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## **UK trade in the wake of Brexit**

Rebecca Freeman  
Kalina Manova  
Thomas Prayer  
Thomas Sampson



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## Abstract

This paper studies the impact of Brexit on the UK's trade with the EU relative to its trade with the rest of the world. We find no evidence that uncertainty and anticipation effects led to a significant decline in relative UK trade with the EU during the period after the UK voted for Brexit in 2016 and before the change in policy was implemented under the new Trade and Cooperation Agreement (TCA) in 2021. However, the UK's departure from the EU's single market and customs union at the start of 2021 caused a major shock to UK-EU trade. We estimate that the new TCA trade relationship led to a sudden and persistent 25% fall in relative UK imports from the EU. In contrast, we find a smaller and only temporary decline in relative UK exports to the EU, but nevertheless a large and sustained drop in the extensive margin of exports, driven by the exit of low-value relationships. The timing and asymmetry of Brexit effects on UK imports and exports is puzzling and provides evidence of important differences in adjustment to integration and disintegration shocks.

Keywords: Brexit, EU, exports, trade policy, globalisation, imports, uncertainty

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Rebecca Freeman, Centre for Economic Performance, London School of Economics. Kalina Manova, University College London, CEPR and Centre for Economic Performance at London School of Economics. Thomas Prayer, University of Cambridge. Thomas Sampson, London School of Economics, CEPR and Centre for Economic Performance at London School of Economics.

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# 1 Introduction

In June 2016, the United Kingdom (UK) unexpectedly voted to leave the European Union (EU). After prolonged withdrawal negotiations, Brexit took place on 31st January 2020, and the UK entered a standstill transition period during which its economic relationship with the EU was unchanged. It was not until 1 January 2021 that the UK left the EU's single market and customs union. On that date, the Trade and Cooperation Agreement (TCA) governing future UK-EU relations came into effect. The TCA is a free trade agreement that allows for UK-EU trade to be tariff and quota free, but does little to engender deeper integration. Consequently, its implementation has led to the re-establishment of a customs and regulatory border between the UK and the EU.

There is no historical precedent for an industrialized economy like the UK leaving a deep integration area such as the EU. Through its single market and customs union, the EU has sought to create a common economic market that allows for the free movement of goods, services, people, and capital across national borders. By some metrics, integration between EU countries even matches or surpasses observed levels of openness between the 50 states of the United States (Head and Mayer, 2021). Therefore, Brexit provides a novel opportunity to analyse the effects of unravelling deep integration (Sampson, 2017).

In this paper, we study the impact of Brexit on trade in goods between the UK and the EU. Our objective is to document how disintegration affects trade flows. We examine both the period before 2021 when there was uncertainty over what form Brexit would take, and the period from January 2021 onwards when the introduction of the TCA created new bilateral trade barriers between the UK and the EU. This allows us to estimate the trade effects of both news about a future, but uncertain, trade cost increase, and of the implementation of higher trade barriers under the TCA.

Our premise is that bilateral trade flows are determined by supply conditions in the exporting country, demand conditions in the importing country, and bilateral trade openness (Head and Mayer, 2014). Our empirical strategy seeks to identify how Brexit has affected UK-EU trade activity primarily through changes in bilateral openness. In particular, we perform a difference-in-differences event study that compares the evolution of the UK's trade with the EU to UK's trade with the rest of the world (ROW) and thereby controls for concurrent changes in exporter supply and importer demand.

We employ product-time fixed effects to absorb shocks to both UK-specific and global supply and demand conditions, and product-region fixed effects to absorb permanent differences in the level of the UK's trade with the EU and the ROW. We also control for product-specific supply and demand conditions in the EU and the ROW using data on US and EU trade with the two regions. We ensure the estimates are not biased by changes in the sectoral composition of trade, by analysing trade at the detailed 4-digit product level for around 1,200 products.

We establish three main empirical facts. First, UK's trade with the EU and the ROW followed broadly similar patterns not only before the referendum, but also between the referendum and the introduction of the TCA in 2021. Although the UK remained in the single market and customs union

throughout this period, Brexit could still have affected UK-EU trade through heightened uncertainty and forward-looking responses to expected future increases in UK-EU trade barriers. The evidence instead reveals that anticipation and uncertainty effects are weaker for disintegration events than for trade liberalisation, possibly because firms that have paid sunk market access costs do not respond to the threat of higher trade costs before it materialises. Of note, UK trade with both EU and ROW countries fell sharply but recovered quickly between Brexit and the introduction of the TCA, in sync with Covid-19 shocks.

Second, the implementation of the TCA triggered a small and only temporary decline in relative UK exports to the EU in 2021. These sharply fell in January, immediately following the introduction of the TCA, but quickly recovered within half a year. Nevertheless, the start of the TCA led to a large and persistent drop in the extensive margin of relative UK exports to the EU, as measured by the number of observed export relationships. The estimates imply that the TCA has reduced the number of 8-digit product-country varieties exported to the EU each quarter by around 30%, and this contraction is driven by the destruction of low-value trade relationships. Consequently, it would be a mistake to interpret the missing export value effect as evidence that UK exporters were unaffected by the introduction of the TCA. Instead, we conjecture that the TCA has increased the fixed costs of exporting to the EU, causing small exporters to exit small EU markets, but not (or at least not yet) severely hampering exports by large firms that drive aggregate export dynamics.

Third and in sharp contrast, the implementation of the TCA led to a deep and sustained fall in relative UK imports from the EU. UK imports from the EU abruptly declined by about 25% more than UK imports from the ROW after the TCA came into effect, and this decline persisted throughout 2021. The fall in relative imports comes from contractions along both the extensive and intensive margins of trade with the EU, but the extensive margin effect is smaller than for exports. This is consistent with the TCA causing a substantial increase in UK-EU trade costs and leading to a shift in UK import activity away from the EU. We surmise that the asymmetric response of UK imports and exports may relate to UK firms making interdependent input sourcing decisions across origin countries, yet independent sales decisions across destination markets.

We pursue several analyses to inform the adjustment mechanisms driving the impact of Brexit on UK trade flows. We first explore whether the TCA exerts differential effects across products with different Brexit exposure. Measuring product-level exposure is challenging because of the difficulty of quantifying trade policy uncertainty and the magnitude of non-tariff barriers. We analyse heterogeneity based on the tariff and non-tariff barriers that the EU imposes on its non-preferential trading partners. These external barriers provide a measure of trade policy uncertainty following the Brexit referendum and may be correlated with the potential future increase in non-tariff barriers under the TCA. We find that UK trade with the EU and the ROW behaved similarly between the referendum and the TCA across products facing different levels of trade policy uncertainty. Under the TCA, however, relative UK exports to the EU fell more for products with higher EU trade policy barriers, particularly on the extensive margin, while the decline in imports was roughly uniform across

products.

We further examine the TCA's effect for different types of goods. Classifying products into capital, intermediate, and consumption goods, we find that the stability in the value of UK exports to the EU relative to the ROW masks an increase in exports of capital and, to a lesser extent, of intermediate goods, and an offsetting reduction in exports of consumer goods. By contrast, the decline in the UK's relative imports from the EU is broad-based across all types of goods.

Although our work provides novel evidence on the trade effects of Brexit, there are a number of caveats to consider when interpreting the results. The sample ends in 2021, meaning that we only analyse the first year of trade under the TCA and do not capture its long-run effects. Our findings may, in part, reflect temporary changes as firms adjust to the new trading environment. We intend to update the paper as more data becomes available. In addition, our estimation strategy is designed to capture the direct effect of Brexit on the UK's trade with the EU relative to its trade with the rest of the world. We do not analyse whether Brexit has indirectly affected the UK's trade with the rest of the world through general equilibrium adjustments or supply chain linkages. Finally, we only study trade in goods and leave the equally important question of how Brexit has affected trade in services to future work.

This paper contributes to the recent empirical trade policy literature that studies how economies respond to higher trade barriers, a question that has become increasingly important following Brexit and the US-China trade war.<sup>1</sup> The key difference between Brexit and other disintegration shocks is the depth of capital, labour, goods and services market integration that existed while the UK was part of the EU. Beyond the regulatory alignment of these markets, also striking is the extent of cross-border economic activity in practice: In 2015, for example, the EU accounted for 52% of UK goods trade. By studying the impact of unravelling this integration, we provide novel evidence on the economics of deep integration.

Our work also adds to an active line of research on the multi-faceted impact of Brexit on the UK economy. Prior evidence indicates that the depreciation of the pound sterling after the UK voted to leave the EU increased import prices and the cost of living (Breinlich, Leromain, Novy and Sampson, 2022) and led to lower real wage growth (Costa, Dhingra and Machin, 2019). In addition, higher uncertainty and anticipation of future trade barrier increases led to an increase in outward foreign direct investment from the UK to the EU (Breinlich, Leromain, Novy and Sampson, 2020), fewer online job postings in regions more exposed to potential barriers to professional services exports (Javorcik, Stapleton, Kett and O'Kane, 2020), and reduced domestic investment and productivity (Bloom et al., 2019; Hassan, Hollander, Lent and Tahoun, 2021). This led to a slowdown in GDP growth (Born, Müller, Schularick and Sedláček, 2019). Dhingra and Sampson (2022) review the literature on the economic effects of Brexit before the TCA came into effect.

Our results speak most directly to a growing literature on the trade effects of Brexit. Early work has

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<sup>1</sup>See for example Amiti, Redding and Weinstein (2019) and Fajgelbaum, Goldberg, Kennedy and Khandelwal (2020) for evidence on the US-China trade war.

found that products more exposed to Brexit uncertainty experienced lower trade growth both before and immediately after the referendum (Ahmad, Limão, Oliver and Shikher, 2020; Crowley, Exton and Han, 2020; Graziano, Handley and Limão, 2021). Our findings imply that these initial adjustments did not generate sufficiently large changes in trade values to shift the aggregate geography of UK trade.

The primary contribution to this literature is to estimate the short-term impact of different Brexit milestones including the referendum, the UK’s formal departure from the EU, and the subsequent TCA on UK-EU trade. This allows us to compare the effect of realized trade barrier increases under the TCA with the effect of expected, but uncertain, rises in future trade barriers after the referendum. Our estimates show that the UK’s trade with the EU relative to the ROW changed little before 2021, but then declined sharply (at least on the import side) once the TCA came into effect. Ayele, LARBalestier and Tamberi (2021) reach a similar conclusion in their analysis of the TCA. Our findings are also consistent with the predictions of Steinberg (2019), who uses a calibrated dynamic trade model to study Brexit through the lens of uncertainty. In Steinberg’s simulations, the referendum exerts a very small effect on trade until Brexit takes place, but UK-EU trade falls sharply thereafter.

Our empirical strategy isolates the effects of Brexit on bilateral openness between the UK and the EU, but does not attempt to capture general equilibrium effects caused by changes in exporter supply and importer demand conditions. Synthetic control estimates suggest that the TCA has lowered aggregate UK exports (as well as imports), by reducing trade with both the EU and the ROW (Springford, 2022). As the TCA only applies to trade with the EU, we would expect any trade effects of the TCA to be greater for EU trade. Therefore, our finding that the TCA did not reduce EU exports relative to ROW exports raises the question of whether the observed fall in aggregate exports should be attributed to the TCA or to other shocks in UK export supply conditions.

It may be several years before the economy fully adjusts to the increase in trade, investment and migration barriers under the TCA, and we intend to extend the analysis as more data becomes available. In the long run, such estimates will be useful for evaluating ex-ante forecasts of the economic effects of deep disintegration based on quantitative trade models (e.g. Bevington et al. (2019); Dhingra et al. (2017) and, thereby, for improving the next generation of trade policy models.

The remainder of the paper is organised as follows. Section 2 provides a timeline of Brexit events. Section 3 outlines the empirical strategy, before Section 4 introduces the data. Section 5 presents the main estimation results for trade values, while Section 6 explores underlying mechanisms by analysing different trade margins and product heterogeneity. Finally, Section 7 concludes.

## 2 Brexit Timeline

On 23 June 2016 the UK held a referendum on whether to remain in the EU. Opinion polls predicted a close vote, while betting markets were confident that voters would end up backing the status quo (Sampson, 2017). However, the campaign to leave the EU won an unexpected victory with 52% of

the vote. The Leave vote was followed by sharp falls in both the UK stock market and the value of sterling, and the resignation of Conservative Prime Minister David Cameron.

Not only did the referendum set the UK on the path to Brexit, but it created significant uncertainty about the future relationship between the UK and the EU. When would the UK leave the EU? What form would future UK-EU relations take? Would the UK remain in the EU's single market or in a customs union with the EU? Would the UK leave the EU without any negotiated agreement? The referendum provided no answers to these questions.

Debate over what form Brexit should take dominated UK politics for the next four years.<sup>2</sup> The EU was willing to maintain a close relationship, but insisted that the freedoms of the single market were indivisible: the UK could not have frictionless trade in goods and services without also accepting free movement of people (EESC, 2017).

Faced with this trade-off, the UK government, led by new Prime Minister Theresa May, prioritised controlling immigration and removing the UK from the jurisdiction of the European Court of Justice, while also attempting to maintain a close trading relationship (May, 2017). But after losing her majority in a snap election in June 2017, May lacked parliamentary support for her vision of Brexit. In early 2019, parliament thrice voted down the withdrawal agreement May had negotiated with the EU, forcing the planned Brexit date of 29 March 2019 to be postponed and leading to May's resignation.

May was succeeded as Conservative party leader and Prime Minister by Boris Johnson, who, unlike May, had supported the Leave campaign. Johnson renegotiated the withdrawal agreement and then won an election in December 2019 with the slogan "Get Brexit Done". This success allowed Johnson to pass the revised withdrawal agreement, and the UK eventually left the EU on 31 January 2020, three and a half years after the referendum.

The withdrawal agreement included a financial settlement, protections for UK citizens living in the EU and vice versa, and provisions designed to guard peace in Northern Ireland.<sup>3</sup> However, it did not set the terms of the post-Brexit trade relationship between the UK and the EU. Instead, it provided for a transition period until the end of 2020, during which the UK would remain in the single market and customs union while the future relationship was negotiated. Although the Covid-19 pandemic hit Europe in early 2020, this transition period was not extended.

