

The consequences of the Trade and Cooperation Agreement for the UK's international trade

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Abstract: We analyse the likely trade effects of the Trade and Cooperation Agreement (TCA), which defines the post-Brexit trading environment between the United Kingdom (UK) and the European Union (EU). We apply a computable general equilibrium model and focus on trade in value added rather than just the gross values of exports and imports. We describe the TCA and estimate its effects on the costs of conducting UK–EU trade, including various non-tariff barriers in both goods and services. We suggest that the TCA will reduce UK trade significantly: total exports by around 7 per cent and imports by around 14 per cent. In terms of value added (i.e. incomes generated), textiles and vehicles, both of which trade extensively with the EU, suffer heavily, as do services which trade significantly with the EU, face large increases in trade barriers, and experience declining demand from other sectors as those sectors' exports fall. Such inter-industry linkages spread the losses from Brexit widely through the economy.

Keywords: Brexit, computable general equilibrium modelling, non-tariff measures, Trade and Cooperation Agreement, European Union, trade in value added

JEL classification: F16, F17

I. Introduction

We simulate the effects of the UK–EU Trade and Cooperation Agreement (TCA) of 24 December 2020 on UK international trade and sectoral output. The TCA contains several elements apart from trade or trade-related policies, but here we focus just on the

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Ilaria Fusacchia and Luca Salvatici have received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 861932, and L. Alan Winters from the Economic and Social Research Council grant 'Post-Brexit trade and investment', ES/T002050/1. We are grateful to Christopher Adam and David Vines for detailed comments on, and to participants in the *Oxford Review of Economic Policy* seminar on 5 May 2021 for discussion of, an earlier draft. Naturally, we bear responsibility for any of its remaining short-comings. The article reflects only the authors' views and the Research Executive Agency is not responsible for any use that may be made of the information it contains.

<https://doi.org/10.1093/oxrep/grab052>

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trade provisions. Our estimates derive from simulations of a computable general equilibrium (CGE) model but, in comparison to the standard models, it allows the computation of the value added embodied in gross trade flows. Into this model, we fit detailed estimates of the effects of the TCA on the costs of conducting international trade between the UK and the remaining members of the European Union. The results show that the UK sectors dependent on trade with the EU certainly suffer disruption, but that the adverse consequences are far wider than that, propagated around the economy by the backward and forward linkages between sectors.

Our analysis focuses more heavily on trade in value added than the gross values of exports and imports. Trade policy and trade costs impinge on the gross value of trade (a tariff is levied on the full value of a car), but the effects on incomes and welfare depend on who contributes the value of that trade. Thus, for example, a change in exports of cars impinges not only on the factors of production assembling the car, but also on the providers of all the inputs, a significant proportion of whom may reside outside the UK. Similarly, frictions on imported intermediate goods may reduce UK firms' competitiveness and hence ability to generate incomes.

We have analysed the prospective effects of Brexit previously—Fusacchia *et al.* (2019, 2020). However, the first considered only the frictions likely to be introduced by Brexit into goods trade; the second, while it introduced frictions in services markets and allowed for the new UK tariff schedule released in May 2020, was published on the day the TCA was completed and was based on predictions of what it would contain. The current estimates are based on the actual outcome of the TCA and hence on improved estimates of its effects on trading costs. These are significantly more detailed than in other modelling exercises in the literature. In addition, in the current paper we have recalibrated the base year of the model to 2019 and made more detailed allocations of imports over final and intermediate use.

The advantage of this approach is the possibility to measure policies' ultimate impact in a theoretically consistent way, by quantifying the changes that result from the interactions and feedbacks by all of the markets in the economy. Yet global CGE models should not be treated as a sort of 'crystal ball': their usefulness in policy analysis owes less to their predictive accuracy, and more to the light they shed on the economic mechanisms through which price and quantity adjustments are transmitted among world markets. Accordingly, the results presented here are not unconditional predictions of the future but rather attempts to quantify the impacts of trade policy changes in a 'what-if' manner. They make no allowance for future changes in economic conditions or policies and are also subject to other uncertainties. The latter stems from several sources, not least the fact that the TCA is far from complete. Much will depend on how the UK and EU authorities develop their future relationship, which, despite the rocky start, remains unknown. As technology is held constant (even as trade policies change), our model-based results are driven by allocative efficiency and relative price effects.

In addition, of course, all economic modelling is subject to various well-known uncertainties, the most significant of which is the huge uncertainty about the height of existing non-tariff barriers to trade, let alone exactly how Brexit will increase them on UK–EU trade. Our approach has been to take the TCA fairly literally and hence to postulate serious increases in many trade costs, which could be reduced by future UK–EU cooperation if the parties were willing to pursue it. Experience shows that in any modelling exercise, the two major determinants of the effects of a trade policy change are the

amount of trade affected and the extent of the change in policy. The former is known more or less perfectly, so the uncertainty about the latter is the major consideration.

The paper starts with a brief description of the model we use, followed by a summary of the key trade components of the Trade and Cooperation Agreement. In section IV we translate the provisions of the TCA into numerical forms which can be input into our model, focusing on five elements of the costs of conducting international trade: tariffs, non-tariff measures, border costs, and rules of origin, all pertaining to trade in goods, and non-tariff measures on services. We then describe UK trade in both gross and value-added terms and finally provide estimates of the effects of the TCA comparing it to a counterfactual of no change in trade policy. An [online Appendix](#) provides additional details on several aspects of the modelling and the trade cost estimates.

II. The model

The estimates here are based on counterfactual simulations using a standard CGE model of the world economy from the Global Trade Analysis Project (GTAP) Consortium. The GTAP model is a perfectly competitive comparative static CGE model, built on general equilibrium theory and designed to assess the inter-regional, economy-wide incidence of economic policies ([Hertel and Tsigas, 1997](#)). The main advantages of the CGE approach are its solid micro-theoretical underpinning, its economy-wide scope, and its complete and consistent coverage of all bilateral trade flows.

Trade policies are implemented on gross trade flows (e.g. a tariff is levied on the whole value of an imported car), so the model first assesses changes in trade flows in gross terms and then uses a separate module to calculate the implied changes in value added embedded in trade—the GTAP-VA module ([Antimiani et al., 2018](#)). These decompositions will show that conclusions based on the effects of Brexit on gross flows alone are not good indicators of its final incidence in terms of incomes.

GTAP is a real comparative model with no nominal rigidities. Capital stocks and total labour supply are fixed in each country, while real wage flexibility and inter-sectoral labour mobility ensure full employment (the model assumes no between-country labour migration). We adopt a simple short-run savings-driven closure (see the [Appendix](#) for full details). For each country, private-sector savings and government tax revenue and spending are constant shares of income (the tax share depends on tax rates), so that the volume of gross domestic private and public saving is endogenous to the level of income. The balance of trade, which is a function of income, preferences, and trade policy, determines net foreign savings. There is no independent investment function in any of the countries. However, to achieve overall macroeconomic consistency in the global model, investment spending in all countries needs to be adjusted, using a simple rule, in order to ensure that overall global investment accommodates the changes which emerge in overall global savings. Cross-border capital flows then ensure that all countries with current account deficits can finance these by borrowing from countries with current account surpluses (see [Hertel and Tsigas \(1997\)](#)).

