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Post-Brexit UK Trade:

An Update

By Jun Du, Emine Beyza Satoglu and Oleksandr Shepotylo

Insight Paper

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1. Introduction

Global trade made a strong comeback in 2022 following its pandemic-triggered collapse and decline. According to the UNCTAD, total global trade was 10% higher in May 2022 than in 2019, reaching $7.7 trillion in 2022Q1.[1] The trade boom, however, has bypassed the UK. This insight paper is our continued endeavour to understand the forces that have shaped this outcome, by following the UK trade dynamics and analysing the factors and mechanisms behind the aggregate figures.

Between the period 2019 to 2022, the UK economy performed less well than the economies of most of its peers. Its GDP growth was lower than the average growth of the OECD, the G7, and the EU27. The UK also fell short in most GDP components compared to its peers, with low growth in consumption and investment, very low growth in exports, and the lowest growth in imports among all OECD countries. The only component that showed above-average growth was government consumption.

We build on Du and Shepotylo (2022), which assesses the trade impact of the newly installed EU-UK Trade and Cooperation Agreement (TCA) up to 2021Q3 and update the period of study to 2022Q1. Employing the same methodology, namely the synthetic difference-in-differences (SDID) method, we estimate the causal impact of the TCA on the UK's trade with the EU and the rest of the world (ROW) through exports and imports for the 15 months that has elapsed since the introduction of TCA. We find that the gap between the exports of the real UK and the synthetic UK has widened rather than closed, reporting 22.9% on average over the period. The post-Brexit export challenges are live and persistent.

Further, we investigate the sizeable decline in UK imports since 2021. This is something that has troubled the minds of many, in that there is no single or clear reason for it. Our analysis shows that, unlike the case of the UK's exports, the large gap between the imports of the real UK and the synthetic UK had closed by 2022Q1, indicating that the TCA effect on UK imports may be regarded as a teething problem. A reduction in import bottlenecks might help exports to rebound, but this recovery is likely to be offset by the rising costs of imports. We analyse the confluence of factors behind the import dynamics and discuss their likely implications.

Moreover, we find that, due to the TCA, the UK has experienced a significant contraction of trading capacity in terms of the varieties of goods exported to the EU. Our

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[1] https://unctad.org/news/global-trade-hits-record-77-trillion-first-quarter-2022,

estimate suggests that as many as 42% of the product varieties previously exported to EU have disappeared during the 15 months following January 2021. We argue that this decline has unfolded in three ways: a large number of exporters has ceased to export to the EU, the remaining exporters have streamlined their product lines, and fewer exporters are choosing to enter the EU market. This decline has been accompanied by an increased concentration of export values to fewer products. Many of the negatively affected exporters are likely to be small, resource-constrained firms who exported single products or a limited range of products, and they exported less intensively relative to the overall sales. Losing these exporters could break the pipeline for future export growth and harm the UK's already frail productivity.

2. The Global Context

Globalisation is back on the march despite calls from national and international politicians and policymakers for friend-shoring, re-shoring, or regionalisation of the global supply chains. The pandemic led to a reconsideration of the risks and benefits of globalisation, spurring discussion about the role of government in supporting or constraining globalisation. Despite all this, the global trade in goods hit a record high of $6.1 trillion USD in 2022Q1, reaching about 30% higher value than in 2019Q1 and 6% higher volumes (UNCTAD, 2022).

Renewed demand for goods, disruption of production, and geo-political uncertainty caused by the Russian invasion of Ukraine have fuelled global prices. The pandemic has also exposed the vulnerabilities of just-in-time supply chains. Relying on a single source of goods or components can leave a company scrambling when that source is disrupted, and firms have been alerted to the benefits of sourcing goods from different geographical locations.

However, as Figure 1 shows, the renewed growth in global trade hides important variations in performance across countries.[2] Among the exporting countries, the UK is an outlier, with zero export growth during 2019Q1–2022Q1. Emerging literature demonstrates that the exporting capabilities of the UK has been greatly damaged by Brexit, which has imposed new barriers to trading with the EU (Springford, 2021; Freeman et al., 2022; Du and Shepotylo, 2022; Kren and Lawless, 2022). Exports have also been affected by the overall slowdown of the UK economy, which is due to uncertainty and its tarnished attractiveness as an investment destination (Driffield and Karoglou, 2019).

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[2] Based on the monthly COMTRADE data aggregated to quarterly data. Data provided only on countries that have reached a threshold of exporting (importing) 50 bln USD or more in 2019Q1. Calculations for France, Korea, and Russia are based on the mirror trade reported by their partner countries.
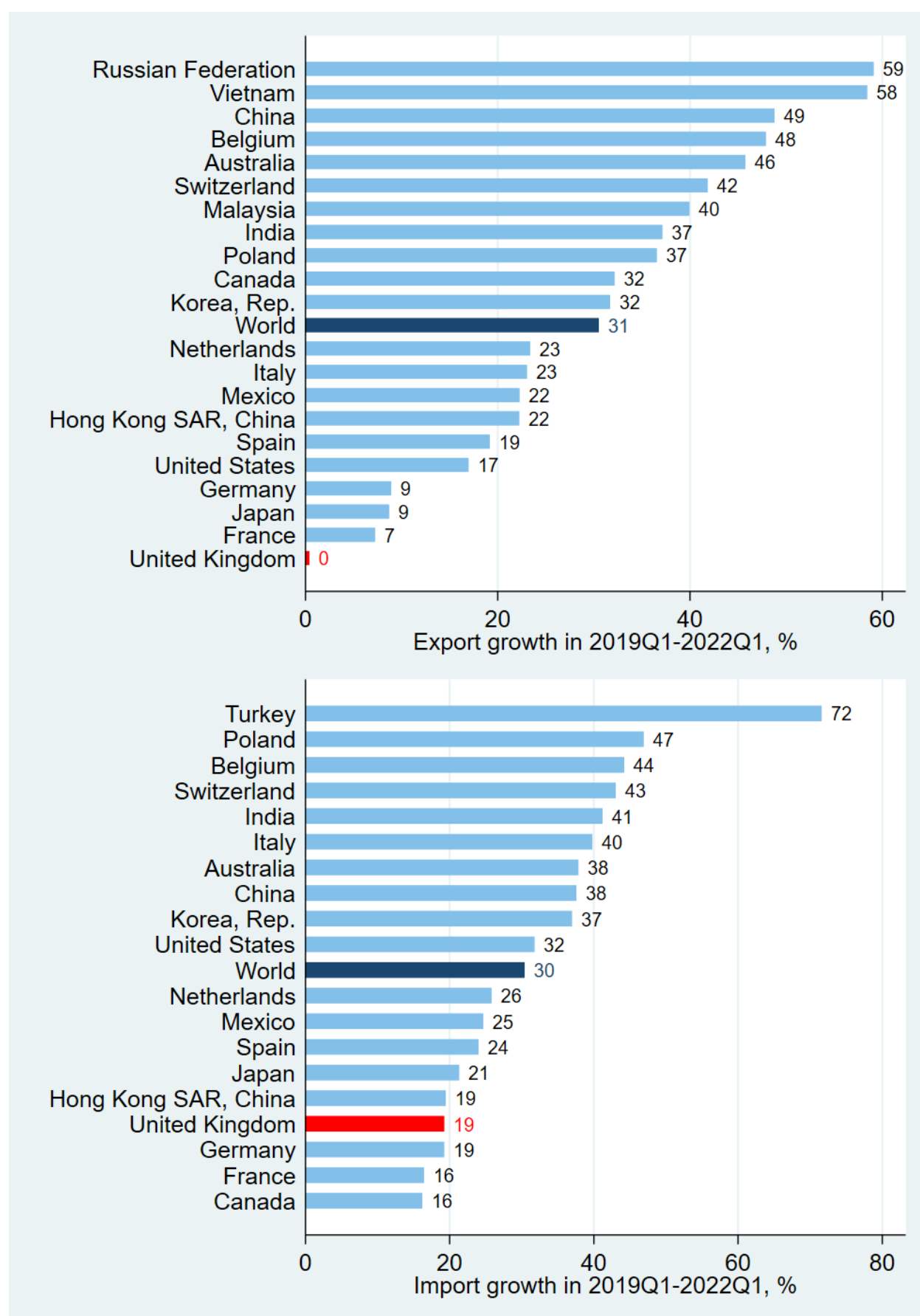
It is noteworthy that Germany and France are the two major EU economies that have performed below the world average (7% and 9% growth respectively). This corresponds well with the theoretical predictions that Brexit would impact negatively on the UK's most important trading partners (Dinghra et al., 2017; Sampson, 2017). While the UK's close trade partners have performed poorly, other EU countries that were less exposed to trade with the UK performed well; for example, Belgium and Poland demonstrate 48% and 37% growth. Also riding the wave of global trade expansion are the South and South-West Asia and Pacific regions, with China, Vietnam, Australia, Malaysia, and India showing above average growth rates. The performances of the US and Japan have been closer to those of Germany, France, and the UK.