The UK government sought a new relationship that offered as much access to EU markets as possible without limiting its ability to set its own policies on immigration, trade, and economic regulation (HM Government, 2020). These objectives inevitably meant leaving the single market and

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<sup>2</sup>The abbreviated timeline here cannot hope to do justice to the twists and intricacies of the Brexit negotiations. See Dhingra and Sampson (2022) for an overview and Grey (2021) for a detailed account.

<sup>3</sup>The status of Northern Ireland under the withdrawal agreement is complex and the subject of ongoing disputes. Effectively, Northern Ireland remains in the single market for goods and has a hybrid customs status that leaves it partially in and partially out of both the EU and the UK customs areas. These arrangements ensure that there is no customs border between Northern Ireland and the Republic of Ireland, but have led to the introduction of a customs and regulatory border in the Irish Sea between Britain and Northern Ireland. Consequently, the trade effects of Brexit are likely to be different in Northern Ireland than the rest of the UK. Since Northern Ireland only accounts for around 2% of UK GDP, we do not analyse Northern Ireland's trade separately in this paper.

customs union, but left the door open to a free trade agreement. For its part, the EU proposed a zero-tariffs, zero-quotas, zero-dumping deal that would ensure UK-EU trade faced no tariffs or quotas provided that both sides adhered to level-playing-field measures designed to prevent the use of labour or environmental standards to obtain an unfair competitive advantage (Von der Leyen, 2020).

The outcome of the future relationship negotiations remained uncertain throughout 2020. If the transition period had ended without a deal, UK-EU trade would have reverted to World Trade Organization (WTO) terms, meaning goods trade would have been subject to most-favoured nation (MFN) tariffs. A deal was eventually struck on Christmas Eve 2020, coming into provisional effect 8 days later at the start of 2021.

The Trade and Cooperation Agreement (TCA) is a free trade agreement that removes all tariffs and quotas on UK-EU trade. However, compared to EU membership, it does little to promote deeper integration by reducing non-tariff barriers (NTBs) or guaranteeing market access for services. Under the TCA, the UK is outside the EU's single market and customs union. Consequently, free movement of people has ceased, and a customs and regulatory border has been introduced between the UK and the EU creating many new non-tariff barriers. These barriers include customs checks, sanitary and phyto-sanitary restrictions on trade in animal and plant products, the need to prove regulatory compliance separately in the UK and the EU, restrictions on short-term business visits, and reduced market access for service providers including the end of passporting rights for financial services. The UK initially postponed introducing full customs checks on imports from the EU, but these are scheduled to be phased in during 2022.

To obtain tariff-free, quota-free access under the TCA, products must meet rules of origin requirements. These requirements usually specify the share of a product's value that must originate in the UK or the EU to qualify to utilise the TCA. Not all goods meet these requirements, and, in some cases, the potential tariff savings from satisfying rules of origin are smaller than the costs of proving compliance. Consequently, trade under the TCA is not always completely tariff free. In the first seven months of 2021, tariffs were paid on around 30% of UK exports to the EU that could have benefitted from preferential zero tariff entry under the TCA (Ayele, Larbalestier and Tamberi, 2021).

Leaving the EU's customs union has also affected trade relations with non-EU countries. But, so far, changes in market access have been limited. Although the UK is no longer part of the EU's free trade agreements with non-member countries, it has succeeded in rolling over the EU's existing deals into mostly equivalent standalone agreements. The UK has also started to negotiate its own trade deals. It has reached free trade agreements with Australia and New Zealand, though these deals did not enter into force during our sample period. And it has applied to join the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP). Finally, the UK has replaced the EU's MFN tariff schedule with a new UK Global Tariff. The new tariff schedule is based on the EU's MFN tariffs, but includes some tariff reductions. For products for which the EU imposes ad-valorem tariffs, the simple average UK Global Tariff is 4.1%, compared to 5.1% under the EU's MFN tariff schedule.



### 3 Conceptualizing Brexit

How do we expect Brexit to affect UK trade? How can we empirically identify and quantify the causal effects of Brexit? This section outlines the conceptual framework that guides our analysis and the empirical strategy we use to implement it.

#### 3.1 Conceptual Framework

Our premise is that bilateral trade flows are determined by supply conditions in the exporting country, demand conditions in the importing country, and bilateral trade openness (Head and Mayer, 2014). Aggregate trade flows are, in turn, the sum of bilateral flows. Shocks to bilateral trade openness due to changes in trade policy directly affect bilateral trade between two trading partners. Bilateral openness shocks may also have additional indirect effects through endogenous responses in supply and demand conditions in the affected countries – and potentially even in other countries through general equilibrium forces.

In the first instance, Brexit directly affects bilateral trade openness between the UK and the EU. We interpret the Brexit timeline above in terms of three periods with distinct economic environments: Period 1 “Before” before the Referendum (prior to June 2016); Period 2 “Interim” between the Referendum and the implementation of the TCA (July 2016 through December 2020); and Period 3 “After” after the transition period, when the UK and the EU start trading under the TCA (since January 2021).

Period 1 corresponds to the status quo of UK membership in the EU’s single market and customs union, with no trade barriers within the EU, common external MFN tariffs and (mostly) common external NTBs with the rest of the world (ROW). Period 2 is characterized by a series of shocks to both the first and second moments of expectations about future trade and economic policy (Bloom et al., 2018), with no immediate change in trade costs. Specifically, the shock to expectations in period 2 raised expected future trade barriers between the UK and the EU (first moment), and also heightened uncertainty over future relations between the UK and the EU, the UK and the ROW, and (presumably to a lesser degree) the EU and the ROW (second moment).

Period 3 features higher UK-EU bilateral trade costs and continuing but reduced uncertainty about future bilateral and multilateral trade policy. Although the TCA entails zero tariffs and quotas, it introduces new trade barriers in the form of customs checks and regulatory barriers for trade in goods, as well as restricted access for trade in services (first moment). Under the TCA there is also uncertainty about the pace of the introduction and streamlining of customs checks, the extent of future regulatory divergence between the UK and the EU, and the future of UK-EU trade arrangements regarding Northern Ireland (second moment).

In general equilibrium, Brexit may also exert indirect effects that go beyond changes in trade openness to alter supply and demand conditions in the UK and in the EU. First, Brexit could trigger endogenous changes in factor and input costs. These changes may affect exporters’ supply potential

through production cost shocks, as well as import demand in destination markets through shocks to income and output prices.

Second, changes in import competition and in access to imported inputs and export markets affect firms' incentives to upgrade productivity through technological innovation or adoption (Bustos, 2011; Goldberg, Khandelwal, Pavcnik and Topalova, 2010; Lileeva and Trefler, 2010). In particular, access to foreign specialized inputs and equipment that are not available or more expensive at home is conducive to technology upgrading. Given economies of scale in productivity improvements, access to a larger export market can make such investments more profitable than they otherwise would be. In turn, higher firm productivity shapes a country's export supply potential.

Third, in the context of global production networks, firm-to-firm trade in intermediates constitutes a large share of aggregate trade flows. Moreover, buyer-supplier production networks are sparse, with evidence pointing to significant costs in matching and transacting with foreign partners (Bernard and Moxnes, 2018; Bernard, Moxnes and Ulltveit-Moe, 2018). Disruptions to bilateral trade openness can thus impact export supply and import demand in both the UK and the EU through cross-country interdependencies in firm-level sourcing decisions and through the impact of sourcing on production costs. For instance, Brexit may cause UK firms to lower their demand for EU inputs relative to non-EU inputs. To the extent that such reorganization of input sourcing lowers production efficiency (at least in the short term), this would reduce the export supply potential of UK firms. Such interdependencies across countries are less likely to operate on the sales side, i.e. in the way firms decide where to sell their output, unless firms face capacity constraints in production or synergies in distribution costs across markets.

It is not ex-ante obvious how quickly these direct and indirect effects of Brexit will lead to UK firms adjusting their trade activity. To the extent that trade depends upon forward looking decisions that require sunk cost investments, expectations about future trade costs can affect current trade flows (Handley and Limão, 2015, 2017, 2022). Although not previously examined, the speed and magnitude of these responses presumably depend not only on knowledge about the expected new steady state, but also on firms' capacity and incentive to transition to it in the short and long term. For example, adjustment is likely to be more rapid when firms face no credit or capacity constraints.

In the case of trade liberalization, the literature has shown increases in aggregate trade flows in anticipation of new preferential agreements coming into force (Egger, Larch and Yotov, 2022). Further, aggregate trade flows often increase gradually as firms make sunk-cost investments in market entry and undertake product customization and technology upgrading (Albornoz, Calvo Pardo, Corcos and Ornelas, 2012; Das, Roberts and Tybout, 2007). The recent literature on firm-to-firm production networks finds that matching costs are key to understanding endogenous network formation, which suggests that buyer-supplier matching likely plays a critical role in the adjustment to expansionary trade policy.

Less is known about how quickly firms adjust to disintegration shocks, such as Brexit. Scaling down trade flows does not require new sunk-cost investments in market entry, which may lead to faster

adjustment than when firms are scaling up trade. On the other hand, firms that have made sunk-cost investments may retain existing trade links even if these become less profitable due to higher trade costs, so long as the expected value of their future profits outweigh marginal costs of production and potential exit costs. In this case, changes in trade may occur primarily on the extensive margin of entry leading to slower adjustment. The speed of adjustment may also depend upon the ease with which firms can form new relationships with suppliers and buyers in other markets, which will differ across products and between exporters and importers.

In sum, we can distinguish between three conceptually separate effects of Brexit on trade: (i) a response to uncertainty about future changes in trade openness; (ii) an anticipatory response to future expected changes in openness, and; (iii) an impact response to realised changes in openness when Brexit is implemented. These effects operate first and foremost through changes to UK-EU bilateral trade openness, with the potential for additional endogenous changes to UK and EU export supply potential, import demand and trade openness with the ROW. During the Interim period between the Referendum and the introduction of the TCA, effects (i) and (ii) operate. The After period starting in 2021 is likely to be dominated by effect (iii) as new trade policies are implemented, with some remnants of (i) and (ii) due to ongoing uncertainty and some policy changes being phased in gradually.

### 3.2 Empirical Strategy

We aim to identify the causal impact of Brexit on the UK’s bilateral trade openness with the EU. To this end, we first perform an agnostic difference-in-difference event study that evaluates the evolution of UK bilateral trade flows with the EU over time, relative to UK trade flows with the ROW. We then consider a series of split sample and triple-difference exercises that exploit various dimensions of heterogeneity in the data to inform underlying mechanisms of interest.

We analyse goods trade at the HS 4-digit (HS4) product level to alleviate concerns with estimation bias arising from changes in the sectoral composition of exports and imports. We work at the quarterly frequency for the period 2013 Q1 through 2021 Q4 to guard against measurement noise and lumpiness in monthly trade flows. This corresponds to 14 quarters in the Before period (2013 Q1 – 2016 Q2), 18 quarters in the Interim period (2016 Q3 – 2020 Q4), and 4 quarters in the After period (2021 Q1 – 2021 Q4).

We estimate the following baseline specifications for UK exports and imports, respectively:

$$\ln X_{pct}^{UK} = \sum_t \beta_t D_t EU_c + \gamma \ln X_{pct}^{US} + \delta \ln X_{pct}^{EU} + \alpha_{pc} + \alpha_{pt} + \varepsilon_{pct}, \quad (1)$$

$$\ln M_{pct}^{UK} = \sum_t \beta_t D_t EU_c + \gamma \ln M_{pct}^{US} + \delta \ln M_{pct}^{EU} + \alpha_{pc} + \alpha_{pt} + \varepsilon_{pct}. \quad (2)$$

In equation (1), the outcome  $\ln X_{pct}^{UK}$  is log UK exports by product  $p$ , quarter  $t$ , and region  $c = EU, ROW$ , where bilateral trade flows with EU members and non-EU countries have been aggregated

up to two country blocs, EU and ROW, both excluding the UK. The main estimates of interest are the quarter-specific coefficients  $\beta_t$  on a full set of interactions of binary indicators for each quarter,  $D_t$ , with a binary indicator for the EU bloc of countries,  $EU_c$ . We cluster standard errors by HS4 product-region pair to account for correlated supply and demand shocks at that level. Specification (2) is the analogous specification for the value of UK imports.

To help isolate the causal effect of Brexit on UK-EU relative to UK-ROW trade, specification (1) features a stringent set of fixed effects and controls. Product-quarter pair fixed effects,  $\alpha_{pt}$ , absorb global trends in product-specific supply and demand conditions, such as the global Covid-19 waves in 2020 and 2021. These fixed effects also control for export supply conditions in the UK, including changes in export supply due to Covid-19 disruptions, under the assumption that the same forces are relevant for UK exports to the EU and the ROW. Product-region pair fixed effects,  $\alpha_{pc}$ , account for permanent differences in product demand between the EU and the ROW.

We also proxy for differential changes in product-specific demand conditions in the EU versus the ROW using data on each region’s imports from the US and the EU. To this end, specification (1) includes log US exports by product, quarter and region,  $\ln X_{pct}^{US}$ , where, with some abuse of notation, the relevant regions are now the EU and the ROW excluding both the US and the UK. Symmetrically, we control for log EU exports by product, quarter and region,  $\ln X_{pct}^{EU}$ , to the EU and the ROW without the UK.

Through the lens of the conceptual framework above, the coefficient estimates  $\beta_t$  from specification (1) provide a flexible, agnostic assessment of the differential change in UK bilateral exports to the EU versus the ROW as Brexit unfolded. We highlight three features of specification (1). First, it does not impose three delineated time periods corresponding to Before, Interim and After in the Brexit timeline, but instead lets the data speak. This is informative as it can reveal the dynamics of gradual trade adjustment.

Second, equation (1) quantifies the overall response in trade flows regardless of the driving mechanism. In particular, it accommodates the role of both changes in expectations about future trade costs and changes in actual trade costs. Given the Brexit timeline, one expects the estimates for quarters during the Interim period to capture only the former, and those for quarters in the After period to reflect predominantly (if not only) the latter.