Like all models, ours is a simple representation of the actual economy, based on many assumptions. These are explained in a bit more detail in the [Appendix](#), including the modelling of consumption, investment, government expenditure, production, and

international trade, the assumptions about factor markets, and the model closure (how it all fits together). Because it is a model, not reality in all its indescribable detail, the results it produces are indicative rather than precise. However, given that the main determinants of the effects of trade policy changes are invariably the structure of trade (which we know) and the changes in trade barriers that are made (which we have estimated as carefully as possible from available data and empirical work), they are still highly informative.

The data we use are drawn from version 10 of the GTAP Data Base, a baseline of consistent data on consumption, production, and trade for 121 countries and 20 regions in 2014.¹ For our calculations, we aggregate the 141 countries/regions into ten regions: the UK (United Kingdom); France; Germany; Italy; the remaining members of the EU; the 70 countries (excluding Japan) with which the EU has signed Free Trade Agreements (which we term the TAC countries²); China; Japan; the United States; and the rest of the world.³ In the calculations, we use a relatively detailed sectoral aggregation (55 products constructed from the 65 goods and services included in the GTAP 10 Data Base), but when we present the results we do so for just ten aggregate sectors (see the [Appendix](#) for definitions).

The relative sizes of different economies have changed since 2014, and so in these simulations we update the base year to 2019 using various macroeconomic data. We also incorporate into the base the effects of three significant EU trade agreements signed since then—with Japan, Canada, and Singapore. Of course, several trade agreements for other countries have come into operation since 2014, but given that this is a story about the changes in the costs of conducting UK–EU trade, they have barely any influence on our estimates of the incremental effect of the latter.

III. The Trade and Cooperation Agreement⁴

The Trade and Cooperation Agreement (TCA) between the UK and the EU came into force on the 1 January 2021. It is 1,256 pages long and covers a wide range of issues including institutional arrangements, trade in goods and services, travel, transport, fisheries, social security coordination, law enforcement and judicial cooperation, union programmes, and dispute settlement. Structurally, it takes the form of an Association

¹ For a description of the GTAP Data Base version, see <https://www.gtap.agecon.purdue.edu/databases/v10/index.aspx>. The 121 countries cover approximately 98 per cent of world GDP and 92 per cent of world population.

² TAC stands for ‘Trade Agreement—Continuity’, the term the UK government uses for the agreements that it has struck with these countries to continue trading on the same conditions as prevailed until the end of 2020 via their agreements with the EU. So far, agreements have been concluded with 67 of the 70 countries.

³ We treat the UK as a single entity, ignoring the major problems that have arisen because, under the TCA, Northern Ireland ‘is required to align with EU customs and single market rules’ for goods—see [Murphy \(2022\)](#).

⁴ This section draws on three Briefing Papers from the UK Trade Policy Observatory—[Ayele et al. \(2021\)](#), [Borchert and Morita-Jaeger \(2021\)](#), and [Lydgate et al. \(2021\)](#). These papers, and also this article, worked from the version of the TCA released by the European Commission on 25 December 2020. A legally scrubbed version of the TCA was presented to the European Parliament on 19 April 2021, in which, somewhat unhelpfully, the Articles were re-numbered!

Agreement (similar to agreements the EU has with a number of neighbouring countries), creating a Partnership Council, 19 Specialized Committees, four Working Groups, and consultation procedures to deal with specific elements. These provisions allow it scope to evolve (by mutual consent) which is an undoubted advantage given the speed and wishful thinking with which it was completed. But the resulting nearly endless series of negotiations and the various dispute settlement procedures also imply continuing uncertainty about the stability of trading relations between the UK and the EU (Fella, 2021; Lydgate *et al.*, 2021).

Since this paper is about the economic effects of the trade agreement, we describe only the trade elements here, but the other aspects will still be important for the UK's economic fortunes. Despite its length, the TCA creates only a shallow trading relationship between the UK and the EU. After Teresa May failed, as Prime Minister, to engineer a relatively close relationship, Boris Johnson assumed the premiership and declared that all the UK wanted was a 'Canada-style' trade agreement. This was not entirely true, because the UK's suggested draft treaty contained several distinctly deeper arrangements (Holmes *et al.*, 2020). Whenever these were taken up by the EU, however, they required some UK obeisance to EU regulatory and legal powers. Thus, having finally accepted that Brexit was going to be economically costly, even with a deep economic relationship, the government fell back into justifying Brexit politically, in terms of 'sovereignty above all else' and abandoned the pursuit of such arrangements. We do not know, of course, that the UK would have persuaded the EU to grant some of the deeper arrangements it sought, but it is manifest that it did not try very hard. Thus, while all the rhetoric was about fishing quotas and the right to loosen standards that the government insisted it would not actually loosen, major commercial issues such as financial passporting, the recognition of professional qualifications, and coherence with sanitary and phyto-sanitary regulations drifted out of reach.

Briefly, the TCA's key trade provisions include the following:

Tariffs: the TCA allows for the elimination of all tariffs and quotas between the UK and the EU—providing that firms can prove their goods meet the underlying rules of origin, and providing that neither party subsequently levies any anti-dumping duties, or countervailing duties, or any 'rebalancing' measures (i.e. those arising from disputes in certain areas). Most free trade agreements (FTAs) have a few remaining tariffs, so in this dimension the TCA is quite ambitious. Moreover, the UK reduced its most-favoured nation (MFN) tariff from 1 January 2021 below EU's common external tariff, which had ruled until then. For just over 2,000 tariff lines it eliminated tariffs, which had previously averaged (unweighted) 3.6 per cent, and for a further 4,747 it marginally lowered the import tariff in a process of simplification, reducing the average tariff on these goods from 6.8 to 6.0 per cent (Magntorn *et al.*, 2020).

Border formalities: the TCA includes several provisions to ease trade through customs borders, but none makes much impact on the fact that exports from the UK to the EU faced the EU's standard customs procedures immediately, and UK imports from the EU will face similar formalities from January 2022. Both are considerably more burdensome than the almost complete absence of formalities that applied to UK–EU

trade before Brexit. Moreover, the low thresholds for liability to VAT on parcels and small packages passing between the UK and the EU is imposing substantial burdens on sectors that use such retail methods of distribution (Thomas and Foster, 2021).

Rules of origin (ROOs): free trade agreements grant tariff free entry not to goods dispatched from the partner, but to those produced, or ‘originated’, in the partner. For most manufactures, this is complex. Under the Union Customs Code, which applies to all EU members, no ROOs were necessary for UK–EU trade; hence ROOs are a new imposition. The TCA has its very own ROOs. This has two implications. First, they differ from those applied in all the other UK FTAs, which complicates the lives (and the bank balances) of exporters to more than one market. Second, because they also differ from the ROOs in the EU’s other FTAs, the EU is not prepared to permit so-called diagonal cumulation.

To explain, a common form of ROO is that some minimum percentage of the value of material inputs into a good must originate in the country claiming origination. Cumulation is the process whereby inputs from other places can be included in that percentage. Most FTAs have ‘bilateral’ cumulation, such that in the UK–EU case, parts produced in either the UK or the EU can be counted towards either UK or EU origin, although with one exception—see below. ‘Diagonal cumulation’ pulls third countries that have FTAs with both partners under this umbrella—so that, say, Japanese inputs to UK exports to the EU could be counted as ‘originating’ in the UK. Cumulation is generally held to be feasible only if the ROOs operated by both partners with the third country as well as between themselves are pretty similar. (If there were serious differences, trade patterns could be distorted.) The EU insists that the ROOs be identical, so that the TCA precludes diagonal cumulation. This potentially means that some existing UK–EU trade will now face tariffs—and that related imports of inputs may quite possibly disappear as firms reconfigure their supply chains.