We must also factor in the Russian sanctions, which may play an important role in the below average performance of the G-7 economies, given that Russia was an important market for the US, UK, Japan, and EU countries who have all introduced some restrictions on their exports to Russia. Despite the sanctions, Russia has been able to capitalise on soaring energy prices and has been able to expand its exports to exceed those of all major exporters, having 59% growth. This also reflects the fact that the sanctions were not fully applied to the Russian export of oil and natural gas, their main trading items. In 2019, Russian export was $427 bln, with 46.2% going to G-7 countries. Note that 63% of export to the G-7 was in mineral products (HS 27).

The global economy showed strong recovery in demand in early 2022, as indicated by a robust increase in imports. All large importing countries demonstrated robust growth, albeit with important regional differences. European recovery was patchy. France, Germany, and the UK were among the slowest performers, with imports growing by 16-21%. Belgium, Poland, and Switzerland were among the world leaders in imports growth, demonstrating 44%, 47%, and 43% import growth respectively, which are well above the World's 30% import growth. Turkey has been leading in imports growth, recovering from the economic crisis of 2018-2019 (World Bank, 2022). The US also has a robust demand recovery, showing 32% growth in imports. Japan's performance, on the other hand, is similar to that of Europe's laggards.

Given the strong global trade recovery, the substantial heterogeneity in performance across countries, and the UK's lacklustre performance, our analysis below builds on Du and Shepotylo (2022) to follow the UK trade dynamics and analyse the factors and mechanisms behind the aggregate trends.

Figure 1: Trade in goods of leading trading countries in 2019-2022

Export growth in 2019Q1-2022Q1, %

Country	Value
Russian Federation	59
Vietnam	58
China	49
Belgium	48
Australia	46
Switzerland	42
Malaysia	40
India	37
Poland	37
Canada	32
Korea, Rep.	32
World	31
Netherlands	23
Italy	23
Mexico	22
Hong Kong SAR, China	22
Spain	19
United States	17
Germany	9
Japan	9
France	7
United Kingdom	0

Import growth in 2019Q1-2022Q1, %

| Country	Value
Turkey	72
Poland	47
Belgium	44
Switzerland	43
India	41
Italy	40
Australia	38
China	38
Korea, Rep.	37
United States	32
World	30
Netherlands	26
Mexico	25
Spain	24
Japan	21
Hong Kong SAR, China	19
United Kingdom	19
Germany	19
France	16
Canada	16

3. UK GDP and Components

Before diving into more detailed analysis of the merchandise trade, we consider the GDP growth of the main trading countries to identify global trends. We also look at the growth in the components of GDP to offer a more nuanced picture. Drawing on 2019Q1–2022Q1 data from the OECD Quarterly National Accounts, we show the period's growth in real GDP and its components for the UK and for selected OECD and emerging economies. Note that exports and imports in the balance of payments are based on trade in both goods and services.

Although the GDP figure is not a perfect measure of a country's economic health, it is one that allows international comparison of what countries produce. Figure 2 shows that between 2019Q1 and 2022Q1, the UK's real GDP grew by 0.87%, with only Mexico (-2.55%), Japan (-2.33%), Spain (-2.23%), Italy (-0.11%), and Germany (0.75%) performing worse. Among the fast-growing countries, Ireland grew by 34.2%, Turkey by 22.5%, and China by 18.5%. The UK's growth was lower than the average growth of the OECD (4.5%), the G7 (3.26%,) and EU27 (3.12%).

Figure 2 also compares growth rates in GDP components. This gives a crude understanding of the factors behind the overall GDP growth. The UK has consistently performed poorly in the key GDP components, including consumption (-3.47% growth, 3rd lowest among the 20 countries considered), investment (1.54%, 5th lowest), export (-8.1%, 2nd lowest), and import (-0.7%, the lowest). The UK has been growing in government consumption at 9.64%, which is the only component where it grew above the OECD average (8.02%). In fact, the UK's government consumption grew more quickly than most of its peers, such as Germany, the Netherlands, France, and Canada.

Figure 2: Real GDP growth in 2019Q1 – 2022Q1 and its components.