Finally, estimates of  $\beta_t$  in the Interim and After periods arguably isolate the effect of Brexit that operates specifically through changes in UK-EU bilateral trade openness, since the regression controls for concurrent changes in supply and demand conditions in all three markets. Thus  $\beta_t$  do not capture potential general equilibrium effects triggered by Brexit that act through endogenous adjustments in these supply and demand conditions. The difference-in-difference setup implies that neither do they distinguish between trade destruction with the EU and trade diversion to ROW countries.

Interpreting the economic magnitude and statistical significance of the coefficients  $\beta_t$  requires normalizing one of these estimates. We choose as the benchmark the quarter immediately preceding the Brexit referendum, 2016 Q2, such that all subsequent differential movements in UK exports to the

EU versus the ROW are gauged against the Before period. Robustness analysis indicates that this is a more conservative benchmark than the alternative of 2020 Q4 immediately prior to the introduction of the TCA.

In order to shed light on the mechanisms through which Brexit affects UK trade activity, we complement the baseline agnostic analysis with a series of sensitivity checks and extensions. These take the following generalized form:

$$\ln V_{pct}^{UK} = \sum_t \beta_{1t} D_t EU_c + \sum_t \beta_{2t} D_t EU_c P_p + \gamma \ln V_{pct}^{US} + \delta \ln V_{pct}^{EU} + \Phi Y_{pct} + \alpha_{pc} + \alpha_{pt} + \varepsilon_{pct}. \quad (3)$$

Here  $\ln V_{pct}^{UK}$  refers to a UK export or import outcome by product, time period and country bloc, where the outcome may be the log of trade value or one of its components (e.g. product variety), and the country blocs may comprise EU and ROW or individual country partners. Whenever the trade outcome pertains to UK exports (imports), the specification controls for the corresponding metric based on US and EU exports (imports),  $\ln V_{pct}^{US}$  and  $\ln V_{pct}^{EU}$ , following the same logic as in equations (1) and (2). Different exercises add a vector of further controls  $Y_{pct}$  to rule out concerns with omitted variable bias, or include triple interactions  $\sum_t \beta_{2t} D_t EU_c P_p$  that evaluate the differential evolution of UK trade with the EU versus the ROW across products with different characteristics  $P_p$ , e.g. product-level measures of the EU’s MFN tariff and non-tariff barriers.

## 4 Data

We collect detailed data on UK trade with EU and non-EU countries to analyse the evolution of UK exports and imports across key Brexit milestones. We also exploit information on US and EU trade, EU trade policy, and standard product and sector characteristics. We introduce these data in this section, with further details provided in the Data Appendix.

### 4.1 UK Trade Flows

We use quarterly data on UK exports and imports over the period January 2013 - December 2021, from the UK HMRC Overseas Trade Statistics (HMRC OTS). The choice of start point ensures that several years of data prior to the referendum can be used to benchmark trade activity. The choice of end point reflects the lag with which trade statistics are released and permits expanding the analysis forward in time as more data become available. While data is published at the monthly frequency, we choose to work with non-overlapping quarterly data in the regression analysis to diminish the role of lumpy transactions and high-frequency shocks.

HMRC OTS reports UK import and export values in pound sterling by partner country and 8-digit Combined Nomenclature (CN8) product.<sup>4</sup> Our baseline analysis compares the evolution of total UK

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<sup>4</sup>In January 2021, the underlying data source for exports from Great Britain (but not Northern Ireland) to the EU

trade with the EU to total UK trade with the ROW, after grouping all EU and all non-EU countries into two country blocs. We also consider bilateral imports and exports explicitly in sensitivity checks. We aggregate trade flows to the HS4 product level in order to allow for a stable product definition over time; overall there are 1,221 HS4 products in our dataset. We also use data on trade in CN8 varieties within HS4 products to decompose changes in trade values into the extensive and intensive margins of trade.

## 4.2 US and EU Trade Flows

We require data on US and EU trade with EU and ROW countries to construct proxies for supply and demand conditions in these two regions. We obtain information on monthly US imports and exports by partner country and 10-digit Harmonised Tariff Schedule product from the Monthly International Trade Dataset maintained by the US Census Bureau. Likewise, we obtain monthly EU trade by country and CN8 product from the Eurostat Comext Database. We aggregate these US and EU data to two country groups (EU and ROW) at the HS4 level and quarterly frequency, in symmetry with the UK data.

## 4.3 Trade Policy

For some specifications we include product-level measures of UK and EU trade policy. We calculate changes in the UK's MFN tariffs in January 2021 using UK Department of International Trade data on the new UK Global Tariff. We compute the ad-valorem tariff reduction as the average decrease in ad-valorem tariffs, comparing the UK Global Tariff to the EU's MFN tariffs, across CN8 products within an HS4 product category. And we construct a non-ad-valorem tariff change dummy equal to one whenever the UK Global Tariff changed the non-ad-valorem component of any CN8 tariff within an HS4 product category.

We also obtain data on the EU's MFN tariffs by 10-digit product and its non-tariff barriers by CN8 product from the UNCTAD Trade Analysis Information System (TRAINS), accessed through the World Bank World Integrated Trade Solution (WITS) platform. We use applied policy measures in 2015, the last year before the Brexit referendum. The TRAINS data provides binary indicators at the product-level of whether MFN imports face different classes of NTBs, such as types of sanitary and phyto-sanitary measures or technical barriers to trade. Given the difficulty of measuring and quantifying NTBs, this data is likely not comprehensive and does not indicate the intensity of different NTBs.

We aggregate trade policy measures to the HS4 level to match the trade data. For tariffs, we take the simple average across all tariff lines within an HS4 category. For NTBs, we count the average number of NTBs that apply to a CN8 code within an HS4 product category. Tariffs and NTBs exhibit significant variation across products, as illustrated in Table 1. The mean EU MFN tariff in 2015 was

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changed from Intrastat surveys to customs export declarations. In future work using firm-level data, we plan to analyse whether the change in data collection methods led to any systematic bias in measured trade flows with the EU.

5.4%, almost double the median of 3%. The mean number of EU NTBs applied against the rest of the world in 2015 was just under roughly 7, close to twice the median of 4. The correlation between the EU’s MFN tariffs and NTBs at the HS4 level is 0.3.

#### 4.4 Product Types

We explore several product characteristics to investigate the impact of Brexit across different segments of the economy. In particular, we distinguish between capital, consumption and intermediate goods, as defined by the UN Broad Economic Categories (BEC) classification. We map HS6 trade flows to BEC Revision 5 product types, i.e. capital, consumption and intermediate goods, and then aggregate HS6 trade flows to the HS4 level for each BEC product type. Across years 2013-2021, 46.4% of UK exports to the EU were in intermediates, while 33.5% and 20.1% were in consumption and capital goods, respectively. The composition of UK imports from the EU was similar, with 41.2%, 38.4% and 20.5% of imports falling into intermediate, consumption and capital goods categories, respectively.<sup>5</sup>

**Table 1:** Summary Statistics

Row		Mean	SD	Min	Median	Max	Observations
(1)	UK Export Value (m£)	30.5	169.5	0.0	3.1	5,478.0	85,720
(2)	UK Export Varieties (#)	100.8	152.3	1.0	50.0	2,024.0	85,736
(3)	UK Import Value (m£)	44.0	224.1	0.0	5.6	10,734.4	85,479
(4)	UK Import Varieties (#)	55.8	82.3	1.0	28.0	980.0	85,498
(5)	EU MFN Tariff (%)	5.4	9.8	0.0	3.0	139.5	87,616
(6)	EU NTBs (#)	6.7	7.1	0.0	4.2	55.8	88,260
(7)	UK MFN Advalorem Tariff Reduction (%)	1.3	1.9	0.0	0.6	17.4	86,824
(8)	UK MFN Non-Advalorem Tariff Change	0.1	0.2	0.0	0.0	1.0	87,544

Notes: This table provides summary statistics for our HS4-region-quarter dataset. Rows (1) and (3) present UK export and import values in millions of pounds. Rows (2) and (4) show the number of CN8-region varieties that the UK exports and imports. Rows (5) and (6) present EU MFN tariffs in percent, and the average number of NTBs across CN8 products within an HS4 category. Row (7) shows the reduction in ad-valorem UK MFN tariffs compared to EU MFN tariffs in January 2021. Row (8) presents a binary indicator for changes to non-ad-valorem tariff components.

## 5 UK Trade and Brexit: Agnostic Baseline

We examine the evolution of UK trade activity in response to key Brexit milestones in three steps. First, in Sections 5.1 and 5.2 we establish an agnostic baseline by documenting broad trends in the raw data and estimating conditional effects using our difference-in-difference event study described in Section 3.2. We find that Brexit did not shift UK trade away from the EU in the Interim period

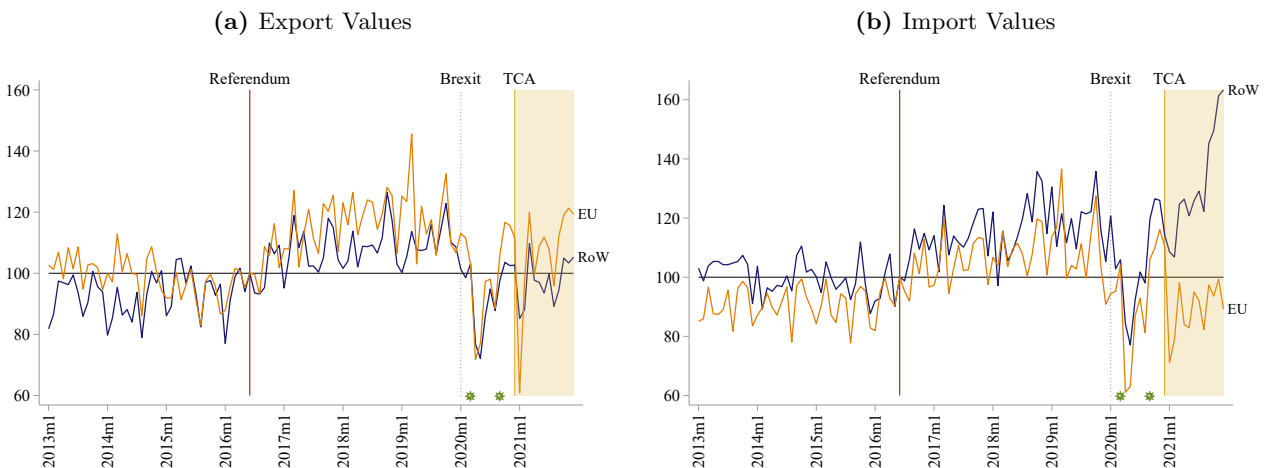
<sup>5</sup>HS6 products map to either one or two end use categories within the BEC Revision 5 classification. In cases where two end use categories are specified for a given HS6 product, we count that product for both BEC end use categories when aggregating to the HS4 level. The percentages given in the text are renormalised to sum to 100%.

after the Brexit referendum but before the introduction of the TCA. On the other hand, both exports and imports with the EU fell sharply after the TCA was introduced, with exports bouncing back but imports showing signs of persistent declines throughout our sample period. Second, in Sections 6.3 and 5.4 we confirm the robustness of this main message when considering trade partner heterogeneity and various sensitivity analyses. Finally, in Section 6 we explore a series of empirical extensions that shed light on possible mechanisms through which Brexit may have affected UK trade.

## 5.1 Broad Trends

Figure 1 shows the evolution of monthly UK trade flows with EU and ROW countries over the January 2013 – December 2021 period. Exports and imports by country bloc have each been normalised to 100 in June 2016, the month of the Brexit referendum, which is indicated with a solid vertical line. The dashed line for January 2020 identifies the UK’s withdrawal from the EU, and the yellow shaded area marks the After period, which starts with the implementation of the TCA. As the timing of the UK’s departure from the EU coincided with the Covid-19 pandemic, we also denote the start of the first and second Covid-19 waves in the UK in March and September 2020 with two green virus icons along the x-axis.

**Figure 1:** UK Trade over the Brexit Timeline



Notes: Panels (a) and (b) plot monthly aggregate UK export and import values to the EU and ROW, respectively. Values are normalised to 100 in June 2016.

Three patterns stand out in Figure 1:

***Fact 1.***—*UK trade with EU and ROW countries followed broadly similar patterns before the referendum, between the referendum and Brexit, and after Brexit until the introduction of the TCA.*

UK exports and imports both fluctuated over time but generally remained stable around a long-run average during the period prior to the referendum. They exhibited slightly higher volatility at a marginally higher midpoint after the referendum and before the UK’s official departure from the EU



in January 2020, but trade flows returned to their June 2016 baseline by 2019 Q4. Notably, the trends and the deviations from these trends are correlated and of similar magnitude for UK trade with the EU and the ROW.

***Fact 2.—UK trade with both EU and ROW countries fell sharply but recovered quickly between Brexit and the introduction of the TCA, in sync with Covid-19 shocks.***

UK exports to the EU and the ROW dropped abruptly by around 30% in the second quarter of 2020, as the first Covid-19 wave hit the UK. Imports from the EU fell by as much as 40% during this period, while imports from the ROW were less sensitive, with half as big a decline at 20%. These trade flows all bounced back quickly within two quarters, and were at or above their June 2016 baseline by the end of 2020 when the new TCA came into effect.

***Fact 3.—UK trade with EU countries fell sharply relative to UK trade with ROW countries immediately after the implementation of the TCA. Relative to UK trade with the ROW, UK exports to the EU recovered robustly during the course of 2021, while relative UK imports from the EU remained persistently lower.***

Following the introduction of the TCA, UK exports to the EU fell by close to 50% in January 2021, but regained ground in subsequent months. Some of this decline may be due to stockpiling that occurred prior to the end of the transition period. UK exports to the ROW, meanwhile, experienced a more modest decline of less than 20% before they, too, recovered. In other words, in 2021 UK exports to the EU and the ROW both continued to fluctuate around their respective benchmark point, but the oscillations in the former were roughly twice as large.