The exception to bilateral cumulation, which seems to have caught nearly everyone off-guard, is the ‘insufficient processing’ rule. Article ORIG:4 (3) of the TCA states that even bilateral cumulation shall not apply when the exporting country has not carried out ‘sufficient processing’ on the input. This means that whereas before Brexit it was possible for a manufacturer to produce a product in the EU, send it in bulk to the UK to be, say, painted or repackaged, and then re-import it tariff-free back into the EU, the re-import now attracts a tariff. This disturbs joint UK–EU final-stage distribution chains.

Testing and certification: UK exports to the EU must meet EU standards. Previously this was presumed through the institutions of the Single Market, and where third countries required such assurance it could be provided by any certified tester within the EU. After Brexit, conformity with EU standards must be explicitly certified and the EU does not generally recognize certificates issued by UK testers. The UK had proposed to include such recognition in its draft treaty, but that has not prevailed, and so UK exporters face an extra cost and delay obtaining certification for new varieties or new goods.

For many non-sensitive goods, UK exporters can self-certify conformity, but they still need to find an importer within the EU willing to take legal liability if there are

problems. In automobile and aircraft manufacture the use of common global standards and certification in both the UK and EU make UK certification possible *de facto*. However, for a significant number of sectors, all this is an added expense. One egregious example is the UK insistence on having its own rules and certification system to rival the EU's REACH scheme for chemicals. The industry is deeply opposed to divergence and will have to incur the expense of duplication of registration and testing. Many third countries insist on certification that chemicals meet EU REACH standards, and this will have to be done by EU accredited bodies.

A second expensive standards issue concerns sanitary and phyto-sanitary standards, which mainly affect food and drink. The TCA makes no concessions towards mutual recognition, leaving British exporters (and, after January 2022, importers) with very heavy testing and documentary requirements for such trade. The press has been full of stories of such delays and there is a widespread expectation that cross-channel food sales will diminish strongly.

Fisheries: the UK invested huge amounts of political capital in achieving small increases in UK fishing quotas for UK waters. This tiny industry truly dominated the negotiations and yet, when all was said and done, UK fish exports fell significantly on Brexit because of the time- and cost-consuming new testing and documentary requirements that they entailed.

Services—the general approach: the TCA lays out general provisions for cross-border trade and investment in services in one section, but with notable exclusions—financial services (for which an adequacy decision is pending) and audio-visual trade (which the EU always excludes from its FTAs)—and separate sections dealing with digital trade, aviation, road haulage, and the movement of natural persons. Investment is already quite liberal, so a plausible response to frictions on cross-border trade will be for services firms to re-locate (part of) their business to their destinations. This will have consequences for cross-border trade and tax revenues.⁵ The EU is offering access to its markets very roughly equivalent to that which it offers Canada, but with some detailed additions and subtractions. The EU–Canada Comprehensive Economic and Trade Agreement (CETA) has some services provisions, but they do not progress very far—[Magtorn and Winters \(2018\)](#)—and many of the restrictions that remain pertain to member states individually, rather the EU as a whole, increasing the informational burden of trading.

Transportation services: the TCA hits UK air and road transport providers hard, with no rights to provide services for transport within the EU and little right even to serve additional collection/drop-off points on trips to/from the UK. Some UK airlines have already relocated their registrations to Europe to cope with this. Maritime

⁵ It may also explain why services firms apparently undertook little lobbying to maintain their market access to the EU during the Brexit process: at a firm level, perhaps it did not matter very much.

transportation, on the other hand, is liberal, except for cabotage (trading between ports within the partner).

Financial services: whereas UK financial institutions had almost unlimited rights to sell in the EU (the financial passport), the TCA offers no such facility. If the EU unilaterally declares UK regulations to be ‘equivalent’ to EU ones, some rights will be recreated but in a form the EU can withdraw on 30 days’ notice. So far (November 2021), the equivalence decision has not been made and now seems unlikely to materialize.

The temporary movement of natural persons: the free access of citizens of one EU member to another’s labour market ceases with Brexit. Relocations prior to January 2021 can be maintained, but it remains to be seen what flows emerge subsequently; most commentators expect them to be severely curtailed. This will affect labour availability, the incentives to train, and where skilled workers choose to locate. The TCA offers slightly better conditions for the movement of business persons than does CETA, but the bureaucracy is cumbersome and will have to be completed for each member state to be visited. The movement of personnel is an essential part of many service trades and so these restrictions are likely to curtail cross-border trade.

The mutual recognition of professional qualifications (MRPQ): the Directive on MRPQ (2005/36/EC) no longer applies to the UK. Qualifications will need to be regained in individual EU member states according to locally applicable rules. The TCA has provision for future agreements on the mutual recognition of specific qualifications with individual member states, but the process is optional, piece-meal, and resource intensive. It is unlikely to yield much of value, at least for several years.

Digital trade: the TCA is the EU’s first FTA to include data flow provisions; it constrains the parties’ ability to demand data localization or the use of local computing facilities. It is modelled on EU digital trade policy and so is not very business-friendly compared, say, to what the UK has agreed with Japan. Moreover, it is dependent on a unilateral decision by the EU that UK law is adequate to protect EU citizens’ data. Adequacy has been granted, but as with financial equivalence, is subject to review and challenge.

The level playing field (LPF): a major concern of the EU is that the UK will seek to create a competitive advantage over the EU by relaxing its regulations—and so, potentially, initiating a ‘race to the bottom’. The LPF section of the TCA addresses this: the UK regime for managing subsidies will be very similar to the EU’s and the UK and EU will be able to challenge each other’s subsidies. On labour standards and the environment, the EU and UK have committed not to weaken standards in ways that boost trade or investment and there is a fairly rigorous procedure for addressing violations. In addition, there are highly innovative procedures for rebalancing the

trade elements of the TCA (and ultimately cancelling them) if one side changes its standards in ways that materially affect its trade.

IV. Modelling the trade effects of the Trade and Cooperation Agreement⁶

To incorporate them into a model, we need to convert the policies just described into numerical forms that the model can absorb. This section describes our estimates of the effects of the Trade and Cooperation Agreement (TCA) on five elements of the costs of doing international trade: tariffs, non-tariff measures, border costs, and rules of origin, all pertaining to goods, and non-tariff measures on services. These vary across countries and with the nature of the UK's trading relationship with them. Our primary interest is on the change in the trading relationship between the UK and the EU when the TCA has been fully implemented (i.e. ignoring the temporary derogations on its application), but there were small concomitant changes on UK relations with other partners which we also include.

Tariffs: the TCA involves no tariffs on UK–EU trade. UK imports from countries with which the UK does not have an FTA, now pay the UK Global Tariff published in May 2020—see [Magntorn Garrett *et al.* \(2020\)](#)—which is slightly more liberal than the EU common external tariff that applied previously. In turn, partners apply their most favoured nation (MFN) tariffs to their imports from the UK. Where we model an FTA, we assume zero tariffs on all goods, although in reality all FTAs except the TCA have a few exceptions. The EU agreements with the TAC countries have somewhat more exceptions. The UK has signed Continuity Trade Agreements with 67 TAC countries, with three remaining under discussion. Although the roll-overs do not replicate existing trading conditions perfectly, we assume that they do, and that the UK succeeds in rolling them all over.⁷ Thus for the TAC we assume no change in tariffs (or indeed other trade policies) from the baseline.