Note: Russian data is available only until 2021Q3.
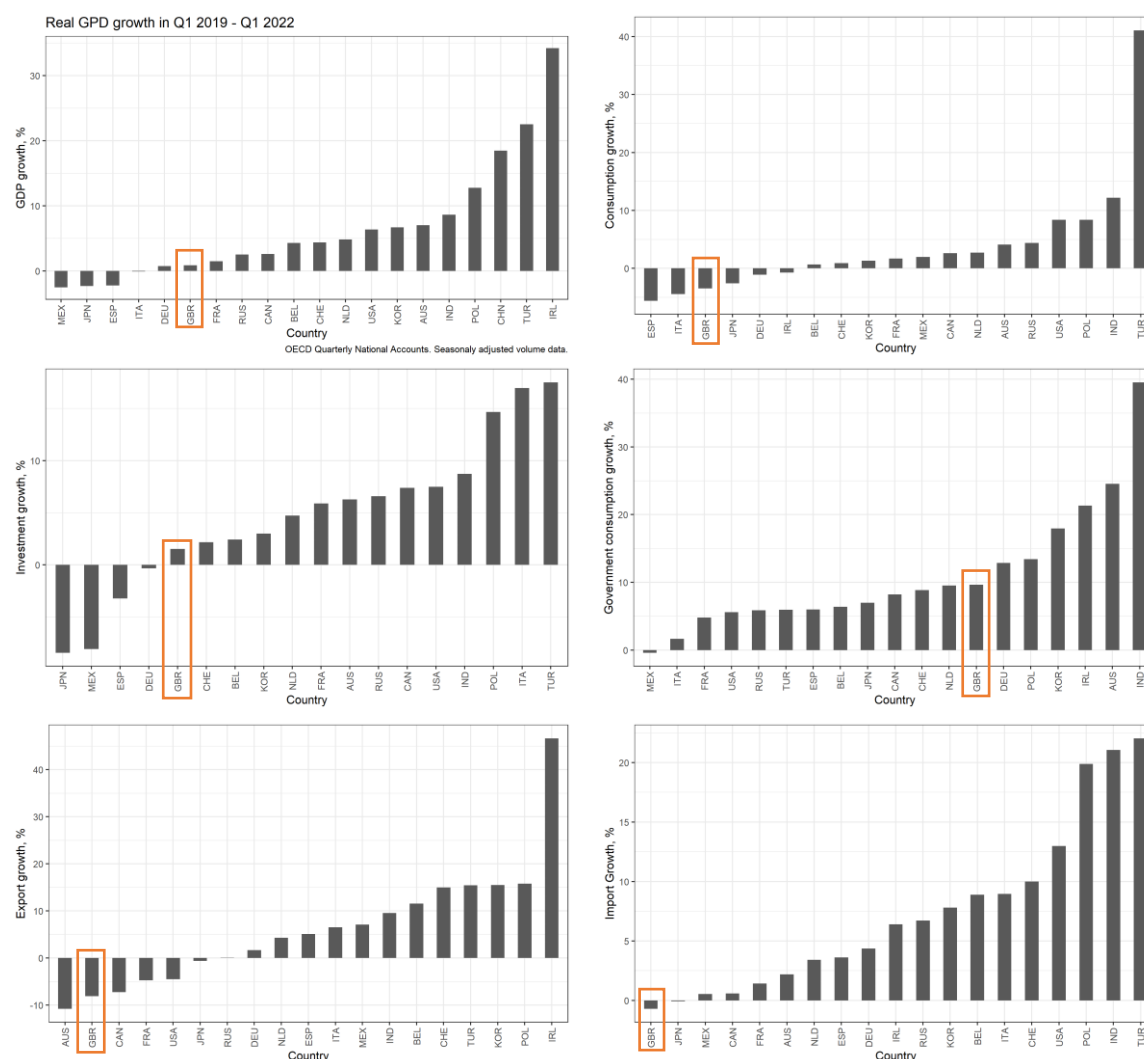
What is striking is that the UK's investment growth rate was low long before the Brexit Referendum.[3] In fact, the UK has a long-standing problem of low investment from both the public and the private sectors, and it underlies the UK's stagnating productivity growth.[4] Following the Brexit Referendum, a prolonged period of uncertainty about the EU-UK relationship further dampened investment, weakened business and financial conditions, and depressed household spending (Bank of England, 2019). The TCA defined a new trade and

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[3] The UK has the lowest percentage of non-government gross fixed capital formation (GFCF) as a percentage of gross domestic product (GDP) across the OECD between 1995 and 2015 (ONS, 2018). The UK's non-government GFCF comprises about 82% of total GFCF. See
https://www.ons.gov.uk/economy/grossdomesticproductgdp/articles/ananalysisofinvestmentexpenditureintheukandotherorganisationforeconomiccooperationanddevelopmentnations/2018-05-03.

[4] Much has been written on this topic, including the most recent comments by Minouche Shafik
https://www.ft.com/content/e77e8669-d4e4-4bc3-8193-b9dfd571b3f9. Also see a focused discussion on the low business investment issue by Wilkes at Institute of Government,
https://www.instituteforgovernment.org.uk/sites/default/files/publications/business-investment.pdf

investment relationship between the UK and the EU; while helpful, this did not eliminate future regulatory changes and potential misalignment between the two parties. These uncertainties continue to depress private investment.

Furthermore, it is not just uncertainty that deters investment. The UK's ability to trade as an open economy matters a great deal to its supply chains and investors, many of which are multinational companies (Górnicka, 2018). Turning to the trends in UK's exports and imports in Figure 3, it is apparent that the UK has, between 2019-2022, lagged behind most comparable countries to an extraordinary degree. Among its peers, only Australia's exports grew less. The UK's increased trade barriers are presumably making existing investors think twice about investing more heavily in the UK. The post-Brexit fact is that cross-border trading of goods and services between the UK and the EU has become more costly since the withdrawal of free-movement rights in the UK.[5] Another key issue concerns the non-tariff measures that have increased with the new TCA. Despite zero tariffs and zero quotas on all goods that comply with the rules of origin, TCA's coverage on NTMs is rudimentary (Amodu et al., 2021). Du and Shepotylo (2022) show that in the first six months of 2021, the increased frictions for goods exposed to NTMs could explain a large part of the UK's observed export decline.

One of the most serious implications of this for the UK economy is the threat to the UK's historically strong integration in Europe's supply chains. If UK businesses can no longer maintain their low cost and high efficiency, the potential for disintegration becomes more than likely. This threat may be compounded by other risks, such as the lack of skills and talents in advanced manufacturing and other high value-adding manufacturing sectors, a lack that is worsened by the EU exit.[6] In a scenario where productivity is strained, skills are immobile, and capital flow remains free, it is possible that private investment may decay, exacerbated by the fact that there is still so much uncertainty about the future UK-EU trading relationship.

Anecdotal evidence suggests this might be already happening. The Financial Times reports the observation of Make UK, the UK manufacturers' organisation, that some UK subsidiaries of global companies in capital-intensive sectors, such as engineering and electronics, are struggling to convince their international parents to invest in the UK.[7] At the

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[5] See reports by the FT on border crossing difficulties at Dover (e.g., report dated 4 August 2022). The border issues have seen improvements over time but are not expected to disappear in the foreseeable future.

[6] See evidence presented to UK Trade & Business Commission on "Protecting UK Manufacturing in a global supply chain", at https://www.tradeandbusiness.uk/past-sessions/protecting-uk-manufacturing-in-a-global-supply-chain.

[7] "Anecdotally we are seeing global conglomerates that have bases in many countries diverting R&D funding to other international bases. It is harder to convince parent organisations to be confident in the UK." (Fhaheen Khan, Senior Economist for Make UK, as reported by the FT on 4 August 2022).

time of writing, BMW has just announced its decision to relocate electric Mini production from their Cowley site (on the outskirts of Oxford) to China by the end of 2023 (Bailey, 2022). In addition, Arrival, a commercial EV company, has announced a shift in focus from the UK market to the US market.[8] These are just two examples of existing multinationals who are relocating their investment away from the UK.

Having reviewed the global context and the UK circumstances using aggregate statistics and anecdotes, we next move on to a causal analysis of the Brexit effect on UK trade.

4.   The TCA Impact on UK Trade

Brexit is the main hypothesis that might help explain the recent UK trade dynamics. We suggest that the increase in trade barriers between the UK and EU has been caused by the changing trade relationship between the two partners after the TCA came into force in January 2021. This has not only had a direct negative impact on the UK's trade with the EU, it has also indirectly reduced the UK's global competitiveness because of dampened investment. To test this hypothesis, we derive the causal inference of the TCA effect on UK trade over the period ending 2022Q1 using the Synthetic Difference-in-Difference (SDID) methodology (Arkhangelsky et al., 2022). Our updated estimate builds on Du and Shepotylo (2022), which reported the estimate up to 2021Q3. We draw on COMTRADE data at the harmonised system (HS) sub-heading level (HS 6-digit) for the period 2019Q1–2022Q1 and adopt the same methodology as in Du and Shepotylo (2022). That methodology is detailed in Appendix 1. Briefly, however, the SDID methodology creates a doppelganger UK (using the counterfactual case that the UK remained in the EU), estimates the synthetic UK's exports and imports, and compares these estimates to the figures for the real UK.