While the initial impact of the TCA on UK exports may have been transitory, the impact on UK imports appears more persistent – lasting at least through 2021 Q4. UK imports from the EU fell by almost 40% in January 2021, and remained below their June 2016 benchmark through the end of the year. This collapse was much more marked than the drop in UK imports from outside the EU in January 2021 and the gap widened further over time, particularly following rapid growth in non-EU imports in late 2021.

## 5.2 Difference-in-Differences Event Study

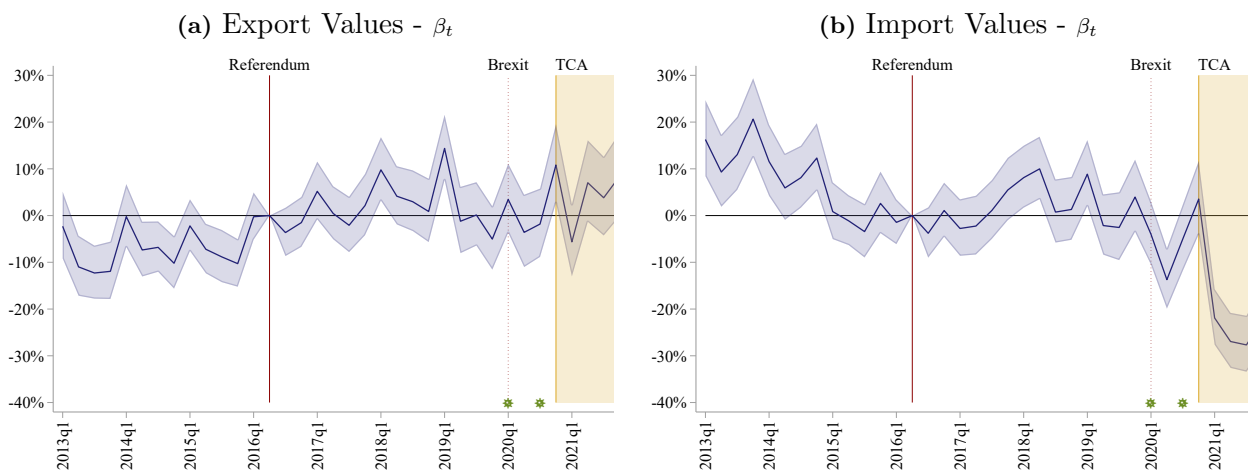
We next confront these broad trends in UK exports and imports with a formal difference-in-differences event study that compares the evolution of UK trade flows with the EU to UK trade flows with the ROW. We estimate specifications (1) and (2) for UK exports and imports respectively by HS4 product, using data at the quarterly frequency. The main estimates  $\beta_t$  quantify the differential change in UK trade activity with the EU relative to its trade activity with the ROW, and does so flexibly over time  $t$ .

Recall from Section 3.2 that these specifications include a stringent set of controls and fixed effects that absorb three aspects of export supply and import demand conditions, meaning that Brexit effects

identified by  $\beta_t$  can be attributed to changes in UK-EU bilateral trade openness. In particular, the regression controls for product-specific changes in UK and global supply and demand conditions (with product-time pair fixed effects), stable differences in supply conditions across origins for UK imports and in demand conditions across destinations for UK exports (with country bloc-product pair fixed effects), and product-specific changes in supply and demand by trade partner (with contemporaneous US and EU trade flows with the EU versus the ROW).

Figure 2 presents baseline results for UK exports (panel a) and imports (panel b) along the full Brexit timeline of interest from 2013 Q1 through 2021 Q4. We plot the estimated percent change in UK trade with the EU relative to the ROW given by  $100 * (e^{\beta_t} - 1)$ , together with the accompanying 95% confidence interval. Coefficient  $\beta_{2016Q2}$ , which demarcates the quarter of the Brexit referendum, has been normalized to 0, such that all other estimates should be interpreted as deviations in UK trade openness with the EU from its trade openness with the ROW relative to 2016 Q2. As with the summary statistics presented in Figure 1, vertical lines visually separate the three main periods of interest: Before the referendum; Interim period between the referendum and the TCA; and After the introduction of the TCA.

**Figure 2: UK Trade with EU versus ROW**



Notes: Panels (a) and (b) plot the estimated percentage changes in UK exports and imports with the EU versus the ROW relative to 2016 Q2 from specifications (1) and (2), respectively. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-region level.

Three main patterns emerge from Figure 2 that are consistent with *Facts 1-3* presented above, and can thus be seen as their econometrically rigorous equivalent. First, we find no robust evidence of significant differences in the evolution of UK trade flows with its EU versus ROW trade partners between the referendum and the implementation of the TCA (*Fact 1*). While relative UK exports and imports exhibit routine fluctuations during this period, they do not appear to have responded notably either to the referendum result or the formal Brexit departure in January 2020. Second, during 2020 UK exports to the EU and the ROW declined and recovered proportionately around the first two Covid-19 waves in the UK, while UK imports from the EU dipped relatively more but

nevertheless caught up with UK imports from the ROW by the end of 2020 (*Fact 2*). And third, UK exports to the EU relative to the ROW temporarily dropped in the quarter immediately following the implementation of the TCA, but this drop was not persistent and we do not find evidence that the TCA reduced UK exports to the EU versus the ROW from 2021 Q2 onwards. On the other hand, UK imports from the EU abruptly declined by about 25% more than UK imports from the ROW, and this decline persisted throughout 2021 (*Fact 3*). Importantly, Figure 1 suggests this effect is driven by a decline in imports from the EU rather than an increase in imports from the ROW: The estimated decline in Figure 2b occurs immediately after the introduction of the TCA and persists throughout 2021, while an increase in UK imports from the ROW is observed only in 2021 Q4 (Figure 1b).

*Facts 1-3* suggest that the referendum outcome exerted only limited anticipation and uncertainty effects on aggregate trade flows. Given that Brexit represents the first episode of an industrialized nation leaving a deeply integrated economic partnership such as the EU, this finding provides new insight implying that the anticipation effects of joining a preferential trade agreement might not be symmetric to those when leaving one. Instead, the main effect of the UK's withdrawal from the EU only materialised once actual changes in trade policy were implemented, i.e. after the transition period ended and the TCA came into force.

Through the lens of the conceptual framework in Section 3, this suggests that UK firms and their foreign trade partners saw no reason to re-optimize their trade activity in response to heightened uncertainty about future trade costs (second moment), even though the Brexit referendum also shifted up expectations about the level of these future costs (first moment). This weak response to the announcement of a negative and highly uncertain trade policy shock stands in sharp contrast to earlier evidence in the literature of notable anticipatory expansion following the announcement of positive and presumably certain trade policy shocks Egger, Larch and Yotov (2022).

A possible rationale for *Facts 1-3* is that scaling down trade activity is faster and less costly than scaling up, such that firms need not pre-emptively disrupt profitable trade relationships that may or may not become unprofitable in the future. When firms face large sunk costs in identifying foreign buyers and suppliers and cultivating those partnerships over time, it may be optimal for firms to gradually build up their partner network ahead of a known trade liberalization, but not to shrink their trade network in advance of an unknown trade de-liberalization. Once an increase in trade costs has been implemented, however, firms may decide to re-optimize to remain profitable or to dampen any loss in profitability.

*Fact 3* also reveals a surprising asymmetry in how UK exports and imports have responded to the TCA in 2021. While there has been a large decline in imports from the EU versus the ROW which persisted throughout 2021, our results do not show similar effects on exports to the EU. One potential explanation is that profit-maximizing firms make interdependent sourcing decisions across input suppliers, but independent sales decisions across buyers (barring credit or capacity constraints). On the import side, the prospect of more expensive input sourcing from the EU may induce firms to shift input purchases away from the EU towards the ROW, in order to dampen the rise in their

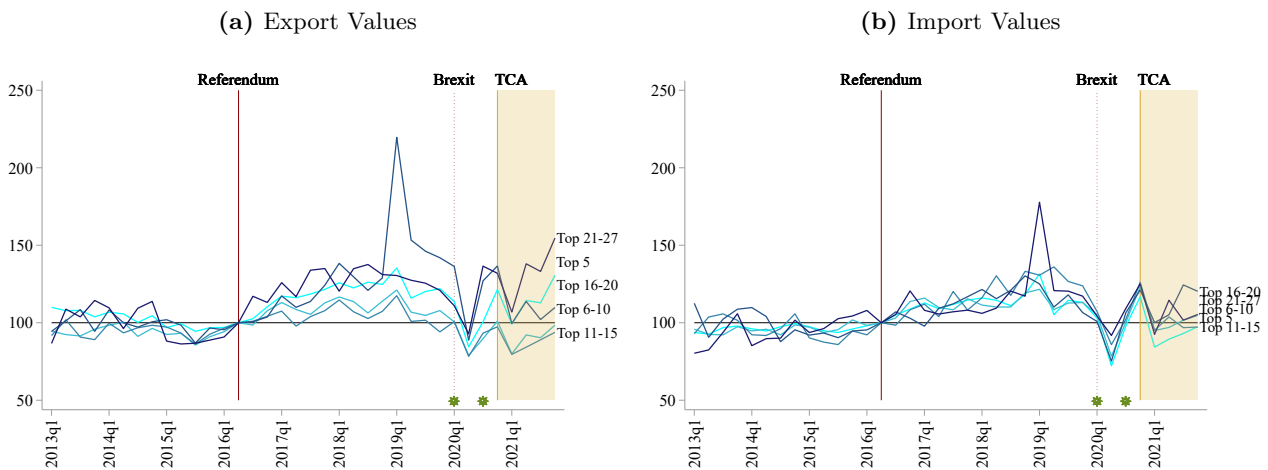
marginal production costs. To the extent that the latter nevertheless go up, lower demand for firms' output may lead them to scale down production and thereby also demand for imported inputs from any origin. On the export side, by contrast, limited changes in EU demand for UK goods in the short run (relative to non-EU demand) could explain why the UK would not alter its exports differentially to EU and non-EU partners. This would in particular hold even if UK firms see their marginal production costs increase, as this cost shock would affect global exports proportionately in the absence of capacity or credit constraints.

An alternative, and not mutually exclusive, possibility is that the *Fact 3* asymmetry reflects size differences between the UK and EU economies. Suppose that the TCA increased the fixed costs of UK-EU trade. As the EU market is larger than the UK, UK exporters might still find it profitable to pay the fixed cost of exporting to the EU, whereas for EU exporters the now higher fixed export costs might make trade with the UK unprofitable. In Section 6, we shed light on this hypothesis by examining how Brexit has affected the extensive margin of UK-EU trade.

### 5.3 Trade Partner Heterogeneity

We next examine the potential role of trade partner heterogeneity in shaping the sensitivity of UK trade flows to Brexit events. We consider two possibilities: First, whether Brexit has impacted UK trade activity with different EU member countries to varying degrees depending on their rank in UK exports and imports, and second, whether heterogeneous market conditions among countries within the EU and ROW regions may generate composition bias in our baseline estimates. We find that cross-country heterogeneity, to the extent that it may be present, does not exert first-order effects.

**Figure 3:** UK Trade with EU Partners by Market Size Groups



Notes: Panels (a) and (b) plot quarterly aggregate UK export and import values for EU countries grouped by UK export and import values in 2015. Values are normalised to 100 in 2016 Q2.

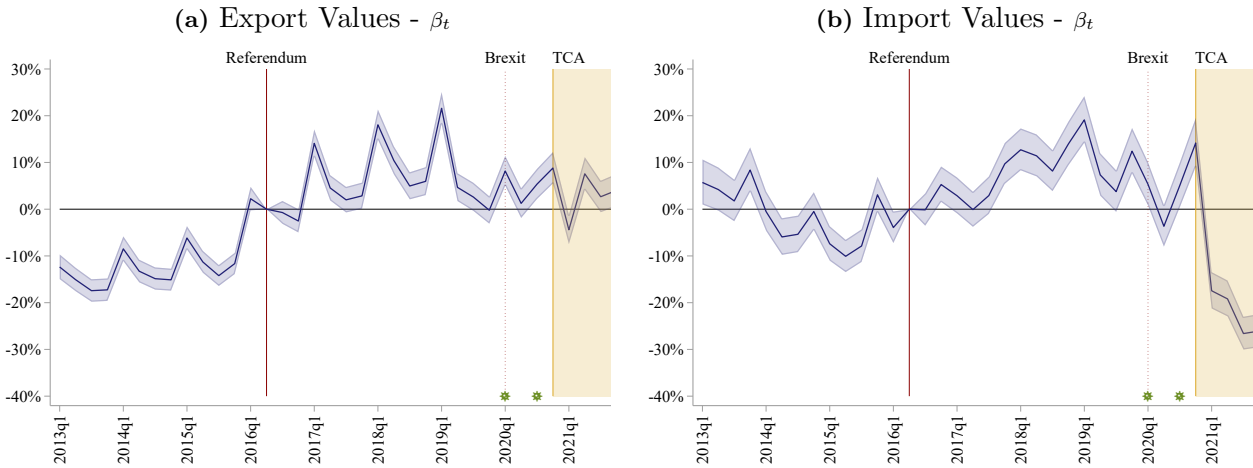
We begin by returning to the raw data to assess the evolution of UK exports and imports separately for five subsets of EU countries, grouped by the size of their bilateral exports or bilateral imports with

the UK in year 2015, i.e. the year before the Brexit referendum. We group the 27 EU members into 5 bins for the top 1-5, 6-10, 11-15, 16-20, and bottom 21-27 countries, and plot the UK’s monthly trade with countries belonging to each bin in Figure 3, where each series is benchmarked to June 2016. This exercise shows that the baseline patterns documented for the entire EU bloc in Figure 1 do not exhibit systematic differences across different size partners.

Second, baseline specifications (1) and (2) account for heterogeneous changes in supply and demand conditions in the EU versus the ROW, but they do not capture heterogeneity across countries within these blocs. The UK’s trade partners, however, differ greatly in terms of their market size, economic and institutional development, geographic proximity and cultural similarity to the UK, among other dimensions. Export supply and import demand conditions may thus differ significantly across countries at a given point in time, and may furthermore evolve asynchronously across countries over time.