Non-tariff measures (NTMs) for goods: estimates of these are taken from [Cadot and Gourdon \(2016\)](#) and are expressed as tariff-equivalents (i.e. as the tariff level that would have the same effect on trade). They are based on price comparisons rather than the more usual quantity-based approach to estimating NTM effects. Cadot and Gourdon provide separate estimates for trade flows taking place within FTAs and those that do not. However, they are explicit that the former refer to deep-integration arrangements and, in particular, they argue that the mutual recognition of conformity-assessment procedures is the main component of the difference. Given that the TCA makes little progress on these—especially on sanitary and phytosanitary (SPS)—we

⁶ Fuller details are provided in the [Appendix](#).

⁷ On the partial nature of the continuity agreements, see [Tamberi and Winters \(2019\)](#)

generally adopt Cadot and Gourdon's non-FTA estimates in both directions in this exercise. Three exceptions based on Annexes to the TCA lead us to use Cadot and Gourdon's with-FTA estimates for motor vehicles and other transport equipment and the average of the FTA and non-FTA estimates for chemicals. We assume the complete absence of NTMs on intra-EU trade in the base period. On average (weighted using GTAP's trade data for the base year) the tariff equivalents of NTMs on goods are 8.0 per cent for UK exports and 8.4 per cent for UK imports.

Border costs: other than within the EU, all goods trade faces border formalities (customs forms and burdensome arrangements for paying local taxes, etc). We assume that after Brexit, all trade does. These costs are not related to the height of the tariff and are not avoided by signing an FTA. With little hard information to rely on, we assume that these costs add 2 per cent of the transaction value to trade with EU member states.⁸ In addition, to allow for the burden of the new VAT arrangements on UK–EU postal and parcel trade, we add a further 1 per cent for clothing and leather goods and a further ½ per cent for sectors supplying consumer manufactures.⁹ No change is assumed for other trade. The costs of regulatory checks are included in the NTM estimates above. The tariff equivalent of the new border costs is 2.1 per cent for UK exports and 2.2 per cent for UK imports.

Rules of origin (ROOs): as noted above, FTAs require rules to define what has actually been made in the partner country. ROOs are often quite burdensome and potentially face any trader trying to take advantage of an FTA.¹⁰ We estimate them as generally adding 3 per cent to the cost of a transaction. However, since ROOs have a significant fixed-cost component we add a further ½ per cent or ¼ per cent where small firms account for a disproportionate share of output (see [Appendix](#) for details) and a further 1.5 per cent where cumulation is precluded because partner goods receive insufficient processing before re-export—see [Appendix](#) for an explanation. Imports that cannot prove they meet the ROO face the standard (MFN) tariff, so if the latter is below the threshold cost for any commodity (defined at the 6-digit level of the Harmonized System), we apply the MFN rate to the flow, whereas if it is above, we apply the threshold (i.e. a preferential tariff of zero plus the ROO-related cost of claiming it). We assume no change in the cost of ROOs for the TAC. We estimate that ROOs add an average 1.8 per cent to the cost of UK exports and 1.9 per cent to the cost of UK imports.

Non-tariff measures for services (NTMS): we do not attempt to measure the level of barriers to services trade in the baseline, but merely to measure the changes in UK–EU barriers that Brexit will induce. [Benz and Gonzales \(2019\)](#) show that in terms

⁸ A basic sensitivity testing on these and other costs is provided after discussion of the central results.

⁹ The list of GTAP sectors so affected is given in the [Appendix](#).

¹⁰ See, for example, [Conconi et al. \(2018\)](#) and [Cadestin et al. \(2016\)](#).

of the OECD's Services Trade Restrictiveness Index, the European Single Market has resulted in intra-EU barriers to services trade being on average just one-quarter of those imposed by EU members on third-country suppliers. For UK–EU services trade, we need estimates of how much dropping out of the Single Market increases trade costs. We derive estimates of the tariff equivalent of the Single Market from [Fontagné *et al.* \(2016\)](#) and [Developing Trade Consultants \(2019\)](#), using methods we spell out in the [Appendix](#). Both are based on inversions of a gravity model of services trade. The former source, which we have used in our previous work, is convenient in that it pertains directly to GTAP sectors, but it is somewhat dated and is subject to a number of reservations. We have, therefore, updated it with estimates from [DTC \(2019\)](#) which is more recent, more precisely specified, is focused explicitly on the UK, and, having been published by the UK government, possibly has a degree of official standing.¹¹ The new estimates are higher on average than our previous estimates (about 15.2 per cent compared with 7.4 per cent) but are still lower than other comparable estimates.

For all flows other than UK–EU trade, we assume that services barriers continue at their base levels.

We readily acknowledge that the NTMs estimates—for goods and even more for services—are very rough. However, they are more detailed than any of the others that have been used in the literature on Brexit. [Dhingra *et al.* \(2017\)](#), for example, assume a single value for NTMs on all goods and services.

The [Appendix](#) discusses the derivation and treatment of trading costs in more detail, but [Table 1](#) summarizes the values we use for UK–EU trade in our various scenarios.¹²

Brexit will increase trade costs between the UK and the EU, leading each party to import less from the other and more from other foreign suppliers and also to increase the use of domestic supplies. The increases in trade costs will cause consumers/users to change what they consume/use; they will do so in a way that minimizes, but cannot reverse, the harm they suffer. Before we turn to the results, however, we briefly describe the pattern of UK trade in the (constructed) base year, 2019.

V. UK gross and value-added trade

As noted above, trade policy operates on the gross value of a transaction, but policy interest is mainly in the effects that changes in gross exports and imports have on incomes—essentially on value added. If an export is lost, this affects the demand for inputs into its production both from other industries locally and also from foreign sources. We can also measure the dependency of UK sectors on inputs from and on

¹¹ Of course, official standing gives no indication of the scientific merit of the estimates. However, given that the most significant disagreement concerning the costs of Brexit is between the UK government (which tries to maintain there are next to no costs) and the bulk of the economics profession (which believes there are), there is an argument for using government-sanctioned estimates of the new trade barriers.

¹² One comparison of relevance to this issue is between our estimates and those of [Davenport and Levell \(2022\)](#). Following [UK in a Changing Europe \(2019\)](#), they postulate increases in trading costs from Brexit of 5.5 per cent for goods and 7.3 per cent for services, which are slightly under half the values we are using.

