smaller, which can affect the significance test. Table 2 (see Annex) shows that the effect on total trade becomes significant at 10% level when Hong Kong is excluded from the synthetic control. Note that the total trade effect is significant at 10% level

using distribution of negative gaps. In other words, the exclusion of Hong Kong only makes the effect significant at the 10% level when the test statistic is calculated for flows that diverged both positively and negatively.

The significance of the impact of EU Exit effect on Scottish exports to the EU in Q1 2021 is somewhat sensitive to the inclusion of Norway in the synthetic control, which has the largest weight (32%) in the counterfactual. Norway's trade with the EU has been particularly high in the last quarter of 2021, making the gap for Scotland's exports to the EU in 2021 look larger. The significance of the export effect in the first quarter is less sensitive to the inclusion of Norway than the effect for the whole of 2021.

Backdating exercise

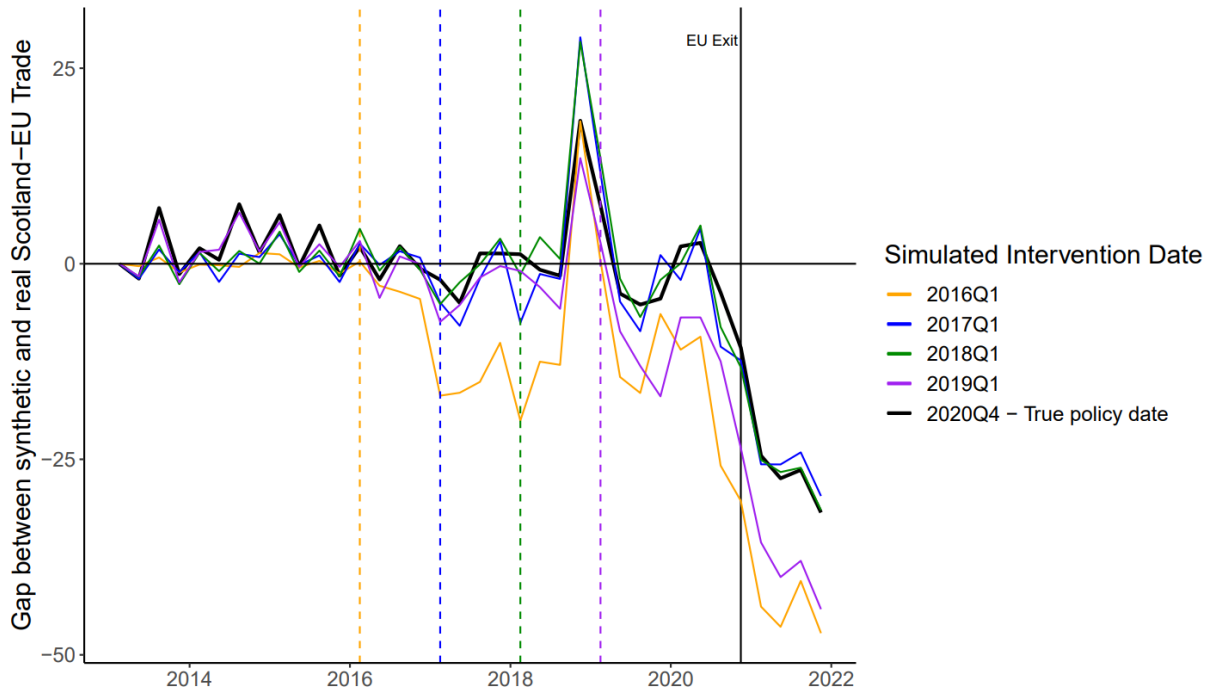
A further robustness check is around the ability of a synthetic control to reproduce the performance of the affected country in the absence of the policy change. To check this, the date of the policy change can be moved to earlier years. If the affected unit diverges from its synthetic control prior the intervention, it may not be a credible counterfactual. It should be noted that the divergence before the actual intervention date could also occur when changes in outcome occur in anticipation of the policy change.

Figure 8 present results of the backdating exercise, where a policy date is moved to the first quarter of 2016, 2017, 2018 and 2019. The change in the gap between Scotland's imports from the EU and the estimated synthetic control broadly follow the same pattern in 2021 across all scenarios. While there is some divergence in results as the policy date is backdated, all series observe a large negative drop after EU Exit. In the 2016 and 2019 backdating scenarios, there is an underperformance relative to the synthetic control, this difference may reflect adjustment in trade flows following the EU referendum in 2016 – the anticipation effects discussed above. Some studies have found that UK's trade has been affected by the outcome of the EU referendum which may provide some support for this explanation.²⁰ Interestingly, backdating scenarios using 2018 and 2017 do not show such a large divergence prior to EU Exit.