Figure 3 illustrates the log of actual monthly UK exports and imports to the EU and Rest-of-World (ROW) in blue, while the SDID estimates for the doppelganger UK are shown in red. The differences between the blue and red lines are interpreted as the causal effect of the TCA. Results demonstrate that the negative impact of TCA on imports from the EU and ROW since January 2021 had mostly dissipated by the beginning of 2022, in that the actual and counterfactual outcomes are approximately the same. The decline in export, however, has remained deep and persistent since January 2021. While the gap between the actual UK exports

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8   See https://arrival.com/uk/en/news/arrival-announces-high-voltage-battery-module-assembly-plant-in-charlotte-nc.

to the EU and the exports of the counterfactual seems to be narrowing in 2022, the gap in the UK exports to ROW is not.
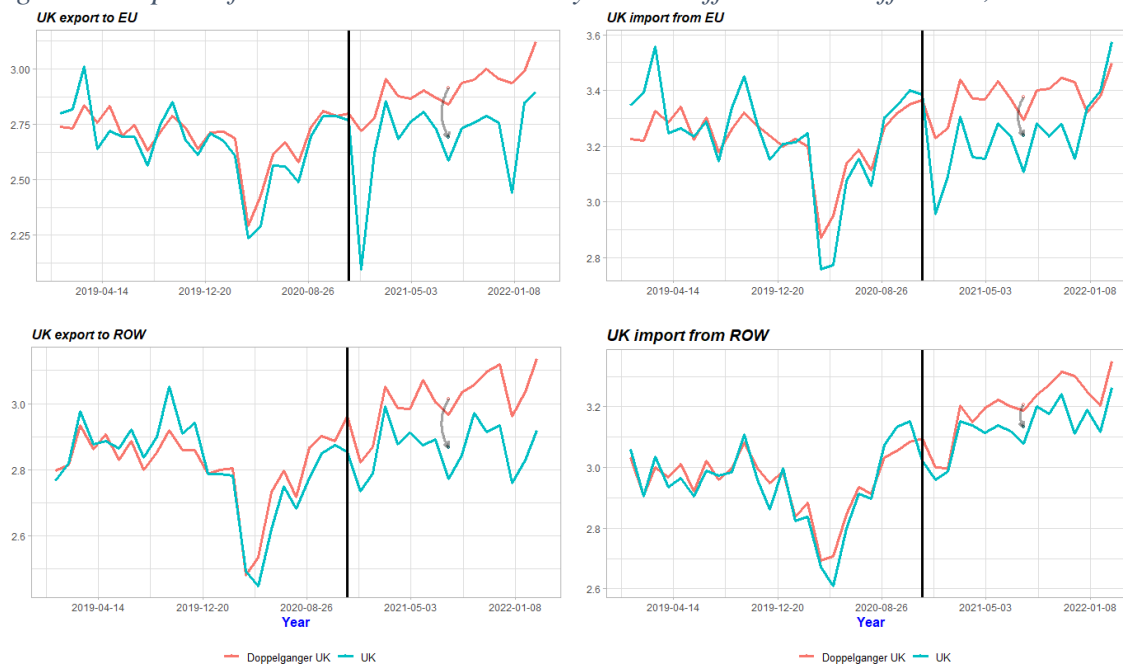
Removing mineral oil does not alter the picture considerably, as shown in Figure 4.

Figure 3: Impact of Brexit on the UK trade: synthetic difference-in-difference
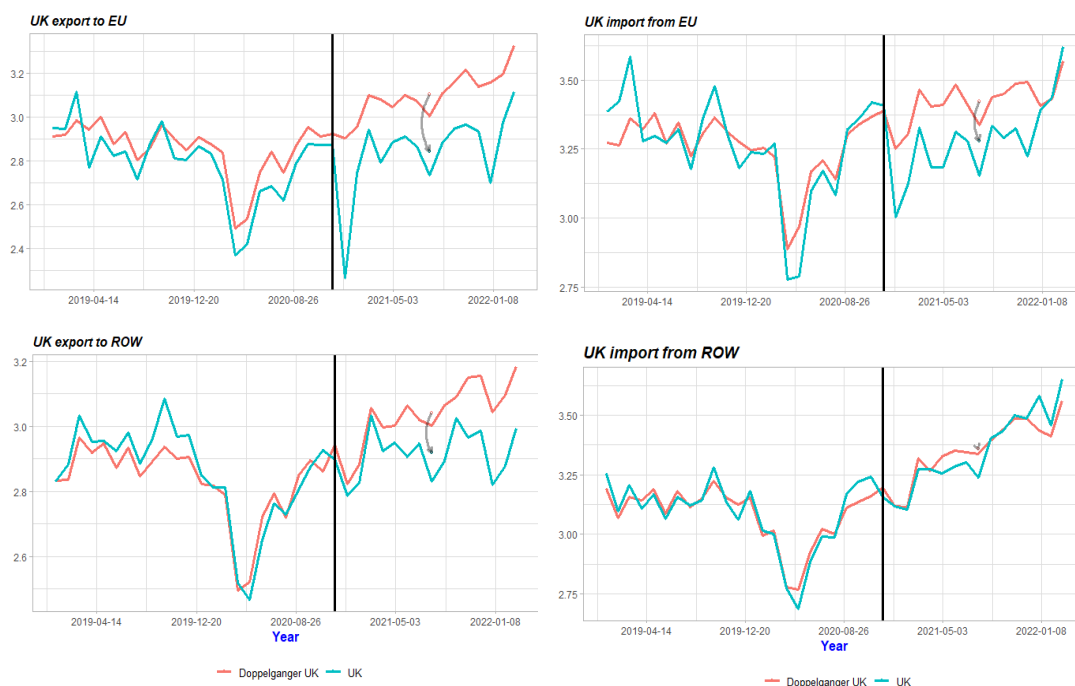
Note: Log scale for monthly export/import in bln USD. Gold (HS7108) is excluded.

Figure 4: Impact of Brexit on the UK trade: synthetic difference-in-difference, no mineral fuel

Note: Log scale for monthly export/import in bln USD. Gold (HS7108) and mineral fuels (HS27) are excluded.

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For the purposes of comparison, Table 3 presents the specific estimates of the causal effect (using the SDID that generated Figures 3 and 4) alongside estimates produced by two other popular methodologies: difference-in-difference with two-way fixed effects (DID) and synthetic control (SC). We consider results with and without mineral fuels. Moreover, following the practice of Office of National Statistics (ONS), we exclude gold from the analysis. Based on the aggregate estimates, exports to the EU since January 2021 are 22.9% lower on average, while exports to ROW are 11.3% lower as a result of TCA. Imports from the EU are on average 13.1% lower, and imports from ROW have barely changed.

The result for aggregate trade flows does not allow precise estimates of the effect; this results in high standard errors. Using bilateral data, we can capitalise on the higher number of treated units (all UK bilateral trade with EU countries post December 2020), which allows us to estimate the coefficient more precisely. These results are shown in the Panel E for imports and Panel B for exports. Based on the bilateral data, the reduction in exports was 16.5% and in imports it was 19.7%. However as shown above, the trends in exports and imports diverge significantly over time. The exports decline is persistent and widening, whereas the imports decline is relatively short-lived, recovering 15 months after the introduction of the TCA.