Table 1: Changes in the costs of conducting UK–EU trade

Trade cost	Base (2019)	Source for estimates under TCA	Mean (%) under TCA for	
			UK exports	UK imports
Tariffs: goods	Zero	Zero	0.0	0.0
Non-tariff measures: goods	Zero	Cadot and Gourdon (2016), non-FTA, with three exceptions	8.0	8.4
Border costs: goods	Zero	2% plus supplements in a few sectors	2.1	2.2
Rules of origin: goods	Zero	3% plus supplements in some sectors	1.8	1.9
Non-tariff measures: services	Unknown	Base + increments derived from gravity models	15.7	14.7

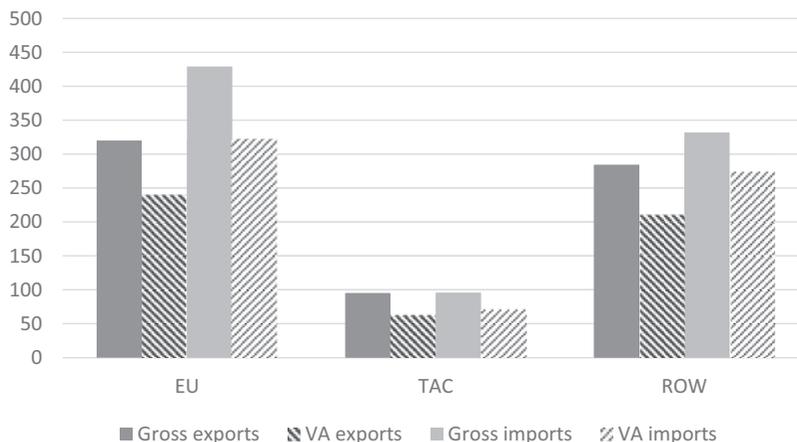
selling outputs to firms in other countries (value-chain integration). By plotting these statistics, we get a much better estimate of the economic incidence of Brexit.¹³

Figure 1 shows UK exports and imports with the three main overseas groups both in gross terms (i.e. the total value of exports or imports) and in terms of exporter value added (VA). Both backward and forward linkages imply intermediate goods travelling back and forth across the exporter–importer borders. This kind of trade is often referred to as ‘global value chain (GVC) trade’.

Three features are evident. First, VA trade is smaller than gross trade—that is, some of the value of UK gross exports is provided by foreign countries and some of the value of UK gross imports is provided by countries different from the final exporter. Second, imports always exceed the corresponding exports—the UK has a trade deficit with each of these three aggregations of partners. Third, with respect to the Trade Agreement—Continuity group (TAC) and the rest of the world (ROW), the VA deficits exceed the gross ones while the opposite is true in the case of the EU. This is explained by two factors. First, imports from the EU have a larger share (5.4 per cent) of reflected VA than do imports from elsewhere (3.2 per cent), i.e. the UK VA embodied in £1 of UK imports from the EU exceeds that embodied in £1 of imports from elsewhere. This is a consequence of the deep integration achieved within the EU Single Market, of which the UK was part until 2021. Second, the composition of UK imports from the EU is biased towards sectors that have relatively lower shares of domestic VA in total value. In other terms, imports from the EU are mostly from sectors that are relatively more downstream than imports from non-EU countries, for example, chemicals and motor vehicles.

In Figure 2 we decompose each UK sector’s gross exports to identify the origin of foreign value added. This reveals the extent to which UK exports depend on imported inputs of goods and services. This dependency is sizeable—about 26 per cent in total, of which about one-third (9.3 per cent) originates in the EU and one-seventh (3.9 per cent) in the TAC. Hence the increases in the cost of importing from the EU that the TCA induces, impinge on approximately 10 per cent of the value of UK exports. The aggregate sectors with the highest overall share of foreign VA in UK exports are iron, steel, and metals (about 45 per cent) and motor vehicles (a bit over 40 per cent); those most dependent on EU value added are motor vehicles, food, and iron, steel, and metals (17, 14, and 12 per cent, respectively).

¹³ As noted above we do this with a module called GTAP-VA (Antimiani *et al.*, 2018).

Figure 1: UK trade, 2019: gross and in domestic value-added terms (\$ billions).

Note: VA imports represent the value added in the exporter country embodied in its exports to the UK.

Source: Authors' simulations using the GTAP-VA model.

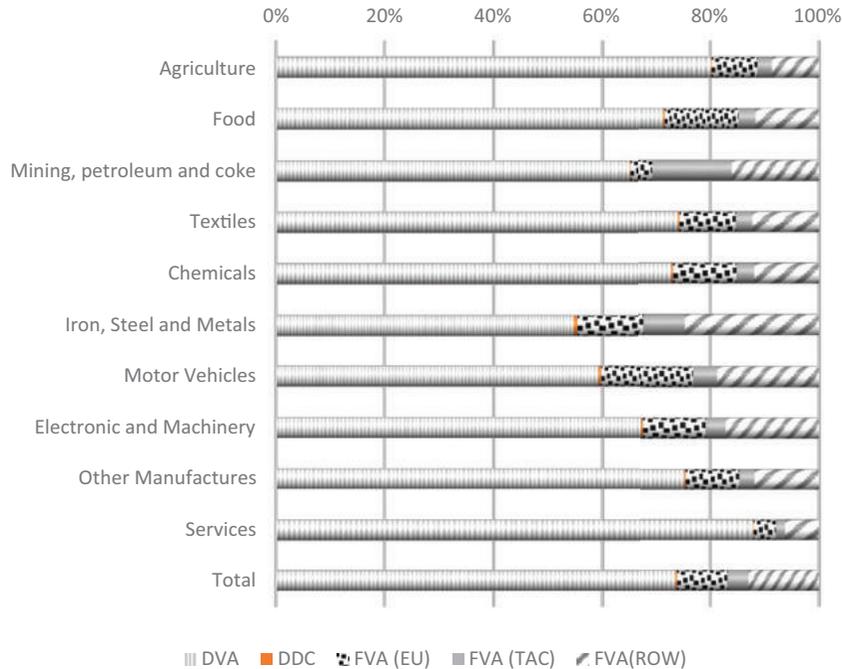
While backward linkages look at the foreign content embedded in UK exports, forward linkages look at where UK domestic VA is absorbed, and capture the value contained in UK inputs sent to third economies for further processing and export through the value chain. Accordingly, a second indicator of the UK's integration with the EU is this so-called multilateral VA, i.e. the UK domestic value added reaching its final destination through an intermediary importer/exporter. This trade is summarized in Figure 3. It amounts to \$165 billion in the base period (about 24 per cent of total UK exports), of which \$90 billion (55 per cent) passes through an EU intermediary. This shows the importance of 'Factory Europe' as a hub for UK firms to reach export markets, even those outside the EU.¹⁴

VI. Results

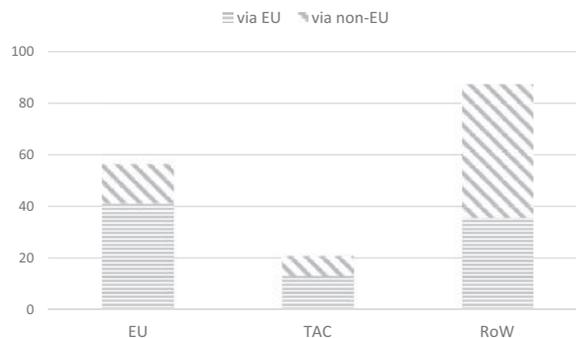
We analyse the effects of the Agreement relative to the 2019 baseline. The TCA avoided the tariffs on UK–EU trade implied by a 'No Deal' Brexit.¹⁵ Nonetheless, the increased costs that UK and EU traders face when they trade with each other will reduce mutual trade and increase trade with other partners. The net effect on the UK will be an overall decline in trade.