²⁰ [The cost of Brexit, January 2021: The end of transition edition | Centre for European Reform \(cer.eu\)](https://cer.eu)

It should be noted that moving the policy date limits the size of the sample over which the synthetic control algorithm finds weights to replicate past trade performance. This means that the synthetic control may not be able to replicate more recent Scotland's trade performance.

Figure 8 – Estimated gaps in imports under different policy dates



Source: OCEA analysis using Eurostat and HMRC data

Is any particular sector driving the gap in trade?

A final robustness check presented in this paper explores how sensitive is the significance of the estimated effect on trade with the EU is to the inclusion of specific sectors in the total trade figure. Figure 9 shows the gap between Scotland's actual imports from the EU and the estimated synthetic control for nine scenarios where one sector is excluded from the total and a scenario where all sectors are included (note that mineral fuels are excluded from any analysis presented in this paper).

The changes in the gap between the actual and synthetic control broadly follow the same pattern: all estimates observe a large drop in the first quarter of 2021 and only a slightly recovery in the subsequent quarters. As shown in Table 3 (see Annex), the Q1 – Q4 2021 effect remains significant at the 5% level when the *machinery and transport equipment* sector is excluded and becomes insignificant at the 10% level when the following sectors are excluded:

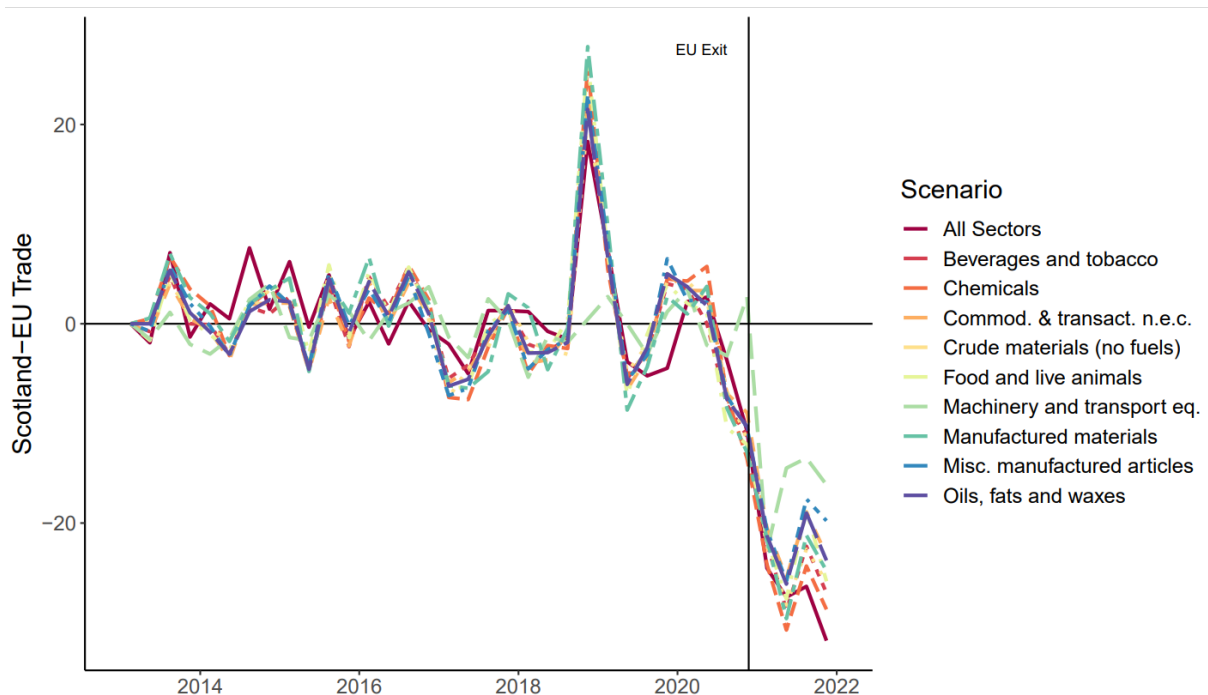
- *Food and live animals*
- *Chemicals and related products*
- *Miscellaneous manufactured articles*

For exports, no sector can be excluded such that the Q1 to Q4 impact on exports to the EU becomes significant. and the significance of the Q1 fall in exports is sensitive to the inclusion of:

- *Food and live animals*
- *Beverages and tobacco*

More broadly, the check suggests that the overall result is somewhat sensitive to the inclusion of specific sectors in the analysis, which may be expected if the EU exit had a significant effect only in some sectors. The sectors to which the analysis is sensitive is in line with what is observed in sectoral trade data. A more comprehensive sectoral analysis would be required to estimate the effect of EU exit for each sector separately and could be explored in future work.