To account for country-product specific changes in supply and demand conditions, we study the UK’s exports and imports by partner country, rather than grouping countries into the EU and ROW country blocs. As such, we estimate a modified version of specifications (1) and (2) that replaces country bloc-product with country-product pair fixed effects, and analogously controls for bilateral US and EU trade flows by partner country instead of by country bloc. The results, presented in Figure 4, exhibit greater quarter-to-quarter volatility and tighter confidence intervals than the baseline estimates, but otherwise corroborate our main findings.

**Figure 4: Robustness I: UK Bilateral Trade**



Notes: Panels (a) and (b) plot the estimated percentage changes in UK exports and imports with the EU versus the ROW relative to 2016 Q2 from a bilateral version of specifications (1) and (2), respectively. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-country level.

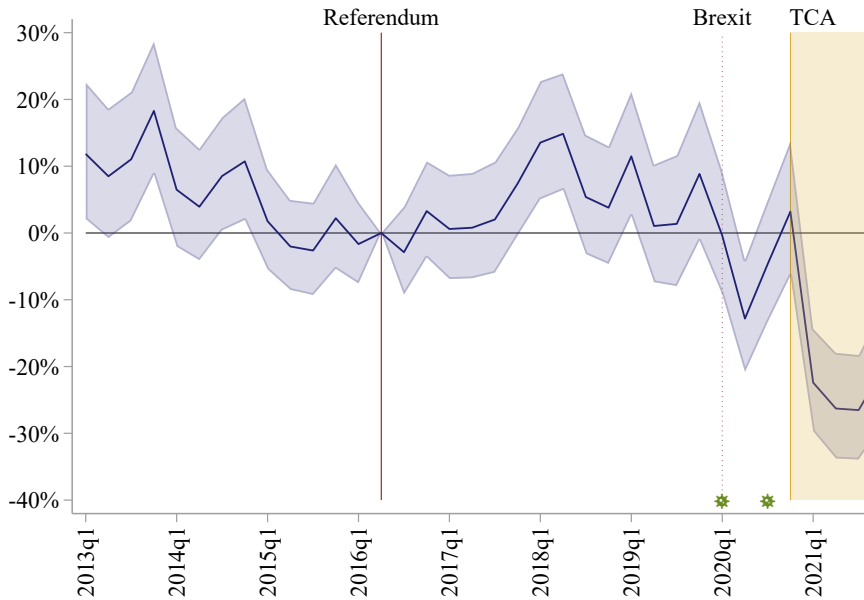
## 5.4 Sensitivity Analysis

We have performed a large set of sensitivity exercises that systematically support the baseline results presented in Section 5.2 above. First, the findings are not driven by a timing convention. While the benchmark analysis considers non-overlapping 3-month calendar quarters, we obtain similar findings

when we instead work at the monthly frequency (which tends to introduce substantially greater fluctuations around the same mean) or study overlapping 3-month moving averages. Second, the estimates are not sensitive to alternative outlier treatment or to weighting trade flows by their share of UK trade value in 2015, the last full year prior to the referendum.

Finally, the decline in EU relative to ROW imports in the After period is not due to reductions in the UK's MFN tariffs under the new UK Global Tariff introduced at the start of 2021. Figure 5 reports the event study estimates for imports when we add two additional controls to specification (2): the reduction in ad-valorem tariffs under the UK Global Tariff, and a dummy for changes in non-ad-valorem tariffs. Both variables are interacted with binary indicators for the ROW country bloc and for each quarter. Figure 5 shows that including these controls makes negligible difference to our baseline estimates.

**Figure 5: Robustness II: UK Trade Policy Towards the ROW**



Notes: This figure plots the estimated percentage changes in UK imports with the EU versus the ROW relative to 2016 Q2 from specification (2), including two additional controls interacted with ROW and quarter indicators: the reduction in ad-valorem tariffs under the UK Global Tariff, and a dummy for changes in non-ad-valorem tariffs in the UK Global Tariff. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-region level.

## 6 Unpacking Brexit Mechanisms

The baseline analysis in Section 5 reveals little change in UK trade activity in response to heightened uncertainty about future trade policy after the Brexit referendum, followed by a sizeable adjustment to the rise in trade barriers and lessened residual trade policy uncertainty after the TCA. In this section, we explore several possible mechanisms that could account for these Brexit effects. We examine in turn the role of different trade margins of reallocation, the impact of EU trade policy measures, and the extent of heterogeneity across product categories. In all cases, we uncover revealing patterns in the

data and offer possible interpretations that we hope can be more rigorously assessed with micro-level analysis in future work.

## 6.1 Trade Margins

Exports and imports can be decomposed into their extensive and intensive margins, by expressing the log value of trade by product-quarter-region as the sum of the log number of trade relationships (extensive margin) and the log trade value per relationship (intensive margin). We use two definitions of trade relationships to measure the extensive margin of trade with the EU and the ROW. First, we count the number of CN8 “products” exported or imported to each region per quarter. Second, we count the number of CN8 product-country “varieties” exported or imported to each region per quarter. As opposed to looking only at the count of products traded, the varieties measure accounts for how many countries each product is traded with per region. This distinction is important, as the extensive margin may evolve differently across countries with different market size.

We analyse the evolution of the extensive and intensive margins of UK exports and imports to better understand how UK firms have reallocated activity across products and markets. We show that the patterns for aggregate trade flows result from significant reallocation of trade activity with the EU along the extensive margin of products and countries, away from peripheral markets and towards core products and markets instead. The data also reveal notable asymmetries in the adjustments of export and imports, with a much greater decline in the extensive margin of EU trade for exports than for imports.

*Mechanism 1.—UK trade with the EU reallocated away from peripheral and towards core product and country markets after the implementation of the TCA, relative to UK trade with the ROW. This extensive margin contraction was much greater for UK exports than UK imports.*

Figure 6 tracks the extensive margin of UK trade with the EU and the ROW in the raw data, defined as the number of CN8 “products” or CN8 product-country “varieties” traded per quarter. Panels (a) and (c) show that the total number of products and varieties exported to the ROW fell sharply at the onset of the Covid-19 pandemic, before partially recovering later in 2020. However, Covid-19 had a smaller effect on the extensive margin of exports to the EU. By contrast, the implementation of the TCA led to a substantial fall in the extensive margin of EU trade, but did not affect ROW exports. Panel (c) shows that the number of varieties exported to the EU declined by around 30% in 2021 Q1. Panels (b) and (d) demonstrate that the number of products and varieties imported from the EU also dropped under the TCA, but the declines are smaller than for exports. The number of varieties imported from the EU fell by around 10% during the course of 2021. However, the number of products and varieties imported from the ROW remained stable or increased after the introduction of the TCA.

**Figure 6:** Mechanism I: Extensive Margin of UK Trade over the Brexit Timeline

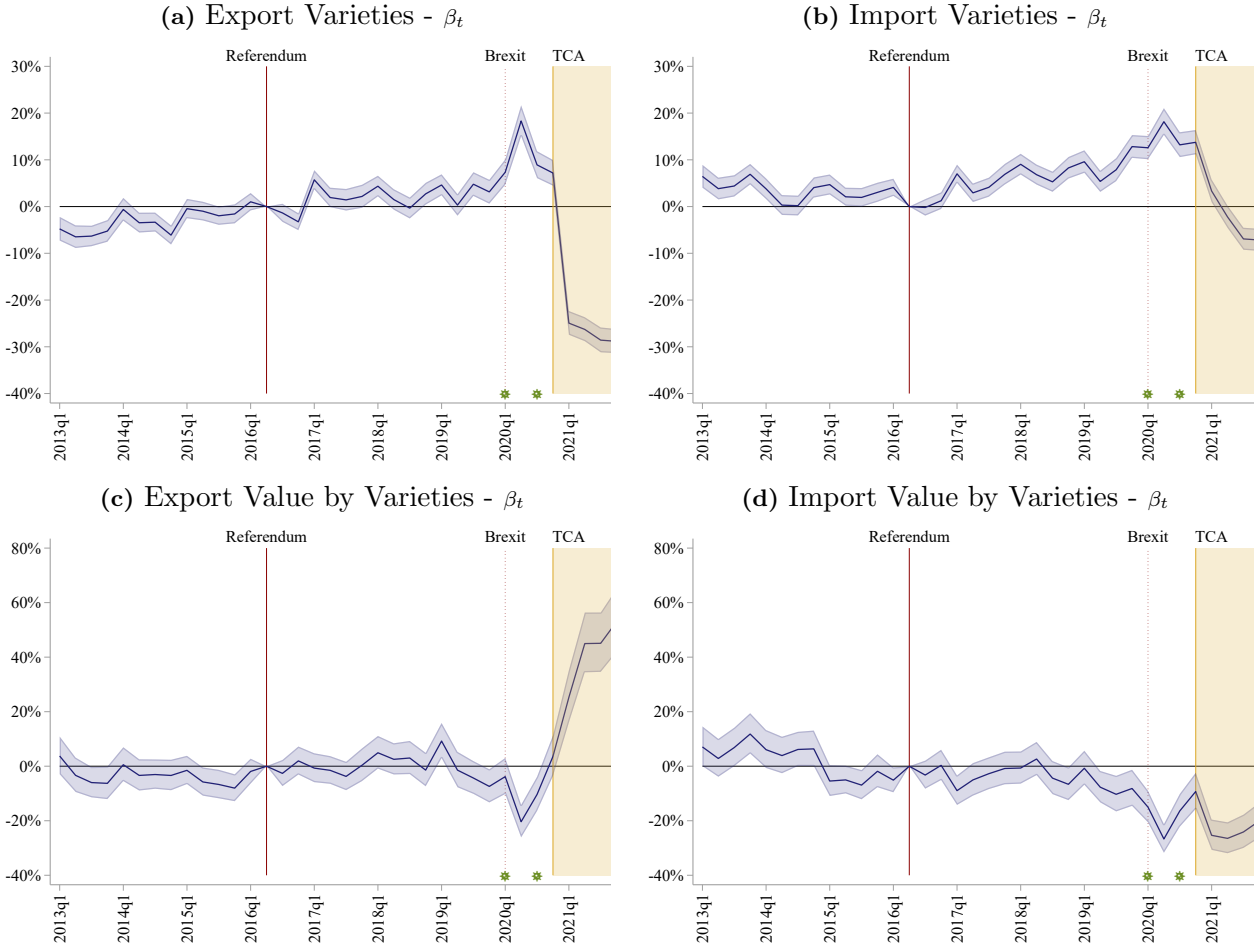


Notes: Panels (a) and (b) plot the total number of CN8 products exported to and imported from the EU and ROW per quarter. Panels (c) and (d) plot the total number of CN8 product-country varieties exported to and imported from the EU and ROW per quarter. Counts are normalised to 100 in 2016 Q2.

Figure 7 re-estimates our baseline specifications (1) and (2), but using the extensive and intensive margins of trade as the dependent variables. The extensive margin here is defined as the log of the number of CN8 product-country varieties and the intensive margin is defined as the log trade value per variety. Panels (a) and (b) show the extensive margin results. We find that the introduction of the TCA led to a fall of around 30% in the number of varieties exported to the EU relative to the ROW, and a smaller, but still significant, drop in relative varieties imported. Panels (c) and (d) report the intensive margin estimates. We find that the intensive margin of exports increased by roughly 40% in 2021, suggesting that the extensive margin decline evident in panel (a) resulted from the destruction of low-value trade relationships leading to higher exports per variety. By contrast, our estimates imply that the TCA reduced the intensive margin of imports by 10-20%, a drop comparable in magnitude to that observed at the onset of the Covid-19 pandemic in 2020.



**Figure 7:** Mechanism I: Extensive and Intensive Margins of UK Trade



Notes: Panels (a) and (b) plot estimated percentage changes in the UK extensive margin with the EU versus the ROW relative to 2016 Q2, where the extensive margin is defined as the number of CN8 product-country varieties. Panels (c) and (d) plot estimated percentage changes in the UK intensive margin with the EU versus the ROW relative to 2016 Q2, where the intensive margin is defined as the value of exports or imports per variety. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-region level. Regression specifications for exports and imports are analogous to specifications (1) and (2) except for the choice of dependent variable.

Additional analysis in Figure 8 confirms that the extensive margin adjustments to the TCA are driven by exit of low-value trade relationships. Panels (a) and (b) plot the number of CN8 product-country varieties exported and imported for the groupings of EU countries by market size in 2015 introduced in Figure 3 above. We see that the TCA-induced contraction in the extensive margin is systematically higher for smaller trade partners, particularly on the export side. For example, the decline in the number of product-country varieties exported to the 7 smallest EU markets under the TCA exceeds 50%, whereas the decline for the top 5 EU markets is below 20

Panels (c) and (d) plot the export and import continuer shares, i.e. the share of product-country varieties traded in quarter  $t$  that survive to quarter  $t + 1$ . They show that the introduction of the TCA led to a decline in the survival rate for exports and, to a lesser extent, for imports. Finally, panels (e) and (f) show the average trade value in quarter  $t$  of varieties that survived from quarter

$t - 1$ . We see that the decline in the number of varieties exported to the EU is accompanied by an increase in average exports per surviving variety. This implies that the TCA has increased the exit rate of varieties with lower export values. In contrast, this effect is not present for imports from the EU.

Taking these results together, we conclude that the apparent stability in the value of UK exports to the EU relative to the ROW under the TCA documented in Figure 2 masks a steep decline in the number of varieties exported, driven by the exit of “small” varieties that account for a low share of total exports. At the same time, the large drop in the value of UK imports from the EU relative to the ROW reflects a moderate reduction in the set of varieties imported, coupled with a decline in imports per surviving variety.