¹⁴ These aggregates are calculated at the level of our ten geographical groups. Hence, they are underestimates because they refer to aggregates of countries. Thus, for example, UK exports to Brazil that are embodied into Brazilian exports to Peru do not show up here as multilateral value added because Brazil and Peru are part of the same geographical grouping in our statistics. Likewise, for exports to Denmark that are embodied in exports to Sweden. The figure averages our groups into three summary blocs.

¹⁵ We have discussed the costs of 'No Deal' and the benefit of (an estimate of) the TCA relative to 'No Deal' in our previous Briefing Papers (Fusacchia *et al.*, 2019, 2020). The current version offers a number of improvements relative to those estimates.

Figure 2: UK's exports, 2019: value added composition by sector.

Source: Authors' simulations using the GTAP-VA model.

Figure 3: UK's multilateral exports 2019 by market (columns) and intermediary (\$ billions).

Source: Authors' simulations using the GTAP-VA model.

(i) The effect on aggregate trade flows

Figure 4 reports the estimated percentage changes in UK trade in terms of both gross value and domestic value added (incomes created in the exporter). UK exports of both to the EU decline by over 35 per cent and imports from the EU by almost 40 per cent, while exports to elsewhere increase by at least 16 per cent and imports by around 10 per cent.

For exporters, there are no changes in market access beyond the EU, but the loss of EU sales will induce them to seek, and have the capacity to supply, greater sales elsewhere. For imports, all non-EU suppliers will become relatively more competitive in the UK as EU firms start to face more barriers. Overall, the extra-EU trade flows do not fully compensate the EU ones, so total exports fall by 7.9 per cent and imports by 14.2 per cent.

The comparison between the changes in gross and value-added export flows shows that the latter register smaller reductions and larger increases. This is because, following Brexit, UK exports will include a lower share of foreign value added as a consequence of the weakening of the UK's economic integration with the EU. The shortening of the European value chains implies a higher share of UK value added embedded in extra-EU exports. Overall, there is a decrease in domestic value added exports (−6.3 per cent) and an even larger decrease for imports (−13.7 per cent).

All sectors register declines in exports of value added to the EU of at least 30 per cent and increases to other markets. The biggest proportionate losses in exports to the EU are predicted to be in food, mostly affected by higher NTMs, and in textiles and motor vehicles, which face relatively large increases in NTMs and the cost of ROOs.¹⁶ The smallest proportionate fall is in services.

(ii) Value-added trade and global value chains

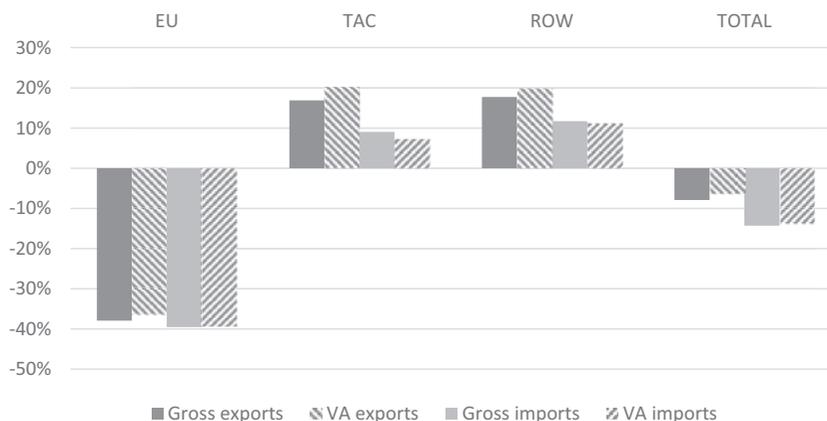
Table 2 looks more closely at how the loss of exports as usually measured (gross exports) is allocated across sources of value added (income). Column [1] reports the decline in each sector's gross exports. All sectors register a reduction to the EU and only in iron, steel, and metals is this offset by increased exports to non-EU markets, mostly the TAC countries.¹⁷ Gross exports are comprised of foreign and domestic value added (columns [2] and [3], respectively) plus a small amount of so-called double-counted value added (0.3 per cent of gross exports in all), which is not reported in the table.¹⁸

Of the domestic value added, some is provided by the sector itself [4] and some by other UK sectors via intermediate inputs [5]. For example, of the \$9.0 billion decline in UK motor vehicles exports, \$4.7 billion is of foreign value added (because the foreign share is large and there is some substitution against foreign inputs) and \$4.1 billion of UK value added. Of the latter, only \$2.7 billion comes from the vehicles sector itself and \$1.4 billion from other UK sectors (so-called indirect exports). These losses of indirect exports are important in policy terms: they arise not because of the barriers raised against the source sectors' exports but because of those applied to motor vehicles. In three other sectors, on the other hand, although gross exports fall, the replacement of foreign intermediate inputs by domestic inputs means that they actually increase the

¹⁶ Recall also that each of the sectors reported here is an aggregation from the finer GTAP classification at which the modelling is done. Hence what we have nicknamed 'motor vehicles' combines motor vehicles and other transportation (mainly ships and planes).

¹⁷ Exports increase even though the TAC countries' barriers to UK exports remain unchanged, because the UK becomes more competitive via what is effectively a decline in the real exchange rate.

¹⁸ Double-counted value added is explained in Fusacchia *et al.* (2019).

Figure 4: Changes in UK bilateral imports and exports (%).

Source: Authors' simulations using the GTAP-VA model.

value added from other sectors that they channel abroad—e.g. ‘Other manufactures’ (\$0.4 billion).

Column [6] collects up these indirect exports in a different way; for each sector, it presents the exports of value added that it makes via other sectors. Due to the increase in gross exports of Metals, a sector which is an important supplier of that industry's intermediate goods such as Electronic and Machinery shows a significant increase in indirect exports (\$1 billion). However, the large declines in gross exports of goods reduce the overall total of indirect exports. In this respect, the most negatively affected sector is Services (−\$8.4 billion) because services inputs are used so widely throughout industry.¹⁹

Column [7] is the sum of the change in direct VA exports (column [4]) and the change in indirect VA exports (column [6]). Accordingly, it shows the loss of export-related income for each sector, and it is quite different in size and distribution from the loss of gross exports in column [1]. For example, due to the indirect impact, the loss in the UK Services sector's total exports of value added (−\$17.8 billion) is significantly larger than the reduction in gross exports (−\$12.7 billion). The opposite is true of Electronics and Machinery, which has a loss of \$4.5 billion in gross exports, but one of only \$0.4 billion in exports of value added. On the other hand, Iron, Steel, and Metals' exported value added (\$1.7 billion) increases by less than gross exports (\$2.9 billion) because the latter includes the increase in the value added provided by other sectors (\$1.2 billion). Overall, the losses in value-added terms show more dispersion than those in gross exports. That is, once we move from considering gross exports to considering the sectors and people contributing to their value, the costs of Brexit are spread more widely.