Figure 9 - Estimated gaps when each sector is excluded from imports



Source: OCEA analysis using Eurostat and HMRC data

Conclusion

On 1st of January 2021, trade between the UK and EU became governed by the new trading agreement which was expected to increase the cost of trading with the EU for Scottish businesses. Since the counterfactual of Scotland and the UK not leaving the EU – i.e., what would have happened in the absence of the policy change - is not observed, it must be estimated.

The counterfactual (the synthetic control) is estimated to show what would have happened to trade in the absence of a policy change. The synthetic control method uses a data driven solution to formalise the selection of countries that will form the counterfactual.

The analysis assumes that the impact of the pandemic or other common shocks on trade with the EU is already reflected in the counterfactual. The difference between the actual trade performance and the performance of the synthetic control represents the effect of the TCA.

Overall, the analysis suggests that Scotland's trade in goods with the EU has been 10%-14% lower in 2021 compared to a scenario where Scotland and the UK did not leave the EU. In cash terms, this is equivalent to a loss of £1.9 billion to £2.7 billion in trade value in 2021. The central estimate shows that trade with the EU has been 12% lower (or £2.3 billion in cash terms), driven primarily by lower imports from the EU (£2.1 billion lower).

When the impact on imports and exports are estimated separately, EU exit is found to have a significant effect on imports from the EU, an effect which has persisted in each quarter of 2021. The model suggests that imports from the EU in 2021 are 18% to 25% lower than they otherwise would be, equivalent to between £1.7 and £2.5 billion in cash terms. The central estimate suggests that imports have been 22% lower (or £2.1 billion lower in cash terms).

Meanwhile the model finds no significant impact of EU Exit on exports to the EU beyond the first quarter of 2021, suggesting an improvement in the export performance in late 2021.

These findings are consistent with the research by LSE CEP and UK Trade Policy Observatory that found a small and temporary effect of the TCA on UK exports to the EU and a persistent decline in EU imports.

Sensitivity analysis suggests that the estimated gap in EU imports is not dependent on any individual country forming the counterfactual (the synthetic control). The estimated effect remains significant when each country is excluded from the data.

Further sensitivity analysis explores whether EU imports diverge from its comparator in the years prior the UK's departure from the EU. While there is some divergence in results as the policy date is backdated and a smaller sample is used to pick the synthetic control, all estimates follow the same pattern in 2021 with a large negative gap in trade after EU Exit.

Final sensitivity check explores whether a particular sector is driving the gap in trade. The gap in imports for 2021, and exports in Q1 2021, is not significant when some sectors are excluded from the total, which may be expected if the EU exit has affected some sectors more than others. A more comprehensive analysis is required to estimate the effect of EU exit for each sector separately.

This study provides a detailed illustration of how Brexit has affected Scotland's trade in goods with the EU so far, however it should be noted that data on post-Brexit trade is still emerging. This study covers the first year of trade under the TCA, and due to limitations in the data only considered trade in goods. The SCM method allows for the effect of the policy change to change over time which means that the impact of the TCA could be monitored over time. For these reasons, we plan to produce the updated estimates of the impact of the TCA as more data becomes available. Future work could also incorporate improvements in the methodology and extend the analysis to cover a wider range of trade measures and estimate the effect of the TCA for each sector separately.