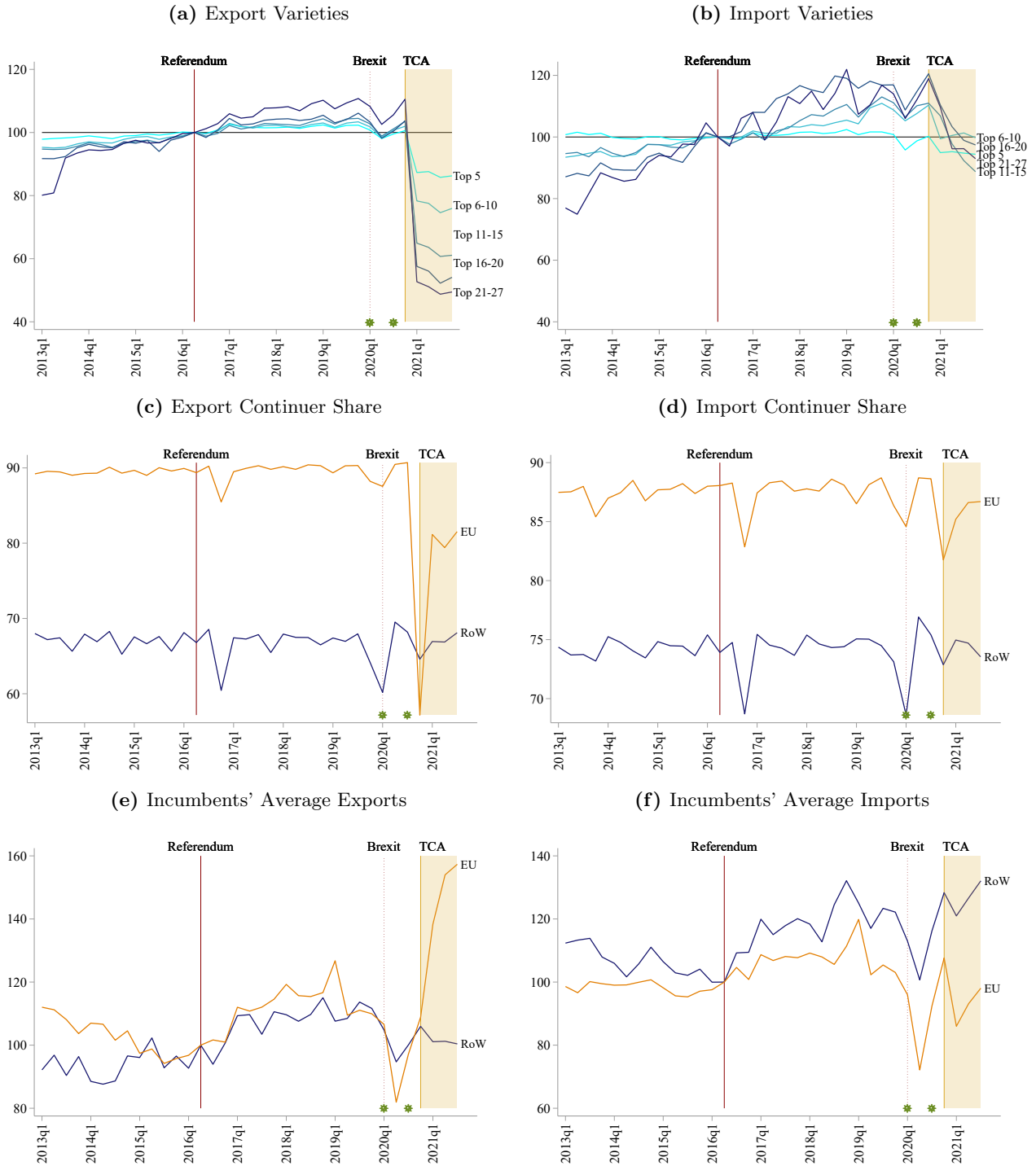
Our extensive and intensive margin findings suggest that the UK has begun reorienting exports to the EU away from peripheral products and markets towards core competencies in response to higher trade barriers under the TCA. This is consistent with heterogeneous firm trade models, in which firms follow a pecking order of destinations by profitability (Eaton, Kortum and Kramarz, 2011). In such frameworks, firms optimally export to all destinations above a minimum profitability threshold. Through this lens, the TCA may have led to the destruction of low-value trade relationships by raising the fixed costs of UK-EU trade. Such forces can operate not only across firms, but also across products within multi-product firms that sell their core (i.e. more efficiently produced) products to more markets down the country pecking order than their peripheral products.

It is surprising that the value of exports to the EU relative to the ROW has remained stable under the TCA, at the same time as EU exports have declined on the extensive margin. It is likely that a large part of the explanation is that exiting varieties are small relative to continuing varieties. But this still leaves open the question of why the TCA has not, at least so far, led to a reduction in export values for core varieties.

For imports, the results indicate that most UK importers have not rushed either to end relationships with EU suppliers or to initiate new relationships with ROW suppliers. This is consistent with large matching costs in production networks and significant reputation effects in buyer-supplier relationship dynamics. At the same time, UK firms may have sustained production activity in the face of higher import costs from the EU under the TCA by scaling up input sourcing from the ROW along the intensive margin.

Nevertheless, the asymmetries between our results for exports and imports under the TCA are puzzling. When studying trade values, we find a larger and more persistent decline in imports than exports. By contrast, on the extensive margin we find larger falls on the export side. Reconciling these findings is an important objective for future work as more data becomes available. For instance, while the market size hypothesis discussed in Section 5.2 could explain why we find bigger effects on trade values for imports than for exports, it could not on its own account for the opposite pattern for the extensive margin effects.

**Figure 8: Mechanism I: Understanding Extensive Margin Changes**



Notes: Panels (a) and (b) plot the total number of CN8 products exported to and imported from EU countries grouped by UK export and import values in 2015, with counts normalised to 100 in 2020 Q4. Panels (c) and (d) plot the share of varieties exported to and imported from the EU and RoW in quarter  $t$  which are also traded in quarter  $t + 1$ . Panels (e) and (f) plot the average export and import values of varieties which were traded with EU and RoW in both quarter  $t - 1$  and quarter  $t$ , with values normalised to 100 in 2016 Q2.

## 6.2 UK-EU Trade Policy Expectations

In the first instance, the Brexit referendum suddenly and dramatically increased uncertainty about the future of the UK-EU trade relationship. After the transition period, the implementation of the TCA in turn eliminated most uncertainty about tariffs, raised new effective trade costs in the form of customs regulations, and maintained or lowered remaining uncertainty about non-tariff barriers. In order to inform the impact of these changes to trade cost levels and expectations, the second mechanism we examine is differential exposure to EU trade policies across products.

Measuring the impact of Brexit on expectations about future UK-EU trade policy poses significant challenges. Our premise is that the MFN tariffs  $MFN_{p,2015}$  and non-tariff barriers  $NTB_{p,2015}$  that the EU imposed on non-EU members in 2015 prior to the referendum are potentially useful measures of cross-product heterogeneity in exposure to Brexit-related trade policy uncertainty. These variables measure the barriers UK-EU trade could have faced without a new trade deal. Moreover, to the extent that the variables are correlated with the EU’s desired level of protection, they may be informative about the level of realised trade cost increases under the TCA.

During the Interim period these EU external barriers can be seen as a threat point that quantifies trade policy uncertainty at the product level, even if the UK and the EU were to ultimately adopt lower trade barriers (Crowley, Exton and Han, 2020; Graziano, Handley and Limão, 2021). In the period after the TCA came into force, when actual UK-EU bilateral tariffs were confirmed at zero,  $MFN_{p,2015}$  measures the tariffs faced by exporters that are unable to satisfy the TCA’s rules of origin and may also be correlated with the stringency of customs checks beyond rules of origin. As for  $NTB_{p,2015}$  in the After period, since the TCA does little to promote deeper integration, it may be a proxy for the rise in non-tariff barriers under the TCA, as well as for residual uncertainty over future non-tariff barrier increases.

We examine the differential effect of Brexit on UK trade with the EU relative to the ROW across products by expanding baseline specifications (1) and (2) to include a full set of triple interactions  $\sum_t \beta_t^{MFN} D_t EU_c MFN_{p,2015}$  and  $\sum_t \beta_t^{NTB} D_t EU_c NTB_{p,2015}$ . The benchmark double interactions  $\sum_t \beta_t D_t EU_c$  now estimate the impact of Brexit for a hypothetical product with no tariff or non-tariff barriers, such that  $\beta_t^{MFN}$  and  $\beta_t^{NTB}$  quantify the deviation in trade activity away from this hypothetical based on the perceived trade policy threat point. The agnostic event-study approach allows these differential Brexit effects to vary flexibly over time. The level effects of  $MFN_{p,2015}$  and  $NTB_{p,2015}$  are subsumed by the fixed effects.

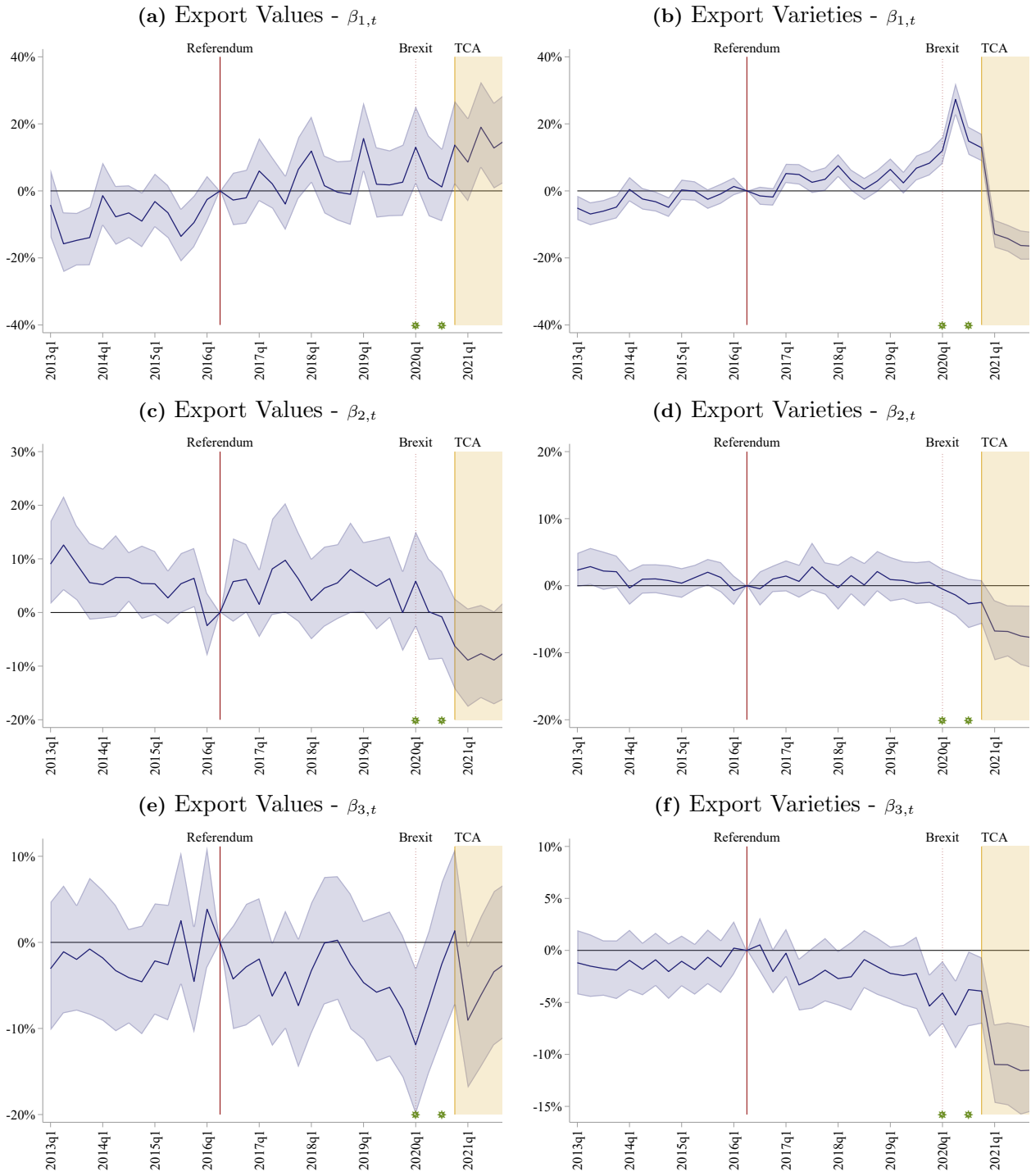
*Mechanism 2.—UK trade with EU countries behaved similarly to UK trade with non-EU countries between the referendum and the TCA across products with different levels of perceived trade policy uncertainty. After the TCA, exports to the EU fell more for products with higher EU trade policy barriers, particularly on the extensive margin. The decline in imports under the TCA was broad based across products.*

Figure 9 presents the results for exports. For the triple interactions, we plot the percent change

in the dependent variable for the EU relative to the ROW resulting from a one standard deviation increase in  $MFN_{p,2015}$  or  $NTB_{p,2015}$ . Panels (a), (c), and (e) reveal no differential impact of the Brexit referendum on the value of UK exports across products with different perceived trade policy uncertainty during the Interim period. The muted change in overall UK exports after the implementation of the TCA in Figure 2, however, masks a rise in relative UK exports of products with low tariffs, counterbalanced by greater declines in relative UK exports of products with higher tariffs. This is indicated by the positive  $\beta_t$  estimates for a reference product with zero trade barriers and the negative  $\beta_t^{MFN}$  estimates for the triple interaction. The estimates of  $\beta_t^{NTB}$  under the TCA are negative, but not significant. Panels (b), (d), and (f) show results for the extensive margin of exports. The fall in the relative number of varieties exported is greater for products exposed to higher tariffs and non-tariff barriers. This amplifies an already steep drop in the extensive margin of exports for a benchmark product with no trade barriers.