Table 1: Causal impact of TCA on the UK trade in Jan 2019 - March 2022

	With mineral oil			Excluding mineral oil		
	DID	SC	SDID	DID	SC	SDID
	A: UK imports from EU					
τ	-0.15	-0.15	-0.14	-0.15	-0.15	-0.14
$\Delta, \%$	*-13.9*	*-13.9*	*-13.1*	*-13.9*	*-13.9*	*-13.1*
σ_τ	(0.15)	(0.18)	(0.14)	(0.13)	(0.17)	(0.15)
	B: UK imports from ROW					
τ	0.02	0.02	0.002	-0.04	-0.04	-0.07
$\Delta, \%$	*2.0*	*2.0*	*0.2*	*-3.9*	*-3.9*	*-6.8*
σ_τ	(0.11)	(0.11)	(0.09)	(0.1)	(0.11)	(0.1)
	C: UK exports to EU					
τ	-0.17	-0.27	-0.26	-0.18	-0.17	-0.22
$\Delta, \%$	*-15.6*	*-23.7*	*-22.9*	*-16.5*	*-15.6*	*-19.7*
σ_τ	(0.2)	(0.23)	(0.27)	(0.17)	(0.19)	(0.18)
	D: UK exports to ROW					
τ	-0.16	-0.12	-0.12	-0.14	-0.11	-0.15
$\Delta, \%$	*-14.8*	*-11.3*	*-11.3*	*-13.1*	*-10.4*	*-13.9*
σ_τ	(0.17)	(0.19)	(0.13)	(0.11)	(0.13)	(0.11)
	E: Bilateral UK imports					
τ	-0.2***		-0.22***	-0.19***		-0.22***
$\Delta, \%$	*-18.1*		*-19.7*	*-17.3*		*-19.7*
σ_τ	(0.04)		(0.04)	(0.04)		(0.04)
	F: Bilateral UK exports					
τ	-0.18**		-0.19***	-0.17**		-0.18***
$\Delta, \%$	*-16.5*		*-17.3*	*-15.6*		*-16.5*
σ_τ	(0.05)		(0.05)	(0.05)		(0.05)

Notes: τ represent the causal change in the respective trade flow post Dec 2020. Jackknife standard errors in parentheses, σ_τ. For aggregate results the treated unit is the UK trade flows. For bilateral results, the treated units are all bilateral trades where the UK is the sourcing unit for exports and the recipient unit for imports. Significant at * 5%, ** 1%, *** 0.1%.

5. The UK Post-TCA Imports Puzzle

It has been recognised as odd that even though the EU has tighter trading restrictions on their side of the border with the UK, the UK's import of goods from the EU has fallen more than UK's exports of goods across the border (OBR, 2022). There are theories for why this has been the case.

The first possible explanation for the shortfall in EU imports against non-EU imports is the rising price of energy imports; the UK has largely sourced energy from outside the EU. What our above analysis illustrates is that when mineral oil imports are excluded from the statistics, the negative TCA effects are larger in the UK's imports from the ROW. This suggests

that the oil price increase has indeed played a role in reducing the negative impacts on imports from ROW. However, this does not explain the decline in UK imports from the EU.

What, then, might explain the low imports from the EU in 2021? A very likely explanation is substitution between EU and non-EU imports. It may be that some goods that passed through the UK because they were in the EU supply chains are now being redirected away from the EU transits. Anecdotal evidence suggests this may be the case: 'Some EU exporters drop UK as a market for exporting when the UK market is relatively small and not worth the paperwork to continue exporting to the UK,' (anecdotal evidence Germany, KPMG survey). Our analysis indicates that the effect of substitution may be limited or short-lived, with UK imports from the EU having recovered in 2022.

Global supply bottlenecks could also have played a role in 2021's import shortfall. We notice that machinery and transport equipment imports, which were reported to account for around half of the import shortfall at the end of 2021 compared to 2019 levels (OBR, 2022), have seen a significant bounce-back.

A problem related to 2021's global supply chain issue was the soaring cost of transportation. Container freight rates increased dramatically between January 2019 and September 2022, reaching a record price of nearly 10,400 U.S. dollars in September 2021. By September 2022, that price fell to 4,000 U.S. dollars.[9] These high transportation costs might have depressed the flow of imported goods in 2021 and the abated price hikes might have helped imports to recover.

What about other trade barriers? Du and Shepotylo (2022) show that the increased trade frictions due to sanitary and phytosanitary (SPS) and technical barriers to trade (TBT) measures as a result of entering the TCA played an important role in the decline of UK exports to the EU. This does not apply to imports however, because the border control has so far been implemented only in the EU and not in the UK. This implies that the non-tariff measures induced by frictions at the border did not cause significant negative impact on UK imports.

Finally, stockpiling towards the end of 2020 could explain to some degree the weak EU imports in 2021. Stockpiling has been documented by the ONS Business Impacts of Coronavirus Survey (BICS) data, especially among the manufacturing (most notably electrical machinery, medical pharmaceutical, and organic chemicals) and hospitality industries, where companies reported they were stockpiling goods in December 2020, prior to the trade deal

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[9] See https://www.statista.com/statistics/1250636/global-container-freight-index/.

having been agreed with the EU.[10] Stockpiling has happened ahead of each Brexit deadline in the past.[11] The ONS reported a spike in EU imports in November 2020, with an increase in the value of imports from the EU by £1.7 billion, which is comparable to that seen in March 2019. Despite no direct evidence, the narrowing gap of our estimate of TCA effect in 2022 suggests that stockpiling is likely to have played a role.

In summary, the Brexit TCA effect on UK imports from the EU was temporary, a "teething" problem experienced by UK businesses and consumers who were adjusting to new rules. This stands in contrast to the persistent decline in UK exports, which is arguably caused by more fundamental factors. There is a combination of factors that has led to the overall loss of competitiveness of UK exports post Brexit/TCA. The higher costs of trading with the EU due to non-tariff trade barriers can explain a large chunk of the decline in the UK's exports to the EU. Du and Shepotylo (2022) initially document this for 2021 and explain in greater detail the possible mechanisms of the decline by reference to different types of commodities and clustering in some industrial sectors. The updated evidence suggests that by 2022, the negative impact of TCA has widened rather than diminished.

On the bright side, UK firms' ability to export might have been impaired due to the challenges in importing intermediate inputs during 2021. With the import bottlenecks subsiding, exports may well experience some recovery with time. However, the rising costs of imports due to energy price increases, the weak pound, and the rising costs of living (from the producers' perspective) may taper any gains made from renewed access to imports; indeed, these factors may drive yet more exporters out of international competition. This would impact on UK exports to both the EU and beyond. These dynamics should be closely assessed in the future.

Taking a more long-term view, weakened investment in the UK from both UK and foreign investors is an important mechanism that may explain the UK export decline. There has been abundant evidence that since the Brexit Referendum, uncertainty impacted on trade before the end of the transition (Bloom et al., 2019; Douch et al., 2019; Graziano et al., 2020; Douch and Edwards, 2021; Fernandes and Winters, 2021) to the extent that investment patterns changed (Breinlich et al., 2020). Post-Brexit, private investment may continue to decay, given that UK productivity remains strained, skills are immobile, and capital flow remains free. These investment conditions are generally considered to have unfavourable prospects, and the

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[10] See https://www.ons.gov.uk/businessindustryandtrade/internationaltrade/articles/didukfirmsstockpileitemsaheadofthebrexitdeadline/2021-02-01.

[11] March 2019 when the Article 50 withdrawal agreement was due, and October 2019 when the withdrawal agreement was extended.

remaining uncertainty about the future UK-EU trading relationship is unlikely to improve investor confidence.

6. The Real Loss of Trading Capacity

Having observed the aggregate trends in the UK's trade post TCA, the next important question is what does this overall picture mean at firm level? How much of the UK export decline may be attributed to a drop in firms' average export values, and how much has been caused by exporters dropping out of the export market altogether? Understanding the specific channels of the export decline is crucial for assessing the severity of the challenges faced by UK trade, and for ensuring that policies are designed to mitigate these challenges. If exporters have exported less but have managed to remain in the export market, this is arguably the lesser of two evils in that it is surely preferable to losing access to the international market completely. Given that entering an export market requires fixed costs, we can reasonably assume that withdrawing from exporting means that these sunk costs have been forgone. Furthermore, having fewer exporters, who are competing with each other and with exporters of other nationalities, means that there is less business dynamism and fewer opportunities to learn. This harms productivity and competitiveness, impoverishing the chance of exporting in the future.