Office of the Chief Economic Adviser

May 2022

Annex

Table 1 - Synthetic control weights

<i>Exports to EU</i>		<i>Imports from EU</i>		<i>Total EU trade</i>	
Trade Flow	Weight	Trade Flow	Weight	Trade Flow	Weight
Norway	32%	Chile	31%	Hong Kong	26%
Argentina	17%	Algeria	20%	Bulgaria	25%
Estonia	14%	United States	14%	Algeria	16%
Chile	9%	Bulgaria	11%	Chile	15%
Finland	9%	Egypt	11%	Egypt	9%
Israel	5%	Hong Kong	7%	Libya	5%
UAE	4%	UAE	3%	Cyprus	2%
China (excl. HK)	4%	Portugal	2%	China except Hong Kong	1%
Brazil	2%	Mexico	1%	Israel	0%
Latvia	2%				
Cyprus	0%				

Source: OCEA analysis using Eurostat and HMRC data

Figure 1 - Gap between actual Scotland's imports from the EU and the synthetic control

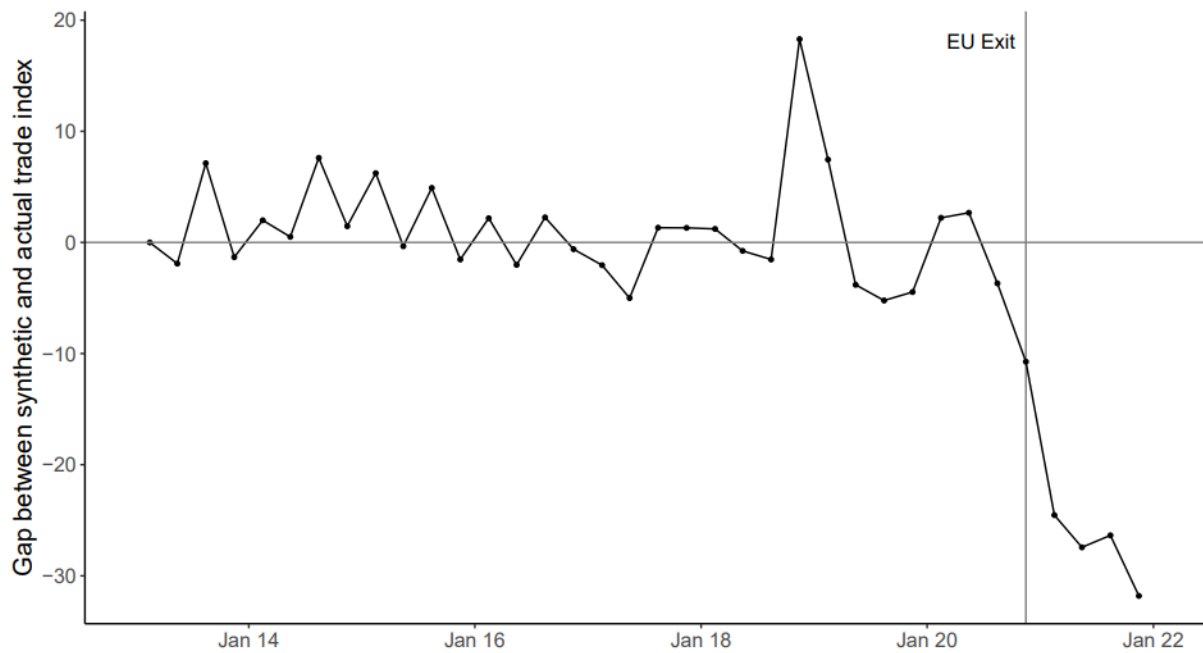
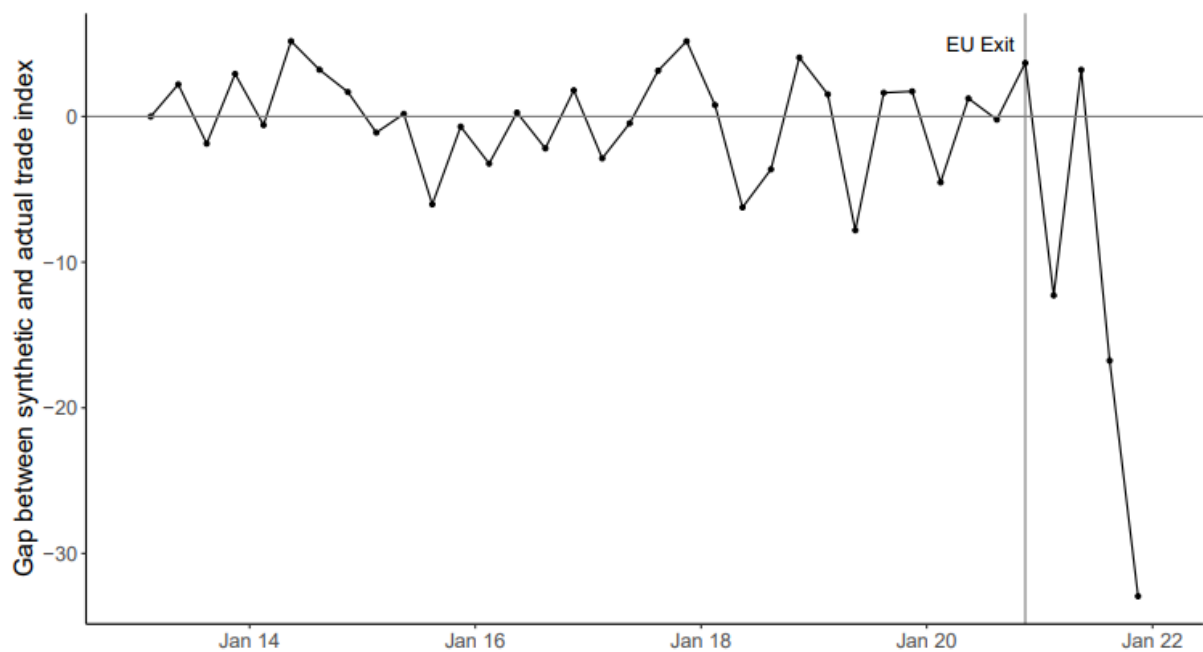