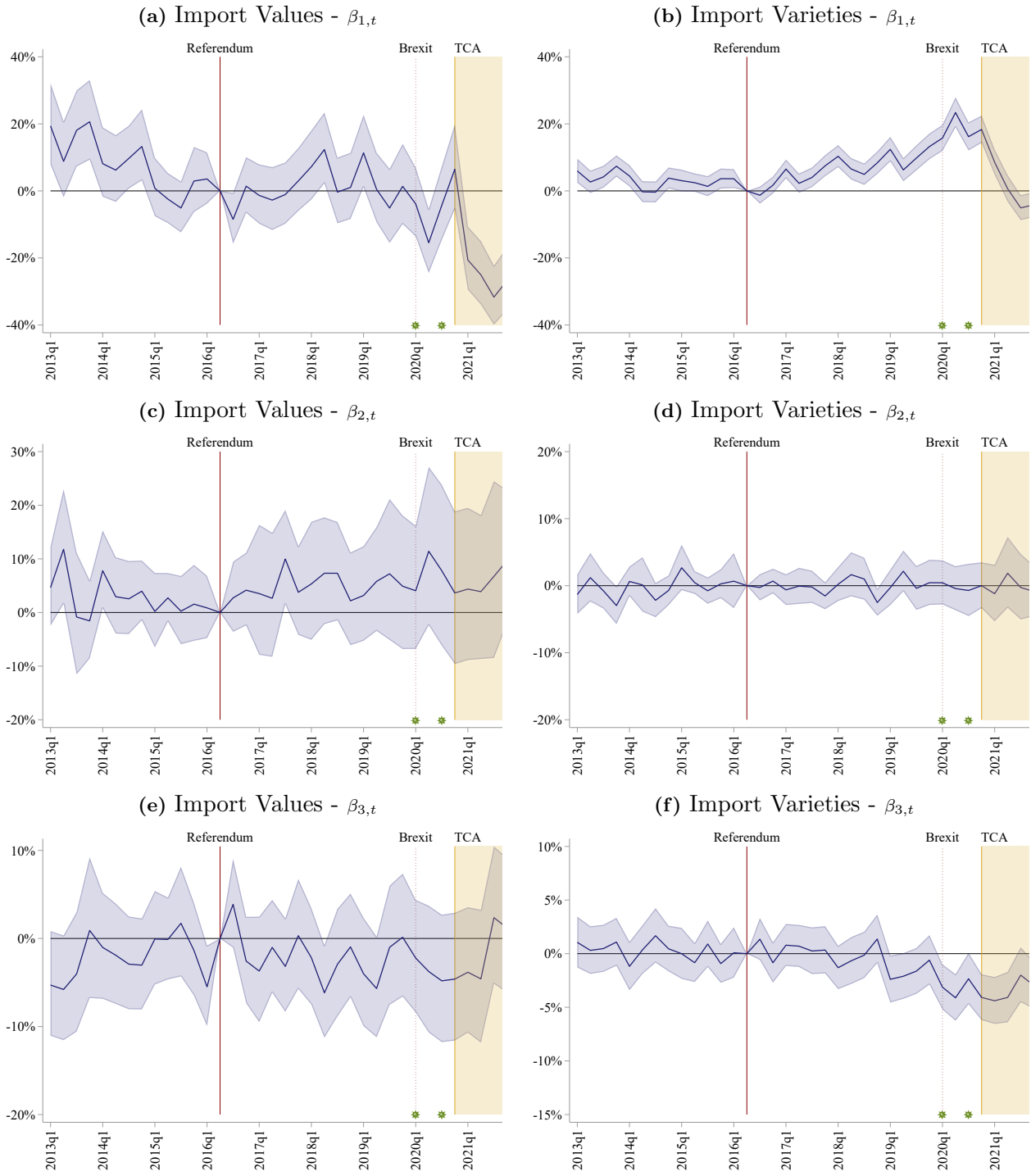
Figure 10 displays the corresponding results for imports. As with exports, panels (a), (c), and (e) show no evidence that the referendum exerted differential effects on the value of UK versus ROW imports across products with different trade policy threat points during the Interim period. Unlike the case of exports, the steep decline in the value of relative UK imports after the TCA came into force was also broad based across products. In turn, panels (b), (d) and (f) demonstrate that the sudden and significant drop in the extensive margin of imports in terms of product-country varieties after the TCA compounds several forces: The extensive margin for the reference product with zero trade barriers in fact grew considerably during the Interim period before falling quickly below its starting point in the After period. While the extensive margin adjustment varied little across products with different tariff threat points, it contracted slightly more for products with higher non-tariff barriers in the run up to and after the TCA.

**Figure 9: Mechanism II: UK Exports and EU Trade Barriers**



Notes: Estimated percentage changes in UK export values and varieties with the EU versus the ROW relative to 2016 Q2 from specification (4) including the triple interaction terms  $\sum_t \beta_t^{MFN} D_t EU_c MFN_{p,2015}$  and  $\sum_t \beta_t^{NTB} D_t EU_c NTB_{p,2015}$ . Panels (a) and (b) plot estimates for a hypothetical product with  $MFN_{p,2015}$  and  $NTB_{p,2015}$  equal to zero. Panels (c) and (d) plot effects of a one standard deviation increase in  $MFN_{p,2015}$ . Panels (e) and (f) plot effects of a one standard deviation increase in  $NTB_{p,2015}$ . Varieties defined as CN8 product-country pairs. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-region level.

**Figure 10: Mechanism II: UK Imports and EU Trade Barriers**



Notes: Estimated percentage changes in UK import values and varieties with the EU versus the ROW relative to 2016 Q2 from specification (4) including the triple interaction terms  $\sum_t \beta_t^{MFN} D_t EU_c MFN_{p,2015}$  and  $\sum_t \beta_t^{NTB} D_t EU_c NTB_{p,2015}$ . Panels (a) and (b) plot estimates for a hypothetical product with  $MFN_{p,2015}$  and  $NTB_{p,2015}$  equal to zero. Panels (c) and (d) plot effects of a one standard deviation increase in  $MFN_{p,2015}$ . Panels (e) and (f) plot effects of a one standard deviation increase in  $NTB_{p,2015}$ . Varieties defined as CN8 product-country pairs. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-region level.

### 6.3 Product Heterogeneity

The timeline of Brexit developments entails changes in trade costs and expectations about the future of the UK-EU economic relationship that may affect producers and final consumers differently. The third mechanism of transmission that we explore is heterogeneity in the dynamics of trade adjustment across three product categories: final consumer goods, capital goods, and intermediate inputs. We consider trade in consumer goods as driven primarily by final demand, including through general equilibrium forces that move income or prices. From the perspective of producers, we view capital expenditures as associated with long-term investment in equipment and machinery that replaces depreciating assets and potentially grows productive capacity. Conversely, we interpret input purchases as short-term variable costs that reflect the desired production scale and per unit production costs. Brexit may therefore exert differential effects on trade activity in consumer, capital and intermediate goods through its differential impact on trade costs and thereby on supply and demand over time.

Panels (a), (c) and (e) in Figures 11 and 12 replicate our baseline analysis for each product type, while panels (b), (d) and (f) provide the corresponding results for the extensive margin of each trade flow as measured by the log number of CN8-country varieties traded. Note that the coefficient estimates across the three product types do not represent an exact decomposition of the overall effect on UK trade, both because some products are double-counted as explained in Section 4.4, and because of the log transformation.

*Mechanism 3.—The stability of UK exports to EU relative to ROW countries after the TCA masks an increase in exports of capital and intermediate goods and a reduction in exports of consumer goods. By contrast, the decline in UK imports to EU relative to non-EU countries is broad based across imports of capital, intermediate and consumer goods.*

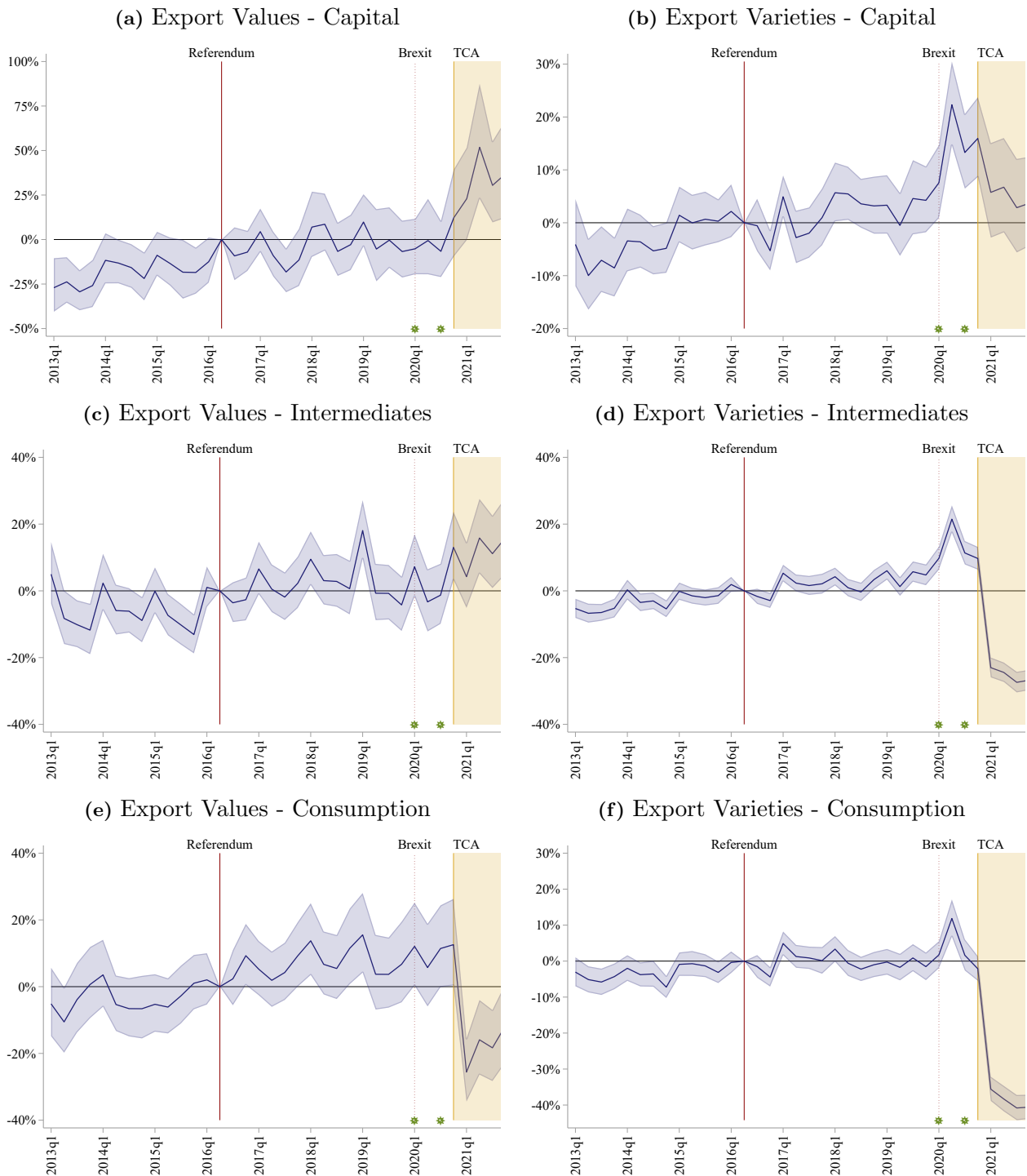
On the export side, the evolution of total UK exports and export varieties documented in Figures 2 and 7 masks important product type heterogeneity that is revealed in Figure 11. Export activity evolves similarly across product types after the referendum, but exhibits considerable differences in response to the introduction of the TCA. In particular, UK exports of capital and intermediate goods to the EU grew compared to ROW exports, while relative UK exports of consumption goods first dropped precipitously and mostly recovered thereafter. At the same time, the extensive margin of export varieties fell significantly and persistently for both intermediates and consumer goods.

We cannot yet draw any definitive conclusions about why the impact of the implementation of the TCA on UK exports differs by product type, but we can suggest some possibilities. Immediately after the TCA comes into force, UK firms may struggle to market inputs and equipment that have been customised to downstream producers in the EU to buyers elsewhere. They may thus have an incentive to deplete stocks of such customised output by exporting it intensively to existing EU customers. In turn, EU producers might need time to re-optimize their global sourcing strategy, whereby they might in the short run stock up on UK products that are difficult to replace by other suppliers,



stop purchasing UK products that they can more easily obtain elsewhere, and thus maintain or even increase their total expenditure on UK products. As for final demand, EU consumers might be quite sensitive to changes in trade costs that make UK products relatively products originating in the ROW.

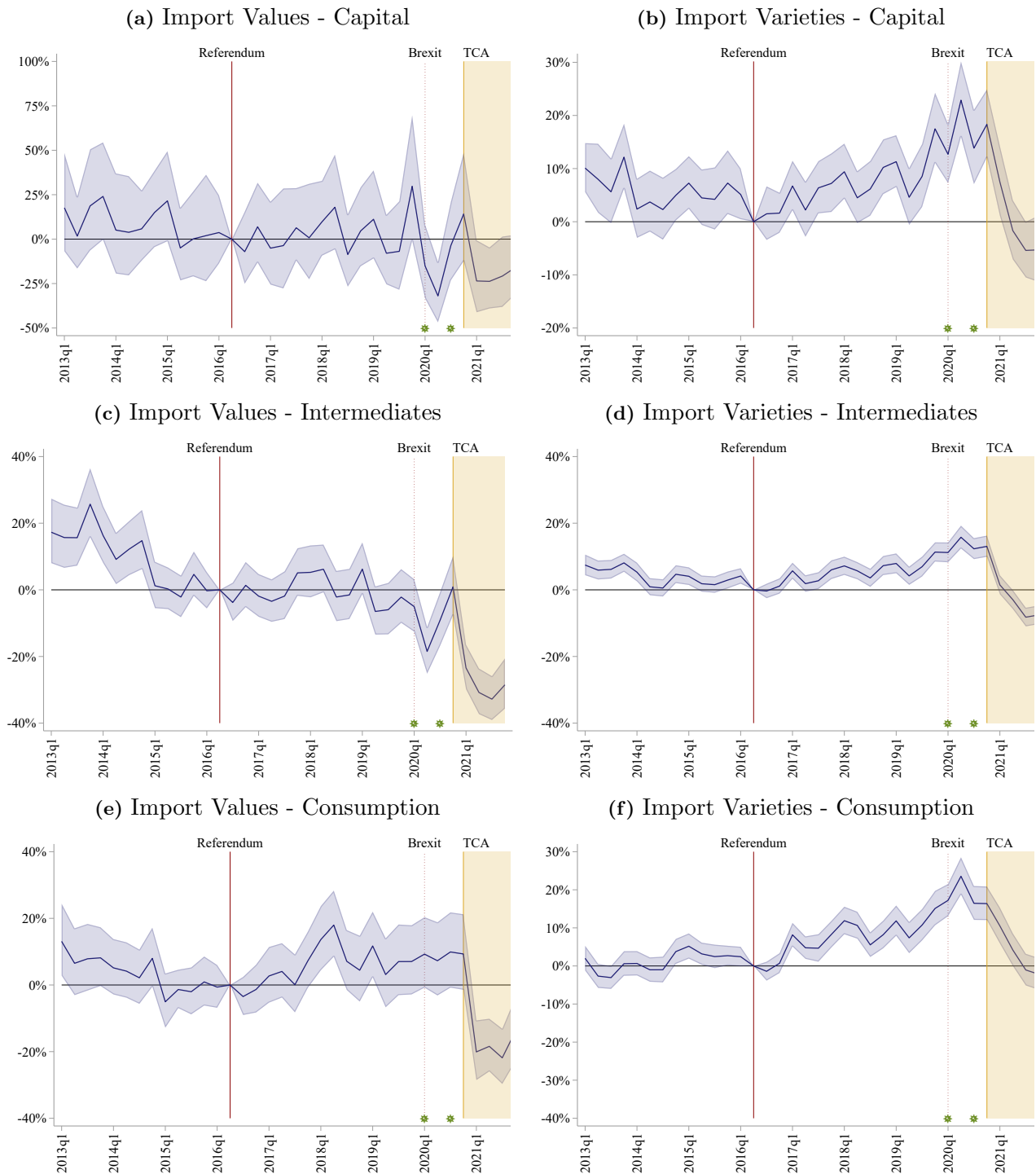
**Figure 11: Mechanism III: Exports of Consumer, Capital and Intermediate Goods**



Notes: Estimated percentage changes in UK export values and varieties with the EU versus the ROW relative to 2016 Q2 by product type. Varieties defined as CN8 product-country pairs. Regression specifications are analogous to specification (1) except for the choice of dependent variable. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-region level.