Unfortunately, there is still no large-scale granular data available for 2021 for the time being. We therefore investigate this issue by first decomposing changes in the value of trade (exports and imports) for a variety of products into changes in the number of varieties traded with a country (extensive margins), and the average of value traded per variety with that country (intensive margins). Typically, changes in trade driven by extensive margins are related to factors that alter fixed costs of trade, while changes in intensive margins are relative to changes in the variable costs of trade (i.e., tariffs) or to variety level changes driven by technologies or price shocks. The detailed theory and methodology are found in Appendix 2.

The calculated trade margins in Figures 5 and 6 show how the extensive and intensive margins of the UK trade evolved from January 2019 to March 2022. What immediately captures attention is the tumble in the number of varieties exported to the EU immediately after the introduction of TCA. In the absence of tariff changes, the fall from 70 thousand varieties in December 2020 to 34 thousand varieties in January 2021 (i.e., over half of the varieties were lost) shows that the new trade arrangements resulted in a considerable increase in the fixed costs of exporting to the EU. That number has recovered slightly from its lowest point in

January 2021, but the post-TCA average for exported varieties between 2021Q1 and 2022Q2 was only 42 thousand varieties; this is equivalent to a staggering 40% reduction on the December 2020 figure.

The UK exports to ROW follows a flat line in terms of the number of exported varieties of goods, except for a dip in mid-2020 which is mainly driven by the unprecedent trade collapse sparked by COVID-19. By March 2022, the UK's total varieties of exported products (32 thousand varieties) to the ROW recovered to a level similar to that of March 2019 (+1.5%). This decline was greater than that of the UK's exports to the rest of the world, which also saw an average decline, dropping from an average of 61 thousand varieties in 2019 to an average of 55.6 thousand varieties in 2020 (-9.3%); it then recovered slightly to 57 thousand varieties in 2021-2022 (2.8%).

The varieties of the UK's imports also reduced but on a much smaller scale. January 2021 saw a drop of around 10% in varieties imported from the EU compared to December 2020. That number also recovered in 2022, pulling up the average number of UK import varieties to nearly 40 thousand in the post-TCA period, compared to 42.6 thousand in the pre-TCA period, a 7% decline. We note that the number of varieties imported from the rest of the world increased marginally from 30.6 thousand varieties per-TCA to 31.3 thousand varieties post-TCA (2.3%).

Figure 5: Extensive margins of UK trade
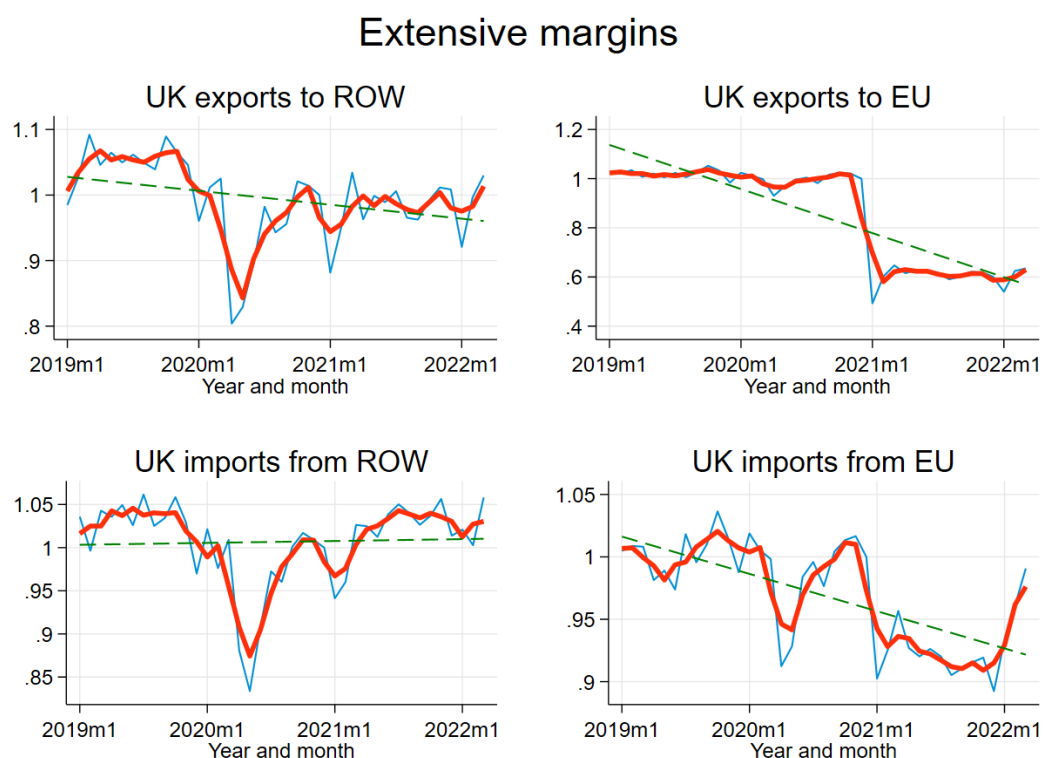
Extensive margins

Note: Index, Dec 2020 = 1 Blue line is the index based on the actual number of varieties. Red line is the 3-month moving average index. Dashed green line is the linear trend.

Figure 6: Intensive margins of UK trade
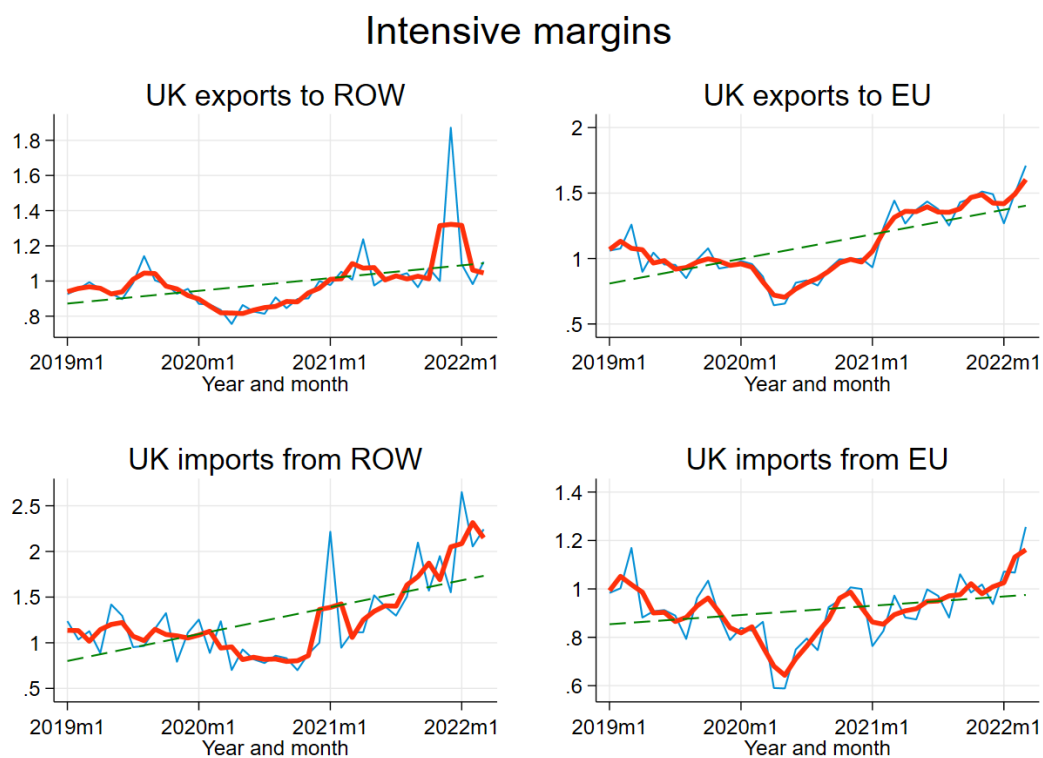
Intensive margins

Note: Index, Dec 2020 = 1 Blue line is the index based on the actual average trade value. Red line is the 3-month moving average index. Dashed green line is the linear trend.