Figure 2 - Gap between actual Scotland's exports to the EU and the synthetic control



Source: OCEA analysis using Eurostat and HMRC data

Figure 3 – Placebo gaps for imports

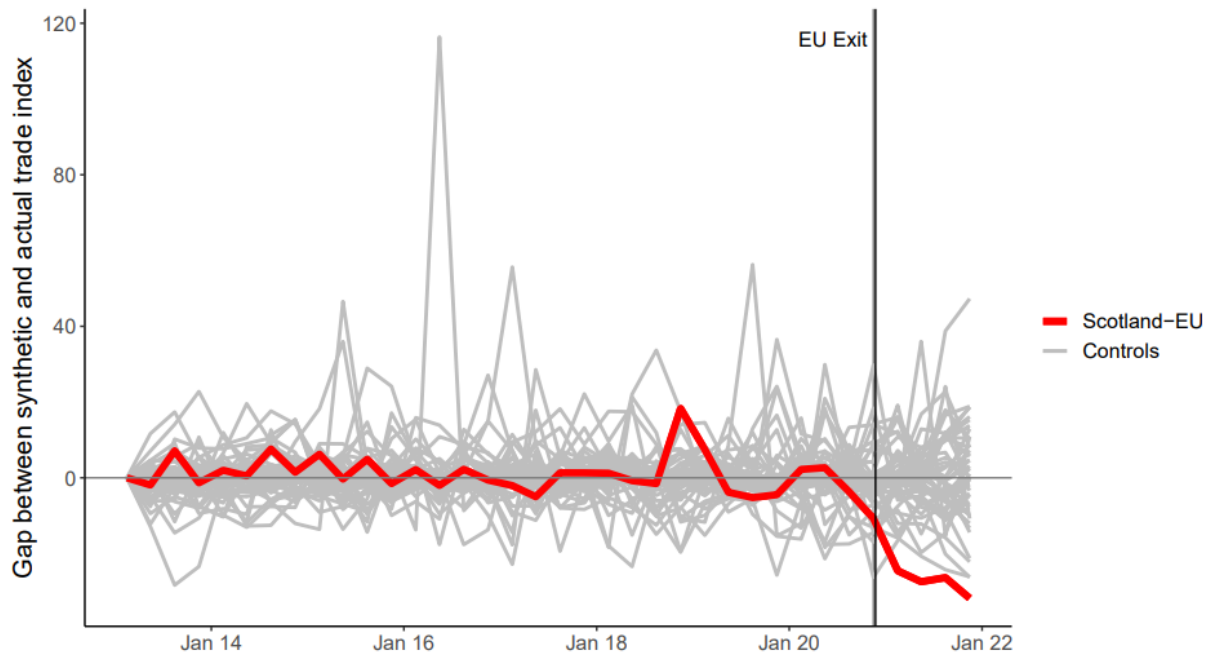
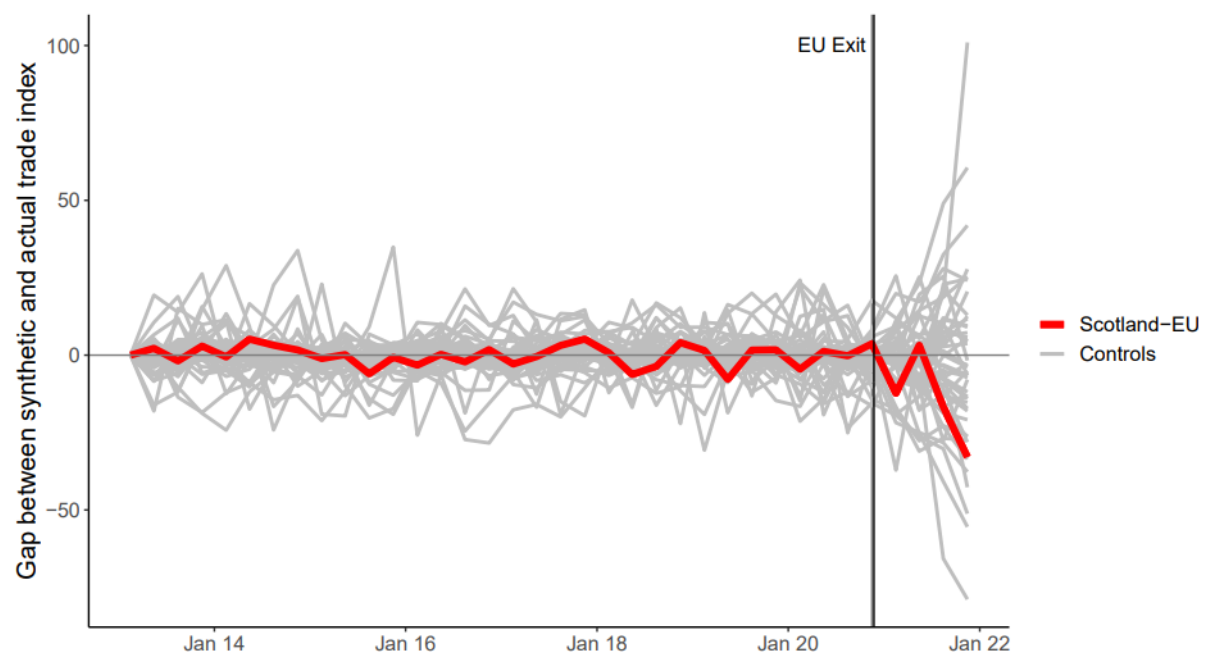