The decline in foreign value added in column [2] of Table 2 demonstrates how Brexit erodes global value chains (GVCs). It arises from both the reduction of UK gross exports, which implies lower demand for inputs and the reduction in the share of foreign value in the total value of exports, displaced by UK value added. The loss is

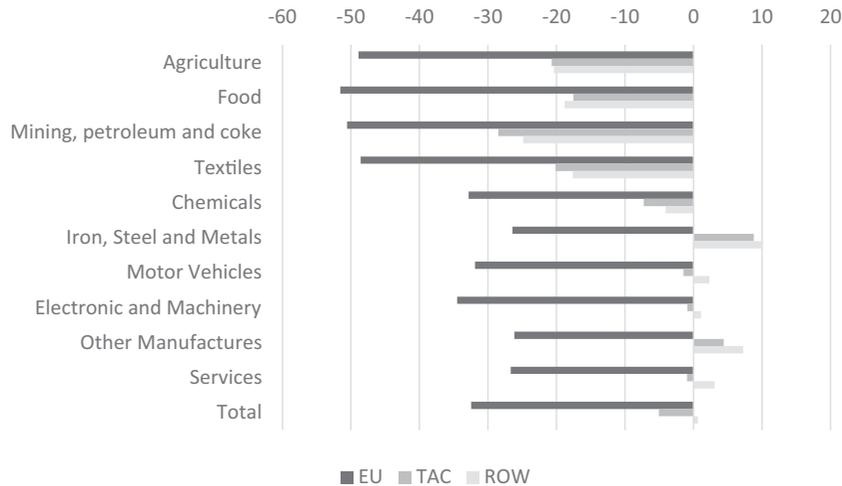
¹⁹ These indirect exports are sometimes known as Mode 5 service exports, as discussed by Borchert and Tamperi (2018).

Table 2: Change in exports, gross and value added (\$m, relative to 2019 base-line values, 2014 prices)

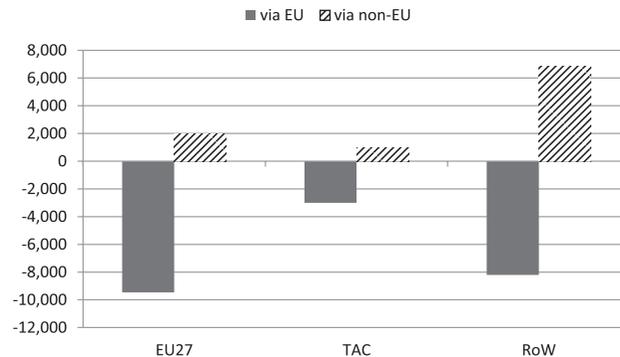
	Gross exports [1]	FVA [2]	DVA			Indirect exports of		Exported VA [7]
			Total [3]	Own sector [4]	Other sectors [5]	DVA [6]		
Agriculture	-1,599	-356	-1,234	-830	-404	-333	-1,163	
Food	-8,346	-2,664	-5,627	-2,847	-2,780	-63	-2,911	
Mining, petroleum, and coke	-9,119	-3,272	-5,826	-4,398	-1,429	52	-4,346	
Textiles	-3,300	-998	-2,284	-1,573	-711	-8	-1,581	
Chemicals	-9,408	-3,887	-5,400	-3,877	-1,523	324	-3,553	
Iron, steel, and metals	2,867	-90	2,969	1,704	1,265	81	1,785	
Motor vehicles	-8,961	-4,727	-4,077	-2,696	-1,381	56	-2,640	
Electronic and machinery	-4,458	-3,097	-1,270	-1,347	77	973	-374	
Other manufactures	-100	-442	362	-46	408	28	-18	
Services	-12,673	-2,364	-10,222	-9,399	-823	-8,412	-17,811	
Total	-55,096	-21,898	-32,610	-25,309	-7,301	-7,302	-32,611	

Note: The totals in columns [3] and [7] and in columns [5] and [6] differ only because of rounding.

Source: Authors' simulations using the GTAP-VA model.

Figure 5: Providers of foreign value added (FVA) in UK's exports (% changes).

Source: Authors' simulations using the GTAP-VA model.

Figure 6: UK multilateral DVA exports, TCA scenario (\$ million, relative to 2019 base-line values, 2014 prices).

Source: Authors' simulations using the GTAP-VA model.

concentrated on value added from the EU, which falls by more than 30 per cent—see [Figure 5](#). These declines show that Brexit will have a major impact in terms of GVC reduction and restructuring, and it is worth noting that such a reshuffling of suppliers will be much more dramatic—and hence more costly—at the firm level than at the level of our aggregated sectors.

By the same token, the reduction in the competitiveness of UK inputs in EU markets for intermediates will also reduce UK multilateral value-added exports—that is, exports of UK value added to one foreign country via transformation in another. UK value added reaching one EU country after transformation in another will decline by \$9.5 billion and that reaching TAC and ROW destinations via the EU by another \$11.2 billion in total—see [Figure 6](#). The loss of the market for intermediates in the EU allows

(and incentivizes) UK firms to supply more to producers elsewhere in the world—\$9.8 billion in all. Thus, in this dimension also we see how Brexit erodes global value chains.

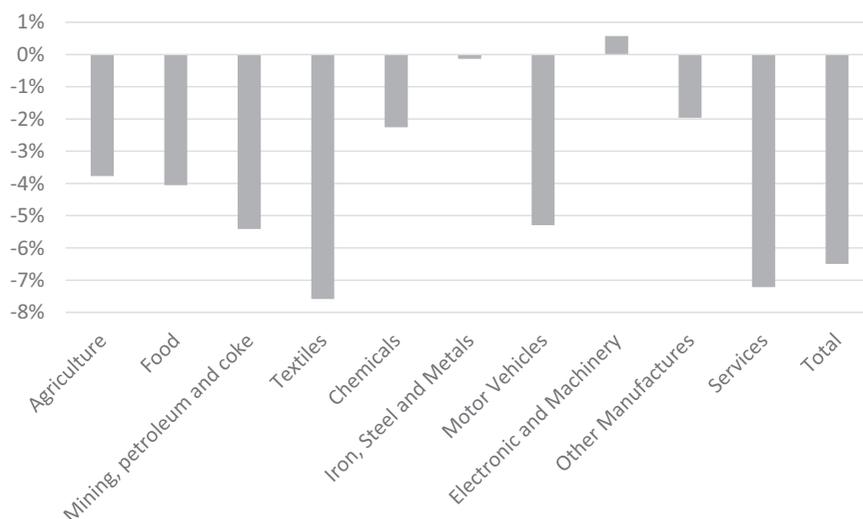
(iii) Total value added and welfare

In [Figure 7](#), we report the changes in overall value added by sector in percentage terms: that is, changes in the incomes that the sectors generate. The largest proportionate declines of income are in Textiles (−7.6 per cent), Motor Vehicles (−5.3 per cent) and Services (−7.2 per cent), the last driven as much by indirect export losses as by the direct loss of exports or consumption. At the industry level, at which the analysis is conducted, some industries suffer from the loss of exports—e.g. Textiles and Motor Vehicles—while others are mainly hit by the decline in the domestic market, as in the case of Metals.

While this paper is about trade and output changes, much of the literature is expressed in terms of macroeconomic outcomes—GDP, consumption, etc. For reasons spelled out in the [Appendix](#), our static multi-country model is not well set up to model these, but we can shed light on two elements of them. An assumption of the model is that all displaced workers and equipment get re-employed somewhere, so that, absent changes in technology (which we do not include), the consequences for consumption and welfare are driven by changes in allocative efficiency and the terms of trade, which we present in [Table 3](#).