After decomposing trade flows into the extensive margins and intensive margins of trade, we analyse the causal impact of the TCA using an approach similar to that used earlier for trade values. The causal analysis allows us to separate the impact of the TCA from the impact of other factors, such as COVID-19, global value chain disruptions, and global price increases. As reported in Table 2, our estimates suggest that the TCA resulted in a 42.3% decline in the extensive margins of exports to the EU (47.3% if measured against bilateral exports to the EU) between 2019Q1 and 2022Q1. This is in line with estimates of the TCA effect on UK export values, and it is likely to be larger than the recent estimate evidence provided by Freeman et al. (2022).[12] In itself, this is not so surprising because we know that improved market opportunities abroad are associated with a greater variety of export products and higher overall productivity in a sector (Feenstra and Ma, 2014), while worsened market opportunity should lead to the opposite. But the size of the effect is nonetheless astonishing.

How did this happen? The existing theories do not offer much guidance. Our first conjecture is as follows. To experience such a huge decline in the variety of products exported, there must have been a large number of previously exporting companies that simply quit exporting by 2021. Drawing on evidence elsewhere,[13] we argue that the exiting companies are likely to be small and resource constrained. They were exporting either a single product or a limited product range, and they exported less intensively relative to their sales before 2021. Second, companies that remained in the export markets would, on average, have streamlined their product ranges, exporting less variety to maximise each variety's economies of scale. Third, there were fewer "would've been" exporters offering new product varieties than would have been the case had the TCA not been put in place post-Brexit. These counterfactual exporters arguably fell below the competitiveness threshold for exporting post-2021; a threshold that Brexit had raised.

While observing a significant contraction in the UK's trading capacity, we also note a considerable increase (18%) in the average value of exports per product variety to the EU. Combining this with evidence on the reduced extensive margins, this may suggest two

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[12] It is useful to note that the estimates of Freeman et al. (2022) are based on 8-digit level products in 2013 Jan-Dec 2021, which explains the lower level of TCA effect than the estimates we report here. Our estimates are based on 6-digit level products for 2019Q1-2022Q1.

[13] The existing literature provides evidence that smaller exporters can be disadvantaged compared to their large counterparts in internationalisation. For example, NTMs affect smaller firms disproportionally and are sometimes prohibitively high (Fugazza et al., 2017), given these firms' limited capability to absorb sunk costs. This is likely to reduce small firms' opportunities to trade internationally. Smaller exporters are also found to be more likely to experience export destruction in the wake of Brexit uncertainty (Douch, Du and Vanino, 2019).

underlying patterns. First, there has been certain degree of substitution between products. Some product varieties were replaced by others, something that could happen within a firm or between firms. Within-firm product substitution could happen between different product qualities for exporting, with products that are less demanded, less competitive, and less cost-effective being no longer exported to the EU. Substitution could happen between firms too, as large exporters, who are more productive and export-intensive, step in to fill the gaps left by small, less productive, and less export-intensive exporters who have exited the market.

The implications of this trend are concerning for two reasons. First, the product varieties that have disappeared are mostly those with low export value, and we know this because the average export value increased as the number of varieties declined. These products are typically exported by small firms or new exporters, or are exported to new markets (Albornoz et al., 2012; 2021). When these firms exit from exporting, it not only means that their earlier investment into the exporting infrastructure has been lost, their scope for upscaling in the global market has also been curbed. From an economic perspective, losing small exporters from the global markets could break the pipeline of future export growth.

Second, the concentration of export varieties is likely to lead to export sales being concentrated in fewer exporters, some of which will be superstar exporters. This will worsen the "happy few" phenomena in the UK, where a small number of top exporters account for a large share of total exports, with the vast majority of small exporters accounting for only a tiny fraction of aggregate exports. The "happy few" phenomena has already shown persistence and has intensified over time, with the top 1%, 2%, 5%, and 10% of UK exporters accounting for approximately 65%, 73%, 83%, and 88% of the aggregate exports value in 2018 (Du et al., 2021). They are likely to benefit from the gaps left by small exporters who no longer find it viable to export.

By contrast, the UK's imports from the EU reduced by 8.6% at both margins, whereas the UK's imports from the rest of the world actually increased, especially along the intensive margin (31%), which could be at least partially due to rising prices. Results based on bilateral imports are more pronounced than the results based on aggregate imports: this shows that imports to the UK declined by 15.6% at extensive margins and by 29.5% at intensive margins.

Table 2: Causal impact of TCA at extensive and intensive margins

	Extensive margins			Intensive margins		
	DID	SC	SDID	DID	SC	SDID
A: UK imports from EU						

τ	-0.1	-0.07	-0.09	-0.03	-0.1	-0.09
Δ, %	-9.5	-6.8	-8.6	-3.0	-9.5	-8.6
σ_τ	(0.07)	(0.14)	(0.07)	(0.15)	(0.16)	(0.19)
B: UK imports from ROW						
τ	-0.02	0.002	0.01	0.28	0.16	0.27
Δ, %	-2.0	0.2	1.0	32.3	17.4	31.0
σ_τ	(0.07)	(0.12)	(0.06)	(0.29)	(0.32)	(0.30)
C: UK exports to EU						
τ	-0.57***	-0.52***	-0.55***	0.21	0.17	0.18
Δ, %	-43.4	-40.5	-42.3	23.4	18.5	19.7
σ_τ	(0.10)	(0.11)	(0.12)	(0.21)	(0.31)	(0.30)
D: UK exports to ROW						
τ	-0.07	-0.03	-0.03	0.02	0.11	0.06
Δ, %	-6.8	-3.0	-3.0	2.0	11.6	6.2
σ_τ	(0.10)	(0.10)	(0.09)	(0.21)	(0.28)	(0.32)
E: Bilateral UK imports						
τ	-0.17***		-0.17***	-0.35***		-0.35***
Δ, %	-15.6		-15.6	-29.5		-29.5
σ_τ	(0.01)		(0.01)	(0.05)		(0.05)
F: Bilateral UK exports						
τ	-0.64***		-0.64***	0.38***		0.38***
Δ, %	-47.3		-47.3	46.2		46.2
σ_τ	(0.06)		(0.06)	(0.08)		(0.08)

Notes: τ represents the causal change in the respective trade flow margin post Dec 2020. Jackknife standard errors in parentheses. For aggregate results the treated unit is the UK trade flow margin. For bilateral results, the treated units are all bilateral trade flow margins where the UK is the sourcing unit for exports and the recipient unit for imports. Significant at * 5%, ** 1%, *** 0.1%

7. Conclusion

This paper provides three insights on UK trade post-Brexit. First, we update Du and Shepotylo's (2022) assessment of the TCA impact on UK trade. By using data up to 2022Q1, we show that the negative, large, and statistically significant impact of the TCA on UK exports has persisted and even slightly deepened into 2022. This highlights the continuing export challenges that UK firms have faced since the TCA was put in force and underscores the need to systemically think about the UK's post-Brexit trade policy.