Turning to imports, the trajectory for UK imports and import varieties by product type in Figure 12 closely follows that for overall UK imports in Figures 2 and 7. Thus the value of UK imports from the EU relative to UK imports from the ROW remained stable after the referendum and fell

**Figure 12:** Mechanism III: Imports of Consumer, Capital and Intermediate Goods



Notes: Estimated percentage changes in UK import values and varieties with the EU versus the ROW relative to 2016 Q2 by product type. Varieties defined as CN8 product-country pairs. Regression specifications are analogous to specification (2) except for the choice of dependent variable. 95% confidence intervals are calculated using standard errors clustered at the HS4 product-region level.

sharply and persistently after the introduction of the TCA for each of capital, intermediate and consumer goods, with the caveat of less precisely estimated effects for capital goods. Moreover, for all three product categories the extensive margin of number of product-country varieties trended upwards during the Interim period, before falling after the TCA.

These patterns for UK imports are consistent with UK firms and consumers both reacting strongly to the rise in trade costs brought about by the start of the TCA. As with the aggregate trade trends, the rise in the extensive margin of UK import varieties during the Interim period of heightened uncertainty presents a puzzle. Also puzzling is the asymmetry between exports and imports in the product composition effects hiding behind the aggregate patterns. We hypothesise this may be due to the interaction of two forces: the larger EU share in UK trade flows than UK share in EU trade flows, and the presumed contrast of interdependence in firms' input sourcing across origin countries and independence in firms' sales decisions across export markets.

## 7 Conclusion

The UK's departure from the EU has led to an unprecedented unravelling of deep integration. This paper studies how Brexit has affected the UK's trade with the EU relative to the rest of the world. We examine both the Interim period between the Brexit referendum in June 2016 and the start of the new UK-EU Trade and Cooperation Agreement in January 2021, and the first year of trade under the new arrangements introduced by the TCA.

We do not find evidence of a statistically or economically significant decline in the UK's trade with the EU relative to the rest of the world prior to the implementation of the TCA. This finding holds for both exports and imports and for both the intensive and extensive margins of trade. As Brexit only affected expectations regarding future trade costs during the Interim period, our results provide novel evidence that trade flows are relatively unresponsive to anticipated, but uncertain, increases in trade barriers.

However, we find that the shift from the transition period to the TCA led to immediate and sizable changes in UK-EU trade relative to UK-rest of the world trade, with notable asymmetries between exports and imports. Although UK exports to the EU fell sharply at the start of 2021, they subsequently rebounded, and our results do not show a persistent negative effect of the TCA on export values. Nonetheless, we do find large negative effects on the extensive margin of exports to the EU relative to the rest of the world. We estimate that the introduction of the TCA reduced the count of product-destination export relationships with EU countries per quarter by around 30% in 2021. The extensive margin effect is concentrated in lower value relationships, which is consistent with the rise in non-tariff barriers under the TCA increasing the fixed costs of trade.

In sharp contrast, the implementation of the TCA led to a deep decline in relative imports from the EU, and this decline persisted throughout 2021. Our results imply that the introduction of the TCA reduced UK imports from the EU relative to UK imports from the rest of the world by around 25%

in 2021. This decline comes from both the intensive and extensive margins, although the extensive margin effect is weaker for imports than for exports.

The finding that the TCA had a greater effect on imports than exports in 2021 is surprising, particularly since the UK delayed the introduction of many customs checks until 2022. However, we caution against drawing premature conclusions about the long-run trade effects of Brexit. Our results only cover the first year of the new UK-EU trade relationship, and trade data can be noisy in the short-run, a concern that has been exacerbated by volatility in trade resulting from the Covid-19 pandemic.

We expect trade flows to take several years to fully adjust to Brexit, and, as more data becomes available, we plan to update our findings and to also analyse services trade, the evolution of production networks, firm-level responses to the TCA, and the possibility for changes in data collection methods after Brexit to bias UK-EU trade statistics. In this way, we hope to shed further light on the trade effects of disintegration.

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## Appendix 1 Data Appendix

This appendix provides additional details on the datasets we use in our analysis, as well as on the steps we take to clean and process the raw data. Our final dataset features information on UK, US and EU trade flows as well as EU and UK tariffs and EU non-tariff barriers. It covers the period 2013 Q1-2021 Q4 and contains 171,910 observations, 86,072 for exports and 85,838 for imports, for 1,221 HS4 products traded with the EU and the rest of the world. In what follows, we provide details of each dataset in turn.

### Appendix 1.1 UK Trade Data

We source monthly UK trade flows from January 2013 to December 2021 from the UK HMRC Overseas Trade Statistics. This dataset features information on UK imports and exports by partner country and CN8 product.<sup>6</sup> For UK imports the partner country is recorded as the country of dispatch from which goods were sent to the UK, while for UK exports the partner country is the country of destination to which goods are exported. Trade values are reported in pound sterling, on a free on board (FOB) basis for exports and a cost, insurance, and freight (CIF) basis for imports.

There is a potential structural break in the timeseries for UK exports to the EU in January 2021, when the underlying data source for Great Britain, but not Northern Ireland, changed from Intrastat surveys to customs export declarations. This may introduce a wedge between the date of declaration and the date of shipment. However, this change affects neither UK imports from the EU, nor UK trade with non-EU countries.

We take five steps to clean this data. First, we exclude products outside the CN nomenclature without product description and products reported at unusual levels of aggregation. Second, we exclude trade flows which have been suppressed, for example to preserve the identity of the underlying exporting or importing firm. Finally, we drop trade flows classified with ambiguous country codes, trade in non-monetary gold and negative trade flows.<sup>7</sup> Overall, our data cleaning steps remove roughly 2.1% of all observations in the raw data, accounting for 13.3% of total trade value (suppressed trade flows account for 3.5%, ambiguous countries for 2.9% and non-monetary gold for 6.9%).

We combine countries in the cleaned data into two regions, the EU and the rest of the world, and aggregate trade flows to the HS4 level at quarterly frequencies. Croatia joined the EU on 1 July 2013. We allocate UK trade with Croatia to the rest of the world for the first two quarters of 2013, and to the EU from 2013 Q3 onwards.

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<sup>6</sup>The first 6 digits of the CN8 classification map directly to HS6.

<sup>7</sup>In line with the definition used by UK Trade Info, we define non-monetary gold as the seven CN8 codes 71081100, 71081200, 71081310, 71081380, 71090000, 71123000 and 71129100.



## Appendix 1.2 US Trade Data

We supplement our dataset with US trade data for January 2013 to December 2021 from the US Census Bureau’s Monthly International Trade Dataset. This dataset contains monthly export and import values in US dollars by partner country and 10 digit Harmonised Tariff Schedule(HTS) product.<sup>8</sup> US partner countries represent the country of destination for exports and the country of origin for imports. Exports are provided on a free alongside ship basis and exclude re-exports, while imports are recorded as CIF values.

To clean the US trade data, we exclude trade flows for which the exporter or importer do not have a clear country code as well as trade flows with the UK. These two data cleaning steps remove 3.1% of observations from the raw data, accounting for 2.8% of trade value. As before, we then aggregate across countries, time periods and products.

## Appendix 1.3 EU Trade Data

We also source data on EU trade flows between January 2013 to December 2021 from Eurostat’s COMEXT database. This dataset features monthly export and import values in euros for each EU country by CN8 product and partner. Partner countries represent the last known country of destination for exports, the country of consignment for imports from EU members and the country of origin for imports from non-EU members.

To clean the EU trade data, we drop trade flows i) recorded under a special statistical regime, ii) with product codes outside the CN nomenclature, iii) with ambiguous countries, countries not available in the UK trade data and the UK, and iv) in non-monetary gold. After implementing these steps, which remove 11.4% of observations (8.5% due to dropping trade flows with the UK) and 19.0% of trade value (12.1% due to dropping trade flows with the UK) from the raw data, we again aggregate across countries, time periods and products.

## Appendix 1.4 EU Trade Policy

We source data on the EU’s MFN tariffs and EU non-tariff barriers applied against non-EU countries in 2015 from the UNCTAD Trade Analysis Information System (TRAINS), accessed through the World Bank’s World Integrated Trade Solution (WITS) platform. Tariffs are available at the 10-digit level, with specific tariffs converted to ad-valorem equivalents.<sup>9</sup> Non-tariff barriers are provided at the CN8 product level and comprise binary indicators of whether MFN imports face different classes of non-tariff barriers. Broadly speaking, these fall under headings such as sanitary and phyto-sanitary measures (SPS), technical barriers to trade (TBT), pre-shipment inspection/formalities, and additional requirements related to licenses, quotas, prohibitions and quantity controls. As a caveat, this data may not span the universe of active non-tariff barriers.

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<sup>8</sup>The first 6 digits of the HTS system correspond to the HS system.

<sup>9</sup>The first 6 digits correspond to HS6, the next 2 digits extend the code to CN8, and the last 2 digits reflect the product classification under the Integrated Tariff of the European Communities.

We aggregate trade policy measures to the HS4 level to match the trade data. For tariffs, we take the simple average of all 10-digit tariff lines within an HS4 product. For non-tariff barriers, we count the number of non-tariff barriers that apply to a given CN8 code and then average across all CN8 codes within a given HS4 product.

### **Appendix 1.5 UK Trade Policy**

We use data on UK MFN tariff changes in January 2021 provided by the UK Department for International Trade. This dataset features information on UK MFN tariffs both before and after January 2021 by CN8 product. For ad-valorem tariffs, we calculate the average reduction in ad-valorem tariffs across CN8 products within an HS4 product. To capture changes in non-ad-valorem tariffs we construct an indicator that takes value one whenever there was a change in the non-ad-valorem component of any CN8 tariff within an HS4 product.

### **Appendix 1.6 Broad Economic Categories**

To investigate differences across product types, we use data on end use categories provided by the UN's Broad Economic Categories (BEC) classification (Rev. 5). This data is taken from the UN Statistics Division correspondence tables and maps HS6 codes to up to two of three broad end use categories: capital, consumption and intermediate. We combine this information with our trade data by aggregating trade flows in the same end use category across HS6 products within an HS4 product, double counting products with multiple end use categories.

Table A1: Correlations

	EU MFN Tariff (%)	EU NTMs (#)	UK MFN Advalorem Reduction (%)	UK MFN Non-Advalorem Tariff Change (%)	Export Value (m£)	Export Variety (#)	Import Value (m£)	Import Variety (#)
EU MFN Tariff (%)	1.00							
EU NTBs (#)	0.42 <sup>+</sup>	1.00						
UK MFN Advalorem	0.05 <sup>+</sup>	-0.04 <sup>+</sup>	1.00					
Tariff Reduction (%)								
UK MFN Non-Advalorem	0.26 <sup>+</sup>	0.27 <sup>+</sup>	0.06 <sup>+</sup>	1.00				
Tariff Change								
Export Value (m£)	-0.03 <sup>+</sup>	-0.04 <sup>+</sup>	-0.06 <sup>+</sup>	-0.02 <sup>+</sup>	1.00			
Export Varieties (#)	0.02 <sup>+</sup>	0.02 <sup>+</sup>	-0.14 <sup>+</sup>	0.01	0.27 <sup>+</sup>	1.00		
Import Value (m£)	-0.00	-0.01 <sup>+</sup>	-0.07 <sup>+</sup>	0.00	0.62 <sup>+</sup>	0.27 <sup>+</sup>	1.00	
Import Varieties (#)	0.06 <sup>+</sup>	0.04 <sup>+</sup>	-0.16 <sup>+</sup>	0.04 <sup>+</sup>	0.20 <sup>+</sup>	0.90 <sup>+</sup>	0.28 <sup>+</sup>	1.00

Notes: This table provides correlation coefficients for our HS4-region-quarter dataset. Rows (1) and (2) present EU MFN tariffs in percent, and the average number of NTBs across CN8 products within an HS4 category. Row (3) shows the reduction in ad-valorem UK MFN tariffs compared to EU MFN tariffs in January 2021. Row (4) presents a binary indicator for changes to non-ad-valorem tariff components. Rows (5) and (7) present UK export and import values in millions of pounds. Rows (6) and (8) show the number of CN8-region varieties that the UK exports and imports. Significance: <sup>+</sup>  $p < 0.01$ .

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