Figure 4 – Placebo gaps for exports



Source: OCEA analysis using Eurostat and HMRC data

Table 2 - Significance of the effect (p-value) on trade with the EU when each country is excluded from the synthetic control

<i>Excluded country, totals</i>	<i>p-value</i>	<i>Excluded country, imports</i>	<i>p-value</i>	<i>Excluded country, exports</i>	<i>p-value</i>
Algeria	0.14	Chile	0.06	Argentina	0.24
Chile	0.12	Algeria	0.04	Brazil	0.14
China (excl. HK)	0.12	United States	0.02	Chile	0.14
Egypt	0.16	Bulgaria	0.04	China (excl. HK)	0.18
Hong Kong	0.1	Egypt	0.04	Israel	0.14
Israel	0.12	Hong Kong	0.04	Norway	0.68
Libya	0.14	UAE	0.04	UAE	0.2
Bulgaria	0.16	Portugal	0.04	Cyprus	0.14
Cyprus	0.12	Mexico	0.04	Estonia	0.14
				Finland -EUi	0.24
				Latvia -EUi	0.14

Source: OCEA analysis using Eurostat and HMRC data

Table 3 – Significance of the effect (p-value) on trade with the EU when each sector is excluded from total

<i>Excluded sector</i>	<i>p-value for imports</i>	<i>p-value for exports</i>	<i>p-value for Q1 exports</i>
Machinery and transport equipment	0.039	0.392	0.078
Beverages and tobacco	0.078	0.490	0.118
Crude materials, inedible, except fuels	0.078	0.294	0.020
Animal and vegetable oils, fats and waxes	0.078	0.333	0.020
Manufactured goods classified chiefly by material	0.098	0.314	0.020
Commodities and transactions not classified elsewhere in the SITC	0.098	0.255	0.020
Food and live animals	0.118	0.588	0.157
Chemicals and related products, n.e.s.	0.137	0.216	0.020
Miscellaneous manufactured articles	0.137	0.275	0.039
All sectors	0.039	0.137	0.078

Source: OCEA analysis using Eurostat and HMRC data