Second, unlike exports, the negative impact of the TCA on imports has been subsiding. Although there is a confluence of many factors that might explain the Brexit imports puzzle, it appears to be more of a teething problem. The reduction in import bottlenecks might help exports to rebound, although the rising costs of imports are likely to offset the effect of that recovery.

Third, the UK has experienced a significant contraction in its trading capacity in terms of the varieties of goods being exported to the EU due to the TCA. An estimated loss of 42% of product varieties over the 15 months since Brexit, combined with an increased concentration of export values to fewer products, signify some serious long-term concerns about the UK's future exporting and productivity.

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Appendix 1: Methodology of assessing the causal impact of TCA on UK trade

This section largely draws on Du and Shepotylo (2022).[14] We apply Synthetic Difference-in-Difference (SDID) methodology (Arkhangelsky et al., 2021). A detailed discussion about the pros and cons of the various modelling options can be seen in Du and Shepotylo (2021) and Du and Shepotylo (2022).

SDID combines the strengths of the DID and SC methods. It estimates the causal inference parameter of interest using a two-way fixed effect (TWFE) regression specification, which allows for making proper inferences about the significance of the coefficient. However, it does not treat all units and time periods equally. Like SC, it uses a pool of donors to construct a counterfactual scenario using the optimally selected weights, so only some countries have non-zero weights. In addition, it weights more heavily the pre-treatment periods that are more similar to the post-treatment period, making it a doubly robust method. These modifications make SDID more efficient by locally fitting the model parameters relative to DID. Essentially, it boosts the internal validity of the causal impact estimate at the expense of the external one. We consider this feature to be a strength, as our main goal is to measure the causal impact of the TCA on the UK as precisely as possible.

We follow the literature and introduce the latent factor model, describing total export/import to EU and non-EU countries thus:

$$T_{it}^R = \gamma_i^R v_t'^R + \tau^R \times TCA_{it} + \epsilon_{it}^R$$

where i is the reporting country at time t. $R \in \{EU, ROW\}$ indicates the aggregate partner region: the European Union (EU) and the Rest of the World (ROW). The outcome variable T_{it} is the natural log of either export or import. γ_i is a $1 \times K$ vector of latent unit factors and v_t is a $1 \times K$ vector of latent time factors. TCA_{it} is the TCA indicator, which takes value 1 for the UK after 1 January 2021, and 0 otherwise. τ is the average causal effect of exposure, which is the main variable of interest, interpreted as the causal impact of the end of the transition period on trade. While the structure seems restrictive, it is nevertheless sufficiently flexible and nests a standard two-way fixed effect model among its possible specifications.

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[14] See "TCA, Non-tariff Measures and UK Trade" at https://www.enterpriseresearch.ac.uk/wp-content/uploads/2022/06/ERC-ResPap98-TCA-Non-tariff-Measures-and-UK-Trade-Du-Shepotylo.pdf.

More formally, we observe trade for T period for a balanced panel of N units. Without loss of generality, the first N_c units are never exposed to a treatment. The remaining $N_{tr} = N - N_c$ units are exposed to the treatment after time $T_{pre} \leq T$. The SDID estimator constructs the doppelganger synthetic control from the pool of never-treated units using weights $\hat{\omega}_i^{sdid}$ that trace the actual outcome of the treated group before T_{pre}. It also selects time weights $\hat{\lambda}_t^{sdid}$ to balance the pre-treatment and post-treatment time periods. The role of time weights is to remove the bias stemming from comparing the post-treatment periods with pre-treatment periods that are very different for the whole sample of control units. The time- and pair-specific weights are further applied to the standard difference-in-difference estimator in a two-way panel as follows:

$$(\hat{\tau}^{sdid}, \hat{\mu}_1, \hat{\alpha}_1, \hat{\beta}_1) = \arg \min_{\tau, \mu, \alpha, \beta} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} (T_{it}^R - \mu - \alpha_i - \beta_t - \tau^R \times TCA_{it})^2 \hat{\omega}_i^{sdid} \hat{\lambda}_t^{sdid} \right)$$

SDID uses weights to emphasise units and time periods that are comparable to the treated units in the post-treatment period. The weights for the synthetic control are selected to follow closely the pre-treatment trend of the treated units. In addition, a penalty is imposed on using too many units for comparison. The unit weights are estimated as the outcomes of the following optimisation problem:

$$\left(\omega_0, \hat{\omega}^{sdid} \right) = \arg \min_{\omega_o \in R_1, \omega \in \Omega} \sum_{t=1}^{T_{pre}} \left(\omega_0 + \sum_{i=1}^{N_c} \omega_i T_{it}^R - \frac{1}{N_{tr}} \sum_{i=N_c+1}^{N} T_{it}^R \right)^2 + \xi^2 T_{pre} ||\omega||_2^2,$$

where $\Omega = \{\omega \in R_+^N : \sum_{i=1}^{N_c} \omega_i = 1, \omega_i = \frac{1}{N_{tr}} \text{ for all } i = N_c + 1, \dots, N\}$.

Appendix 2: Methodology of estimating different margins of trade

Consider the economy populated by firms that vary in productivity φ, drawn from a common and ex ante known distribution G. Following Melitz (2003), trading is costly and requires paying fixed costs f_{EXP} and f_{IMP} for exporting and importing respectively. Suppose that prior to TCA, the fixed costs of exporting and importing to EU were f_{EXP}^0 and f_{IMP}^0 respectively. Because non-tariff measures may significantly increase fixed costs of exporting, we further assume that post-Brexit fixed costs of trade set by TCA are $f_{EXP}^1 > f_{EXP}^0$ and $f_{IMP}^1 > f_{IMP}^0$. It follows the exogenous increase in the fixed costs of trading causes the productivity thresholds that separate traders from non-traders to increase: $\tilde{\varphi}_{EXP}^1 > \tilde{\varphi}_{EXP}^0$ for exports and $\tilde{\varphi}_{IMP}^1 > \tilde{\varphi}_{IMP}^0$ for imports. As a result of higher fixed costs for exporters and importers, we expect a lower number of product varieties (extensive margins) to be exported to EU and imported from EU post-Brexit. At the same time, firms that stay in international trading face lower competition and may increase their average exports and imports per variety (intensive margins).

More precisely, we define variety as a product k exported (imported) to country j. Total export (import) of country i at time t is the sum of exports (imports) of varieties. It can be broken into extensive and intensive margins as follows:

$$X_{it} = \sum_j \sum_k x_{ij,t}^k = N_{it} * \bar{x}_{it} \tag{1}$$

where N_{it} represents total number of varieties exported (imported) from country i at time t (extensive margin), and $\bar{x}_{it}$ represents average value per exported variety (intensive margin). Furthermore, the change in the total export (import) can be represented by the changes in extensive and intensive margins as follows:

$$\frac{dX_{it}}{X_{it}} = \frac{dN_{it}}{N_{it}} + \frac{d\bar{x}_{it}}{\bar{x}_{it}} \tag{2}$$

Which can be used to decompose growth in trade into components:

$$\% \Delta Trade = \% \Delta Extensive\ margins + \% \Delta Intensive\ margins \tag{3}$$

Representation (3) is useful, because, as discussed above, changes in trade driven by the extensive margins are related to factors that alter the fixed costs of trade, while changes in the intensive margins are relative to changes in variable costs of trade (i.e., tariffs) or to variety level changes in technologies or to price shocks.

We perform trade flow decomposition (1) and calculate the extensive and intensive margins of trade, and perform analysis on the causal impact of TCA on the extensive and intensive margins for the UK trade. The results are shown in Figures 5 and 6. Table 2 reports the causal impact of TCA.