The new border costs reduce allocative efficiency both in UK and EU. The negative impact is proportionately much larger for the UK than the EU because UK–EU trade accounts for a larger proportion of UK aggregate production and consumption than of EU aggregate production and consumption, making adjustment in the UK harder and more costly. The other countries do not change their trade policies, but these policies have a different and slightly less distorting impact due to the TCA: because the TCA reduces their mutual trade, the UK and EU are keener to increase

Figure 7: Change in total UK value added (% change).



Source: Authors' simulations using the GTAP-VA model.

Table 3: Welfare changes (\$ billion, relative to 2019 base-line values, 2014 prices) and as percentage of private consumption

	Allocative efficiency, \$ billion	Terms of trade, \$ billion	Total \$ billion	Total as % of Consumption
UK	-18.1	-31.2	-49.3	-2.40
Germany	-2.5	-0.7	-3.2	-0.15
Italy	-0.6	-0.3	-0.9	-0.07
France	-1.7	-1.4	-3.1	-0.19
Rest of EU	-7.4	-2.5	-9.9	-0.25
TAC	0.8	7.0	7.8	0.15
Japan	0.0	1.6	1.6	0.06
US	0.6	8.1	8.6	0.07
China	2.5	6.0	8.5	0.18
ROW	2.5	12.6	15.1	0.12

Source: Authors' simulations using the GTAP-VA model.

their exports to other countries and this reduces the distortion cost of the tariffs that the latter impose on their imports. Similarly, because the UK and the EU now import more from other countries than previously, the allocative burden that their exporters feel because UK and EU tariffs reduce their exports below optimum levels is reduced.

The extra costs of trade between the UK and the EU also change the rate at which exports can be transformed into imports through international trade, viz the terms of trade. Regional integration can improve the partners' terms of trade relative to the rest of the world (Chang and Winters, 2002), and so undoing it can worsen them. Because the price of exports falls relative to that of imports, UK exports buy fewer imports than they used to by about \$31 billion; the related loss for the EU is about \$5 billion. The EU figure is smaller because the shock is proportionately smaller for them and, therefore, they have less pressure than do UK firms to reduce their prices in order to try to mitigate the losses of exports. Such changes in the terms of trade are straight transfers of welfare from the UK and the EU to other countries. Together, the efficiency and terms-of-trade losses reduce the amount available for consumption/investment/government by about 2.4 per cent of total UK base-line private consumption.

VII. Sensitivity tests

As we noted above, the main determinants of the outcome of a trade policy change such as Brexit are the structure of trade and production in the base period and the predicted increases in the costs of UK–EU trade. The structures are based on detailed data from 2014 projected forward to 2019, but they are necessarily rather aggregated. Most policy and all production decisions in an economy are made at far lower levels of aggregation than can be included in any model. Turning to trade costs, these are estimates: even *ex post*, economists have found it difficult to estimate trading costs precisely and our problem is to project them *ex ante* in a policy shock the like of which has never been seen. Moreover, we have not included any future developments in trade policy including carbon border adjustments and the possible growth of ‘murky protection’,

Table 4: Sensitivity analysis: impact on UK of different changes in NTMs (% difference from base)

			(A)		(B)		(C)	
			Goods and services		Goods alone		Services alone	
Change in NTMs on:			-50%	50%	-50%	50%	-50%	50%
Central			Changes relative to base (%)					
Exports	Total	-7.9	-5.4	-9.4	-5.7	-9.3	-7.6	-8.0
	Goods	-9.6	-7.1	-11.0	-4.2	-13.3	-12.4	-7.3
	Services	-4.9	-2.5	-6.5	-8.2	-2.2	0.8	-9.2
Imports	Total	-14.2	-9.0	-18.1	-10.3	-17.2	-12.9	-15.2
	Goods	-13.9	-8.9	-17.6	-9.3	-17.2	-13.4	-14.2
	Services	-15.4	-9.3	-19.9	-13.4	-17.0	-11.3	-18.2
Value added	Total	-6.5	-3.9	-8.6	-4.9	-7.8	-5.5	-7.2
	Goods	-2.6	-2.0	-2.8	-1.1	-3.6	-3.5	-1.8
	Services	-7.2	-4.3	-9.6	-5.6	-8.6	-5.9	-8.2

Source: Authors' calculations.

such as implicit or explicit subsidies, changes to public procurement rules, 'Buy British' campaigns, etc.

To give a feel for the magnitude of this uncertainty, we have conducted some additional simulations with different levels of trading costs. They involve solving the model again with all UK–EU trade barriers either 50 per cent smaller than our central case or 50 per cent larger, and then with the same changes applied to goods and to services separately. Table 4 summarizes the result for three sets of aggregates—exports, imports, and value added. Four features deserve note. First, nothing changes qualitatively. Second, the model shows slightly smaller effects as we increase the level of the new NTMs in equal steps from zero (i.e. the base) to 50 per cent of our assumed values, from there to 100 per cent and from there to 150 per cent: for exports when all NTMs change (columns A), the increments are -5.4 per cent, -2.5 per cent, and -1.5 per cent, respectively. (Recall that these are changes in trade, not the welfare costs of trade barriers which we expect to increase more than proportionately with the height of the barriers.) Third, nonetheless, the curvature is sufficiently slight that, for values between our benchmarks, linear interpolation would not be misleading—e.g. the effect on exports of NTMs at 75 per cent of our assumed values would be approximately halfway between -5.4 per cent and -7.9 per cent = -6.6 per cent.

Finally, blocks B and C of Table 4 illustrate the general equilibrium effects captured by our model. If we reduce goods NTMs alone relative to our central simulation (Block B), exports of goods are higher and those of services lower than the central case. Conversely for reductions in services NTMs alone. However, because the main driver of imports is incomes, any reduction in NTMs anywhere makes imports higher. For value added the story is more complex: reducing services barriers alone reduces the predicted decline in services value added and increases that of goods. However, when reducing goods NTMs alone this rivalrous effect is more than offset by the fact that services provide many inputs into goods production and both sectors record smaller declines than the central case.

VIII. Conclusion

These estimates derive from a fairly standard computable general equilibrium modelling exercise into which we have put quite careful estimates of changes that the TCA implies in several of the costs incurred in trading with the EU. Care notwithstanding, these estimates are themselves uncertain and so one must treat the overall estimated effects of the TCA with caution. However, we are confident of the broad magnitudes, and certainly the sign, of the overall estimate. Even 6 years after the start of the Brexit debate, there is still no convincing account of economic benefits of Brexit.²⁰

Our results suggest that Brexit as encapsulated in the trade component of the UK–EU Trade and Cooperation Agreement (TCA) will reduce UK trade significantly: in gross terms UK exports will fall by 7.9 per cent and imports by 14.2 per cent, and in value added terms by 6.3 per cent and 13.7 per cent, respectively. In terms of overall value added, the deepest effects are in textiles and vehicles, both of which trade extensively with the EU, and services which trade significantly with the EU, face large increases in trade barriers, and suffer from the decline in demand from other sectors as they, in turn, lose exports. The UK reduces its integration with the European economy considerably—that is, regional value chains contract. Overall, the analysis of the value-added structure of UK trade flows makes clear that the consequences of Brexit are going to be broader and more far reaching than acknowledged by traditional assessments in terms of gross trade changes.

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²⁰ See, for example, the latter part of the discussion in the UK Trade and Business Commission’s first meeting (<https://www.tradeandbusiness.uk/events/session-1>)

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